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A PRACTICAL TREATISE

ON

MECHANICAL DENTISTRY.

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BY

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THIRD EDITION,

REVISED AND ENLARGED,

WITH

ONE HUNDRED AND EIGHTY-FIVE ILLUSTRATIONS.

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To

JAMES TAYLOR, M.D., D.D.S.,

EMERITUS PROFESSOR OF THE INSTITUTES OF DENTAL SCIENCE IN THE OHIO COLLEGE OF DENTAL SURGERY,

AS AN

ACKNOWLEDGMENT OF PROFESSIONAL EMINENCE AND PRIVATE WORTH,

This Volume is gratefully inscribed,

BY

HIS FRIEND AND FORMER PUPIL,

THE AUTHOR.

PREFACE TO THIRD EDITION.

In responding to the demand made for a third edition of the present work, the author has subjected the preceding one to a careful and thorough revision, and has endeavored to make it, as nearly as practicable, a faithful reflex of the advanced thought and experience of the profession in all essential matters relating to the facts, appliances, methods, and principles appertaining to the department of prosthetic dentistry.

In this endeavor no attempt has been made to incorporate the almost limitless shades of opinion which prevail among members of the profession concerning methods and appliances, or the almost equal diversity of the latter themselves. Much, therefore, of individual thought, experience, and modes of operating, differing chiefly in the manipulative details by which similar objects and results are sought to be obtained by different practitioners, are necessarily excluded. While there are undoubtedly many appliances and methods of procedure which are approved and meritorious, the limits of the work can admit only those which, in the judgment of the author, are esteemed typical of the best.

In addition to the consideration of new and improved methods and appliances of more recent introduction, as well, also, as conspicuous supplementary matters in connection with the older ones, the reader will find throughout the body of the present work not only interpolations of important facts relating to the minor details of practice, but also careful elimination of such portions of the original text as are believed, on more matured reflection, to be at variance with accepted facts and theories. This is done under the conviction that it is the province of a work like the present to preserve and perpetuate only that which survives the ordeal of experience, and to teach only that which has the sanction and approval of the enlightened judgment of the profession.

As still occupying somewhat middle ground between condemnation and approval, the chapter on Vulcanite Base, with some modifications, has been retained in deference to many who continue to claim for it important advantages as a cheap and convenient base. The growing distrust of its fitness, however, for this purpose, points to the conclusion that, at no distant day, it will be classified among the obsolete processes.

While the reader will share the author's regret that nothing additional appears from the pen of Dr. John Allen in connection with the subject of Continuous Gum Work, by reason of afflictive surroundings which rendered it impossible for him to farther enrich this chapter with the results of his added experience, yet, with the additional practical details relating to this unequalled process obtained from other sources, it is believed the descriptions found embodied in the present volume are exceptionally full and complete.

An additional chapter relating to Celluloid as a base has been introduced, embracing a full and particular account of the most approved appliances and methods of manipulating this material.

A new chapter is also introduced relating to an approved method of recent introduction entitled "Gold Alloy Cast Base," of which Dr. Reese, of Brooklyn, N. Y., is the inventor, and to whom the author is indebted for detailed descriptions and illustrative models.

A distinct chapter has also been assigned to the subject of Porcelain Teeth in connection with Carved Block-work, embracing an interesting account of their composition and manufacture, with reflections upon the æsthetic requirements of prosthetic practice.

A separate chapter has also been given to an account of the method of attaching teeth to a metallic plate base by means of rubber or celluloid, a process of constructing dentures scarcely inferior to that of continuous gum work itself.

The author would especially direct attention to the chapter on Pivoting Artificial Crowns. The conceded importance and superior excellence of this method of substitution will fully justify, it is believed, the large space devoted to its consideration. To the members of the profession whose names appear in connection with the several methods, the author is under peculiar obligations for personal courtesies and indispensable aid in the preparation of descriptive material and accompanying illustrations.

While much valuable matter has thus been added to the present volume, the author has not hesitated to exclude whatever, in his judgment, the common experience of the profession has demonstrated to be impracticable, and therefore useless. Among the omitted matter is the consideration of cast aluminum plate base and other forms of this metal requiring the use of solder as a uniting medium for the attachment of teeth. Long-continued, patient, and intelligent experimentation with this metal as a base has demonstrated its practical inutility, its only exceptional use as such being confined to the process in which the attachment is secured in the manner described in Chapter XVI.

For fuller information on the subject treated of in the concluding chapter, and which could not be extended consistently with the proper limits of a work like the present, the reader is referred to a recently published treatise by Professor Norman W. Kingsley, entitled *Oral Deformities*, a comprehensive work, embracing, among other important matters, an exhaustive consideration of Palatal Defects and their Treatment. The author would commend this invaluable work as the embodied thought and experience of the foremost and most successful practitioner in this department of prosthetic dental surgery in this country or elsewhere; a work which not only enriches, in an eminent degree, the special literature of the dental profession, but adds fame and lustre to American authorship.

In closing, the author desires to express his sense of obligation to those members of the profession who have freely and generously assisted in placing their special methods of operating before the profession through the medium of this work, and also to the representatives of the late Dr. S. S. White, the members of the Celluloid and Buffalo Dental Manufacturing Companies, and others, for needful illustrations and essential information respecting appliances, etc.

Remembering gratefully the many valuable suggestions received during a somewhat extended correspondence with representative members of the profession, and cordially appreciating the many substantial and essential favors voluntarily proffered by individual practitioners, the author, in conclusion, trusts that the present volume, thus enhanced in value by the friendly and helpful assistance of others, will continue to merit the same consideration and approval that have been accorded to former editions.

TERRE HAUTE, IND., September, 1880.

PREFACE TO FIRST EDITION.

In the preparation of the following treatise, the author has endeavored to present, in as concise and methodical a form as possible, the material facts and principles which relate to the Mechanical Department of Dental Practice in its present advanced condition. In the accomplishment of this undertaking, the primary and leading purpose has been to furnish the student and more inexperienced practitioner with a practical guide to the manipulations of the laboratory, with accompanying elucidations of the elementary principles which underlie the practice of this important specialty. In furtherance of this design, all matters, discussions, and commentaries, not strictly material, have been carefully excluded.

The arrangement and treatment of the various subjects embraced are such, it is believed, as will best facilitate the student in the acquisition of a knowledge of the department alluded to, and the practitioner in the intelligent and successful conduction of the manipulations which appertain to this branch of Practical Dentistry.

In the belief that these objects have been mainly accomplished, the work is respectfully submitted to the profession.

J. Richardson.

Cincinnati.

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MECHANICAL DENTISTRY.

PART FIRST.

METALS EMPLOYED IN DENTAL LABORATORY OPERATIONS, WITH PRELIMINARY OBSERVATIONS ON THE DIFFERENT MODES OF APPLYING HEAT.

CHAPTER I.

Different Modes of Applying Heat.

THE application of heat to the various mechanical processes of the dental laboratory would seem to require a brief description of some of the agencies employed for the purpose. As full a description of the appliances used will be introduced as is compatible with the scope of the present work.

BLOWPIPES.

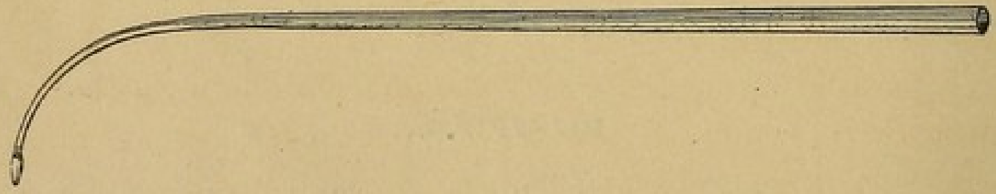
Various modifications in the form of the blowpipe have been introduced from time to time, and are named according to the means used to produce the blast, as *mouth*, *bellows*, *self-acting* or *spirit*, and *hydrostatic* blowpipe.

In addition to the varieties mentioned, there are others used in producing extreme degrees of heat, as the "*oxygen blowpipe*" with which the flame is blown with a jet of oxygen; and another, with which the two gases, oxygen and hydrogen, are burned, called the "*oxy-hydrogen blowpipe.*" The latter is capable of producing a heat that immediately fuses the most refractory substances, as quartz, flint, rock-crystal, plumbago, etc. With it, gold is volatilized, and iron rapidly consumed when placed in the flame; while platinum, next to iridium, the most infusible of all known metals, has been melted in quantities exceeding one hundred ounces by means of this powerful instrument. As, however, these blowpipes are of no special practical utility in the dental laboratory, any further reference to them will be omitted. Nor is it deemed necessary to embrace descriptions of either spirit or hydrostatic blowpipes, as they have fallen of late years almost wholly into disuse.

Mouth Blowpipe.—This instrument has been long in use, is simple in its form and construction, and, for general use in the application of moderate degrees of heat, is both convenient and economical. Those accustomed to its use are enabled to produce a continuous blast of considerable force, and soon acquire the facility of regulating the heat produced with equal if not greater precision than can be readily attained in any other way.

The most simple form of the mouth blowpipe is shown in Fig. 1. It consists usually of a plain tube of brass, larger at

Fig. 1.

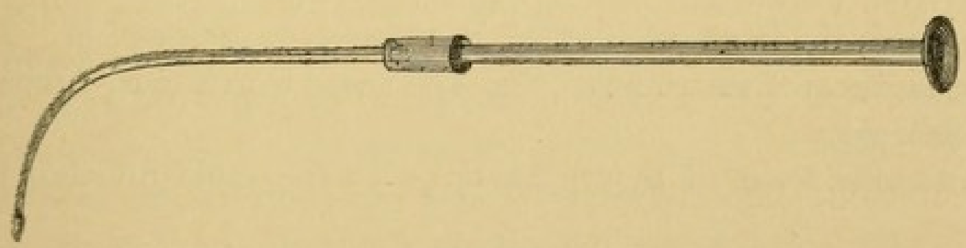


the end applied to the mouth, and tapering gradually to a point at its other extremity, the latter being curved and tipped at the point with a conical-shaped, raised margin, to protect it from the action of the flame; the calibre of the instrument terminates here in a very small orifice. The point of the instrument, as well as that part of it received into the mouth, is sometimes plated with a less oxidable metal than brass, as silver or platinum. The stem is generally from twelve to twenty inches in length, and the mouth extremity from one-half to three-fourths of an inch in diameter.

In operations requiring protracted blowing, a somewhat different form of the instrument will be required, owing to the accumulation of moisture within the tube, which, being forcibly expelled from the orifice, spirts upon whatever is being heated and interrupts the blast; also, on account of the fatigue which in process of time renders the muscles of the mouth and face engaged in the act to a great extent powerless.

The difficulties mentioned may be obviated, in a great measure, by applying the form of blowpipe represented in Fig. 2. To the mouth extremity is attached a circular concave flange or collar which receives and supports the lips. To the shaft, near its curved extremity, is adjusted either a spherical or

FIG. 2.



cylindrical chamber which collects and retains the moisture as it forms within the pipe. By allowing that part of the tube connected with the curved end to pass part way into the chamber, a basin is formed at the depending portion of the latter, which, by collecting the fluids, will effectually prevent them from overflowing and passing into the tube beyond.

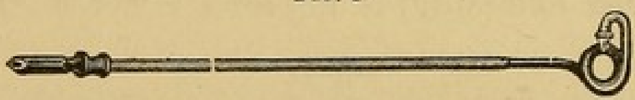
Thomas Fletcher, of Warrington, England, has introduced modifications in the construction of mouth blowpipes, which are unquestionably improvements upon the simpler forms just described.* One form, styled the hot-blast mouth blowpipe,

* The several appliances embraced in the above chapter, and designated by the Figures 3, 4, 5, 6, 8, 9, 11, 15, 16, 17, 18, 19, are such portions of Fletcher's heating apparatus as are more especially adapted to the work of the dental laboratory, and are believed to possess peculiar and unequalled advantages in the application of heat for dental purposes. For the illus-

is shown in Fig. 3. The improvement in this instance consists in coiling the air-tube into a light spiral over the point of the jet. This coil takes up the heat which would otherwise be wasted, and utilizes it by heating the air in its passage. It is claimed that with the use of this instrument much higher temperatures are reached than is possible with the ordinary blowpipe, and that with the same amount of blowing nearly double the work is accomplished, while, if a high heat is not

FIG. 3.

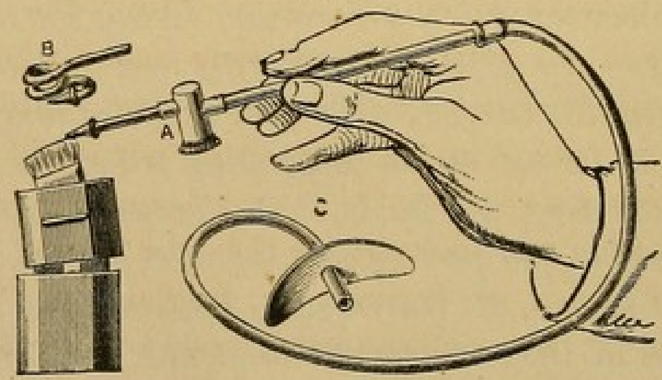
FIG. 4.



required, the labor of blowing is reduced in proportion. A similar form of instrument (Fig. 4) is made with a hard-rubber mouth-piece.

Another form of mouth blowpipe by the same inventor is

FIG. 5.



exhibited in Fig. 5. It will be seen to be wholly unlike any mouth blowpipe yet devised, and admits of great latitude of

trative cuts above alluded to, the author is indebted to the Buffalo Dental Manufacturing Company, sole manufacturers of Fletcher's heating apparatus in this country.

movements in the application of heat. The form of the mouth-piece is especially adapted to continued blowing without strain on the lips, while the opening is well under the control of the tongue. The blowpipe proper is held as a pencil, the chamber collecting condensed moisture and preventing the passage of heat up to the end. The instrument can be readily changed from a cold to a hot-blast blowpipe by substituting the coil (B) for the plain jet or tip.

There are other allied forms of the mouth blowpipe, but as they are constructed more especially for chemical examinations or analyses, and as they possess no advantages for dental purposes over those already mentioned, a description of them is not deemed necessary.

In the production of heat by the use of the mouth blow-pipe, either an oil or alcohol lamp, or the gas flame may be employed, and these will generally be found sufficient when only moderate degrees of heat are required. When gas is used, the ordinary gas-jet should be inclosed within a tube of copper, or other metal not easily oxidized, two or three inches in length and extending some distance above the point of the jet. This tube or funnel should be perforated near its base at a number of points for the free admission of air, which will insure more perfect combustion of the gas, augment the heat, and provide against carbonaceous deposits upon the substances submitted to the action of the flame.

Mechanism Involved in the Act of Producing a Continuous Blast with the Mouth Blowpipe.—As a steady continuous current of air from the blowpipe is preferable to the interrupted jet, in all those operations where it is desired to produce a steadily augmenting heat, the following remarks explanatory of the method of producing it are subjoined, in the belief that they will render easier a process not always readily acquired.

"The tongue must be applied to the roof of the mouth, so as to interrupt the communication between the passage of the nostrils and the mouth. The operator now fills his mouth with air, which is to be passed through the pipe by compressing the muscles of the cheeks, while he breathes through the nostrils, and uses the palate as a valve. When the mouth becomes nearly empty, it is replenished by the lungs in an instant, while the tongue is momentarily withdrawn from the roof of the mouth. The stream of air can be continued for a long time without the least fatigue or injury to the lungs. The easier way for the student to accustom himself to the use of the blowpipe, is first to learn to fill the mouth with air, and while the lips are kept firmly closed to breathe freely through the nostrils. Having effected this much, he may introduce the mouth-piece of the blowpipe between his lips. By inflating the cheeks, and breathing through the nostrils, he will soon learn to use the instrument without the least fatigue. The air is forced through the tube against the flame by the action of the muscles of the cheeks, while he continues to breathe without interruption through the nostrils. Having become acquainted with this process, it only requires some practice to produce a steady jet of flame. A defect in the nature of the combustible used, as bad oil, such as fish oil, or oil thickened by long standing or by dirt, dirty cotton-wick, or an untrimmed one, or a dirty wickholder, or a want of steadiness of the hand that holds the blowpipe, will prevent a steady jet of flame. But, frequently, the fault lies in the orifice of the jet, or too small a hole, or its partial stoppage by dirt, which will prevent a steady jet of air and lead to difficulty. With a good blowpipe, the air projects the entire flame, forming a horizontal, blue cone of flame, which converges to a point at about an inch from the wick, with a larger, longer, and more luminous flame enveloping it, and terminating at a point beyond that of the blue flame."*

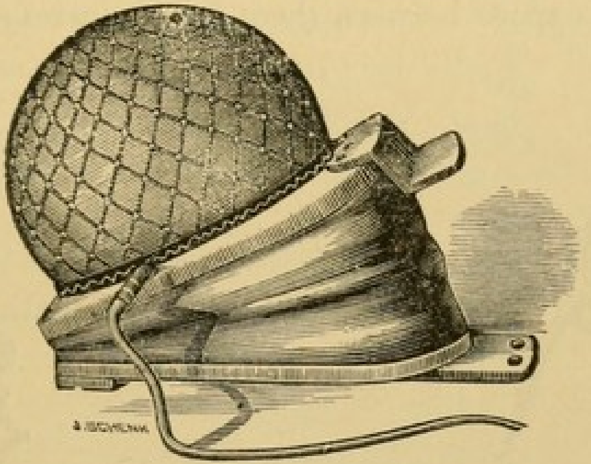
Bellows Blowpipe.—There are many processes of the dental laboratory requiring the application of a higher temperature than is obtainable with the mouth blowpipe. A more powerful and persistent air-blast is readily produced with a bellows or foot blower, used commonly in connection with a burner of suitable form attached to the common gas pipes, by means of

* The Practical Use of the Blowpipe.—*Anon.*

which the gas is furnished with the oxygen required for its combustion in a state of intimate mixture.

A simple and compact form of bellows or foot blower is shown in Fig. 6. The pressure obtainable with this instrument is continuous, equable, and completely under the control

Fig. 6.



of the operator, but the current may be greatly increased in power after the rubber disc is distended until forced against the net.

A contrivance, essentially different in its construction from the ordinary bellows, employed to produce the air-jet, is shown in Fig. 7, and is known as the "Burgess Mechanical Blowpipe." When in use, the air is drawn into a cylinder and condensed in an air-chamber, ready to be used in large or small quantities, at the will of the operator, by a rapid or slow movement of the treadle. When operating, place the entire foot upon the treadle, so that an easy rocking motion is obtained; by pressing the toe downwards air is drawn into the cylinder, and in reversing the motion it is driven into the air-chamber above. The pipe outlet is much smaller than in the mouth blowpipe, to enable a pressure to be obtained, which is increased or diminished by a quick or slow motion of the treadle. The air-chamber is easily filled, and when so a constant supply of pure air is at the control of the operator.

The blowpipes used in connection with the bellows are of various forms. Fig. 8 represents one form of apparatus employed in the application of the air-blast to the gas-flame.

A movable gas-jet attached to two short arms of an ordinary gas-pipe is made to receive within it the blowpipe point connected with the rubber tube, the air-tube terminating a little within the open mouth of the gas-jet; it is thus a tube within a tube, with a space between them for the admission and pas-

FIG. 7.

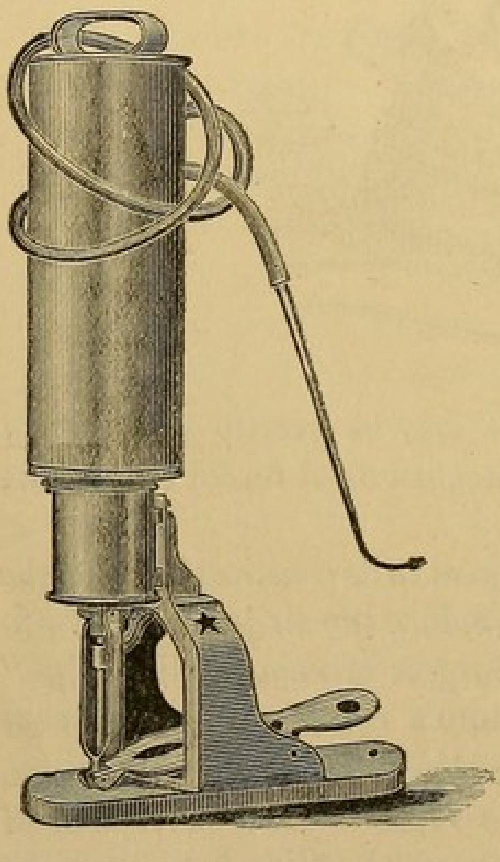
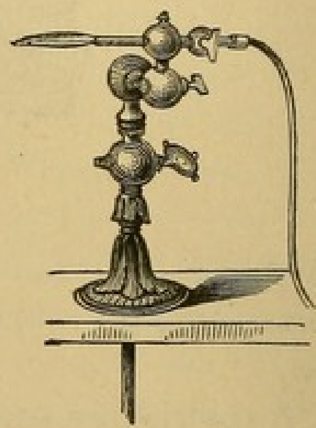


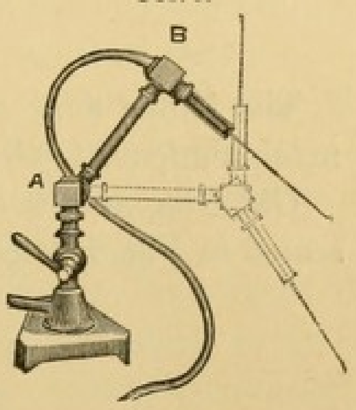
FIG. 8.



sage of gas. The gas, being admitted by turning the tap connected with the gas-pipe, is ignited, when the current of air from the bellows will strike the centre of the flame and project it upon whatever is to be heated. The connected portions of the air and gas jets are so attached to the main pipe as to admit of an upward and downward motion, while the volume of gas and air is readily graduated by the stop-cocks attached to the air and gas tubes.

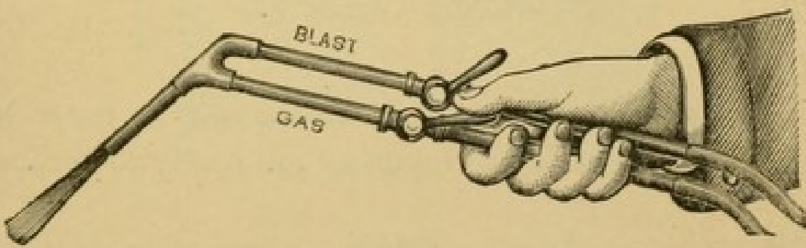
A bellows blowpipe, constructed on similar principles, but admitting of greater latitude of movements, is exhibited in Fig. 9. As will be readily observed, it is capable of being adjusted in any desired position. The jet tube may be raised or lowered to any height, and turned in any direction. A touch will direct the flame on any point while the blowpipe stands in the same position on the table; there being no necessity for raising, lowering, or adjusting work before it.

Fig. 9.



A very convenient, manageable, and effective instrument, for many purposes requiring the application of heat in the dental laboratory, is the hand blowpipe shown in Fig. 10. It is capable of producing very high degrees of heat, but the intensity of the latter may be graduated at the will of the operator, as the stop-cocks, which are both under perfect control of the thumb of the hand which holds the blowpipe, regulates the supply of gas, and controls the volume of air. The air-jet is one-eighth inch bore, and requires a supply from a bellows.

Fig. 10.



The several forms of bellows blowpipes introduced here are the most complete and efficient yet devised for dental purposes. The jet may be elevated or depressed at will, while the force of the air-current and the volume of gas-flame can as readily be increased or diminished. The operator is thus enabled, with the greatest ease, to produce a heat adapted to the most delicate operations, or to instantly change it to a heat so intense that pure gold in considerable quantities is almost immediately fused in the flame. They are, therefore, well adapted to all operations in the laboratory, but will be found of special utility in the construction of work requiring pure gold as a solder.

LAMPS.

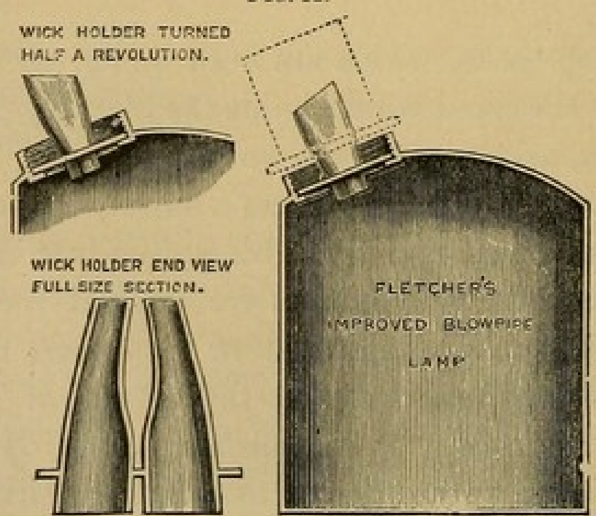
The lamps most commonly used by dentists in blowpipe manipulations are oil and spirit lamps.

Oil Lamp.—When oil is burned, the form of lamp represented in Fig. 11 may be used. It should hold from one to

FIG 11.

two pints, and should have a spout one inch or more where it joins the body of the lamp, tapering gradually to three-fourths

FIG. 12.

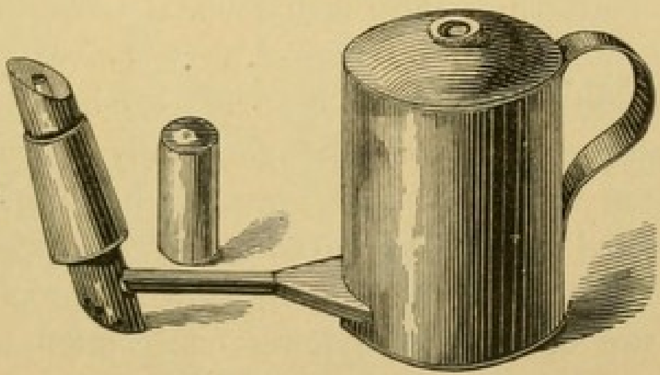


of an inch at the top. The spout should be well filled with wick, but not so tightly as to prevent it from being freely saturated. The best combustible is pure sweet oil, but common lamp or lard oil is generally employed and answers every practical purpose. The wick should be kept well cleaned and trimmed, and fresh oil should be substituted whenever that in use becomes thickened by dirt or otherwise deteriorated.

A somewhat novel form of oil lamp is shown in Fig. 12. The wick-holder is not only of unique design, but can be adjusted to any desired angle by simply revolving it in the fixed collar. The wick-holder lifts out for refilling.

Spirit Lamp.—Alcohol is preferred by many on account of its greater cleanliness, although it does not afford so great a heat as oil. When spirit is employed, a somewhat different form of lamp should be used. With one like that described

FIG. 13.



for oil, there is danger of explosion in the event of the flame, mixed with air, communicating with the alcohol contained in the lamp, and which is more liable to happen when the spout is but loosely filled with wick. To provide against such casualty, it is not unusual to pack the wick too closely, which, by obstructing the flow of alcohol into the spout, lessens the heat of the flame. The proximity of the flame, also, to the body of the lamp, produces undue waste of alcohol by evaporation.

The objections stated may be obviated by employing a lamp of the form shown in Fig. 13. With a lamp like that represented, the spirit is entirely uninfluenced by the heat of the flame, while explosion is rendered impossible. The centre of the upright portion of the spout is traversed by a small tube extending throughout, and open at both ends to admit of the application of a jet of air to the lower orifice, impelling the flame from the centre and thereby intensifying the heat. Around this central tube the wick is arranged; the space occupied by the latter communicating with the body of the lamp through the horizontal arm of the spout.

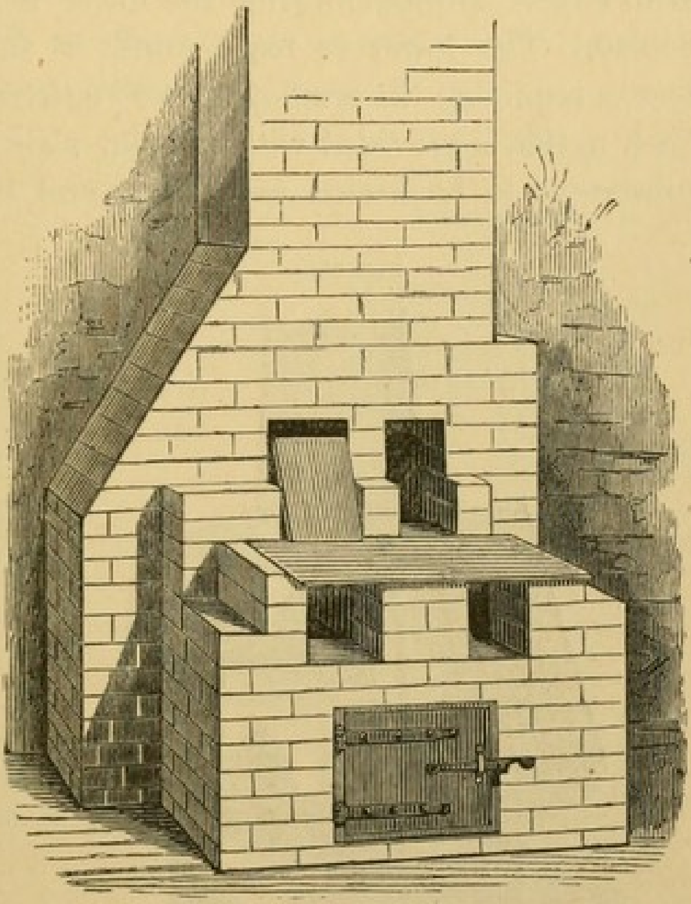
FURNACES.

It would be inconsistent with the design of the present work to introduce a description of any forms of furnace other than those of practical use to the dentist. Many of those used in the arts, or for chemical and pharmaceutical purposes, embrace almost endless varieties, and have no special adaptation to the uses required of them in the dental laboratory.

Draught or Wind Furnace.—A very convenient, portable and economical furnace may be made of sheet iron, of any desired shape or dimensions, though usually of small size, and cylindrical in form. A light grate, or heavy piece of sheet iron, perforated with holes to admit of the passage of air, should be adjusted near the bottom, while above and below the grate are two openings, the lower one communicating with the ash-pit, and the upper one for the introduction of fuel and substances to be heated. By surmounting this simple apparatus with a pipe, or connecting it with the flue of a chimney, it will be found efficient in many of the minor operations of the shop, as melting metals, heating pieces preparatory to soldering, annealing, etc.

A more durable and serviceable draught furnace, however, may be built of masonry, a convenient form of which is represented in Fig. 14. The construction of this stationary fixture is so plainly exhibited in the cut that any extended description of it is deemed unnecessary. The upper holes represent the entrance to the fire-chambers, which are distinct from each other; the lower ones communicate with the ash-pit, which is common to both chambers. Two fire apartments are here shown; one for melting and refining the more precious metals, heating up operations for soldering, etc.; the other being used exclusively for fusing the baser metals, as zinc, antimony, lead,

Fig. 14.



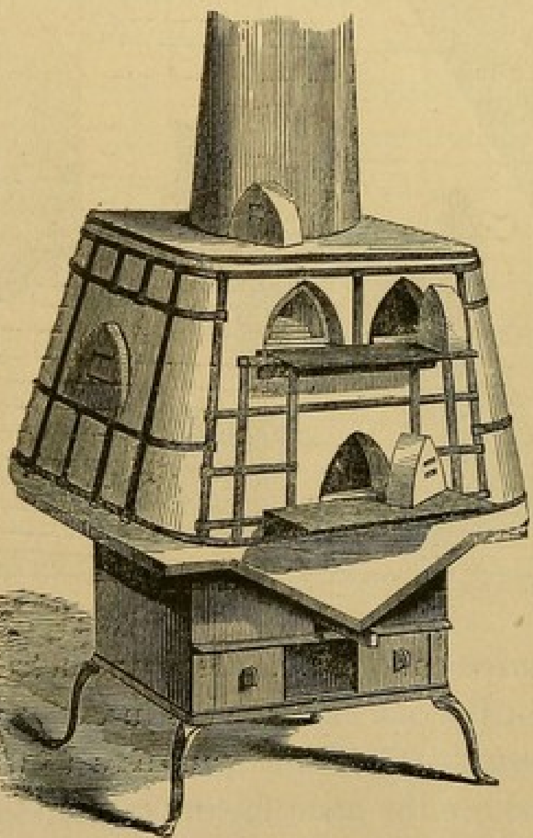
etc. These furnaces are sometimes constructed with a single fire-chamber, but the one exhibited is in every way preferable.

Baking Furnace.—The chief purposes to which these furnaces are applied are the manufacture of porcelain teeth, single and in sectional blocks, the preparation of silicious compounds, and the construction of what is known as "continuous gum work." The most recent and approved form of this furnace is exhibited in Fig. 15.

The body of the furnace rests upon a cast-iron framework or basement, which serves the purpose of an ash-pit. The grate immediately over this inclines from each side of the furnace toward the bottom and the centre of the ash-pit, to afford more ample room for fuel directly underneath the lower muffle.

The upper portion or body of the furnace is made of fire-clay, and contains three muffles arranged horizontally; the upper two, termed "annealing muffles," are designed more especially for drying substances, partial heating preparatory to final baking, and to receive substances from the lower muffle to be gradually cooled. The lower or main muffle is for general baking purposes requiring the employment of extreme degrees of heat. Each muffle is provided with fire-clay slabs or slides, on which substances to be heated are placed and introduced

FIG. 15.



into the muffles; and also plugs of the same material to close the openings to the former. Openings are made on each side of the furnace, intermediate between the muffles, for the introduction of fuel, and to afford ready access to the latter with tongs or other implements. These entrances are also provided with plugs, which are applied during the process of heating. This furnace should be connected with a flue having a strong and unobstructed draught.

Gas Furnace without Blast.—Fig. 16 represents a small crucible furnace, that will be found very convenient for melting and refining the precious and more infusible metals employed by the dentist. It takes crucibles up to $2\frac{1}{2}$ by $2\frac{1}{4}$ inches outside, and with a three-foot chimney, will melt copper, gold, silver, etc., in about ten minutes, or cast iron in thirty minutes from the time the gas is lighted.

FIG. 16.

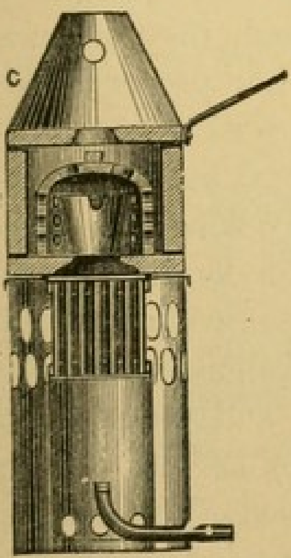
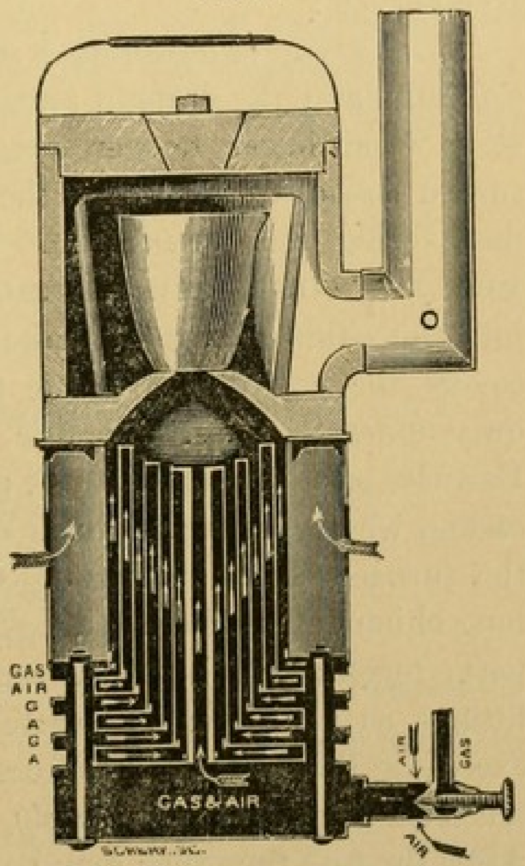


FIG. 17.



The construction of the burner used with this furnace is illustrated by the sectional diagram, Fig. 17, and is thus described. "The gas enters a chamber at the bottom of the burner through a device similar to a Bunsen burner, mixing with air as it enters, and is burned at the upper ends of a series of concentric tubes, furnishing air-spaces alternately with those supplying the mixture of gas and air. The whole burner is constructed of iron, and will be found better able to withstand an intense heat, more durable and quicker in its operation than the old pattern, with gun-metal tubes. In case metal should be spilled into the burner, it can be easily taken apart for its removal.

"Each part of the burner is lettered, and in case of accident, it can be supplied at a small expense, by specifying the letter on the piece desired.

"The burner in its present shape is believed to be the most efficient and economical yet devised for furnace purposes."

The following instructions in the use of this furnace should be observed:

"A chimney or stovepipe 8 or 10 feet high may be used as a fixture, and the draught partially stopped with a damper or slide when lower temperatures are required, the gas being turned down in proportion; the guide for the proper adjustment being that UNDER ALL CIRCUMSTANCES THE FLAME MUST JUST COVER THE CRUCIBLE OR MUFFLE, but not extend into the chimney so as to make it red hot. When the flame covers the crucible or muffle the gas is doing its extreme duty under the most favorable circumstances, without waste. Particles of flux should not be allowed to fall on the fire-clay casing, where the parts touch each other; and the power of the furnace should not be urged too far by the use of very long chimneys, as there is danger of the fusion of the fire-clay parts together so that they cannot be separated. Fire-clay fittings, as a rule, cannot be safely used for temperature much exceeding the fusing-point of cast iron. *Plumbago fittings and crucibles must be heated slowly the first time they are used.* After the first time they may be subjected instantly to the full power of the furnace without injury."

Blast Furnace.—A small, compact, and convenient crucible furnace is shown in Fig. 18. Of this simple but powerful heating apparatus, which will be found especially adapted to the necessities of the dental laboratory, the manufacturers* observe:

Owing to the discovery by Mr. Fletcher of a singularly perfect non-conducting furnace casing, we are enabled to pro-

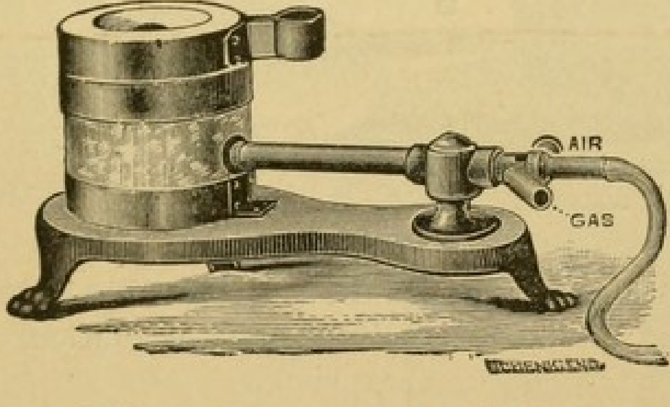
* Buffalo Dental Manufacturing Company.

duce the first really simple gas furnace ever constructed. This material is only about one-sixth the weight of fire-clay, and has not one-tenth its conducting power for heat.

The furnace consists of a simple pot—for holding the crucible—with a lid, and a blowpipe, all mounted on a suitable cast-iron base. As compared with the ordinary gas furnace it appears almost a toy, owing to its great simplicity.

The casing holds the heat so perfectly that the most refractory substances can be fused with ease, using a common foot blower. Half a pound of cast iron requires from 7 to 12 minutes for perfect fusion; the time depending on the gas supply and pressure of air from the blower.

Fig. 18.



The power which can be obtained is far beyond what is required for most purposes, and is limited only by the fusibility of the crucible and casing.

The crucible will hold about ten ounces of gold.

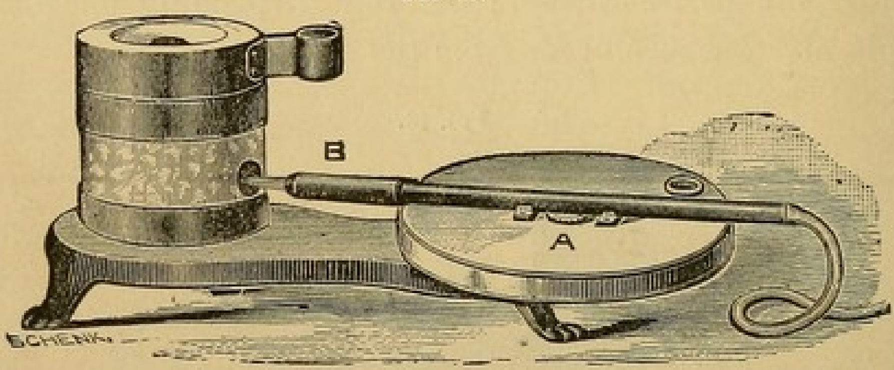
An ordinary gas supply pipe $\frac{5}{16}$ or $\frac{3}{8}$ will work it efficiently. It requires a much smaller supply of gas than any other furnace known. About ten cubic feet per hour is sufficient for most purposes.

Crucibles must not exceed $2\frac{1}{4}$ by 2 inches. Any common blowpipe bellows will work the furnace satisfactorily except for very high temperatures (fusion of steel, etc.), for which a heavy pressure of air is necessary.

In adjusting this furnace for use, put the gauze nozzle of the burner closely against the hole in the side of the casing, turn on the gas and light it in the furnace. Work the bellows and then put the cover on the furnace. The air supply should be such that a flame about two inches long will play out of the hole in the cover, and it may be adjusted by turning the thumbscrew on the side of the burner. The amount of air and gas used by this burner is very small. Care should be taken that the right proportion of each should be used. A *very light* but steady blast of air will give the best results.

A modified pattern of the foregoing furnace (Fig. 19) has been designed, retaining all the peculiar advantages of the one

Fig. 19.



just described, but burning refined petroleum instead of gas as fuel, and is claimed to be equally as efficient as the gas furnace.

The burner for this furnace is constructed upon the principle of an atomizer; and this of course dispenses with a wick. This method has proved the most efficient of any that has been experimented with.

The recent improvements consist in a device for regulating the supply of oil, which is operated by the milled nut (marked A) shown on top of the reservoir in the cut, and the addition of an annular jet of air, which is regulated by turning the sleeve (marked B).

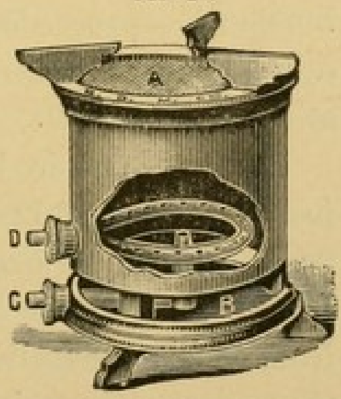
This burner is so made that it can be taken apart and cleansed, in case there should be any obstruction to its proper working. Remove the burner from the reservoir, by unscrewing the small screws; draw out the oil tube, which is operated by the milled nut A, take off the sleeve B, and remove the inside tube.

The same furnace and stand are used for either gas or petroleum, the lamp being fitted for adjustment in place of the gas burner, so that the same apparatus can be furnished for burning either gas or refined petroleum.

There is no doubt that these furnaces in one or both forms will become a necessity in every workshop, as they fill a place intermediate between a blowpipe and a large furnace—which has never yet been filled; whilst their strength, cheapness, simplicity, and general usefulness recommend them to all.

A very useful and almost indispensable heating apparatus in the dental laboratory, suitable for drying, boiling, melting metals requiring a moderate temperature, as zinc, tin, lead, etc., heating flasks preparatory to packing with rubber, and a variety of other purposes, is exhibited in Fig. 20.

Fig. 20.



The burner, consisting, as will be seen, of a circular perforated gas tube, with a central air-jet, gives a complete range of temperature, from a gentle current of warm air to a clear red heat, and is so perfectly under control, that a common glass bottle may be placed on the tripod and heated to any required temperature without the slightest risk of fracture. For very low temperatures the ring must be lighted through the opening B. This gives a steady current of heated air through the gauze above. For boiling, melting, etc., the light must be applied on the surface of the gauze, thereby providing a large body of blue flame, which can be urged by the blast-pipe C. This is one of the most generally useful burners, and stands hard dirty work without injury. The gauze if choked up with dirt can be replaced in a few seconds.

FUEL.

Under this head are comprehended such combustible substances as are used for fires or furnaces, as *wood*, *coal*, *charcoal*, and *coke*. For dental furnace operations only the latter two are, as a general thing, admissible.

Bituminous, or *pit coal*, is unfit for the uses required of fuel by the dentist, and is therefore seldom used.

Anthracite coal, if carefully selected, may be employed, provided it is clean, free from slate, and does not yield a fusible ash. As charcoal and coke are the fuels chiefly used in the processes of the laboratory, these substances will be more particularly described.

Charcoal.—Charcoal is obtained by igniting wood and then excluding it from the air while burning; the volatile products are thus driven off while the carbon remains. When combustion has proceeded slowly for a certain length of time, the openings to the bed or mound are closed, and the wood allowed to char.

When it is desired to maintain a high heat in a small compass, the charcoal best adapted to the purpose is that obtained from what is termed *hard* wood, as the beech, the oak, the alder, the birch, the elm, etc. A cubic foot of charcoal derived from these woods weighs, upon an average, from twelve to thirteen pounds; while a similar bulk obtained from *soft* wood, as the fir, the different kinds of pine, the larch, the linden, the willow, and the poplar, averages only from eight to nine pounds.* There is, therefore, economy in the use of the former when purchased by the bulk; and of this class the beech-wood charcoal is the best, on account of its greater specific gravity. The more heavy charcoals require a stronger draught than those of a lighter character, as a more generous supply of oxygen is necessary to their perfect combustion. Charcoal should be kept as dry as practicable, since it rapidly absorbs moisture from the atmosphere, by which its calorific energy is materially impaired.

Coke.—This substance, like charcoal, is a carbonaceous residuum obtained from pit coal that has been exposed to ignition for some time, excluded from the contact of air, the volatile

* Ure.

products of the coal, like those of wood, having been driven off by the heat. Coke differs in appearance as well as in quality. The principal part of that obtained from gas houses is of a dull, iron-black color, very spongy and friable, and is more rapidly consumed, and produces less heat than the harder and more compact kinds. The best coke for furnace use is that used by brassfounders, and has a steel-gray color, with a somewhat metallic lustre; is compact in its structure, and splits into pieces having a longitudinal fracture.

Coke does not readily ignite, and at first generally requires the admixture of charcoal to effect its combustion; it also requires a strong draught to burn it, but when thoroughly ignited it produces an intense and persistent heat. It is the principal fuel used in baking mineral teeth, porcelain blocks, and the silicious compounds employed in the fabrication of continuous gum work.

Professor Piggot, in his remarks on the comparative value of fuels, observes: "Practically, for the purposes of the chemist, the best fuel is charcoal or coke, or a mixture of the two. The ash of charcoal being infusible it passes through the bars of the grate as a white powder. Should potash, however, be in large excess it corrodes the bricks, by forming with them a silicate of potash, which runs down the walls and chokes the bars. In small quantities this action is beneficial, as it furnishes a protective varnish, and unites the bricks and lutes, by forming a sort of cement, which intimately combines with them.

"Coke contains a very variable amount of ash, which is composed chiefly of oxide of iron and clay. The latter is not fusible by itself, but may soften. When pure it forms a harmless slag, which injures neither the furnace nor the crucibles. Usually, however, the oxide of iron predominates. In this case the ash is very injurious, for it is reduced to a protoxide, which is not only fusible, but powerfully corrosive to all argillaceous matters, so that both the crucibles and furnaces suffer." *

* Dental Chemistry and Metallurgy, p. 274.

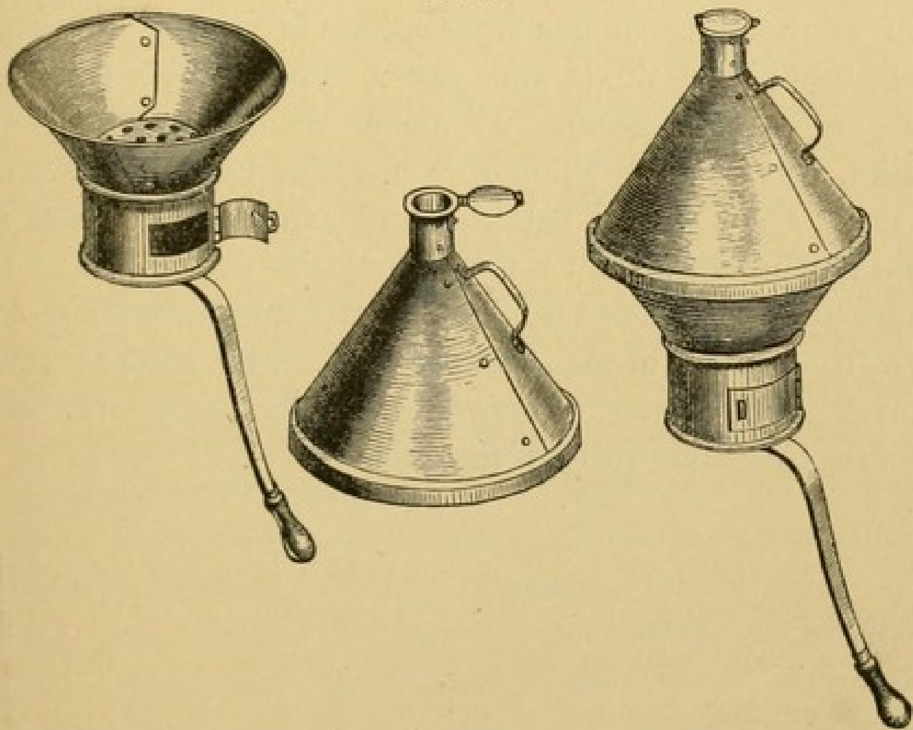
In order that the greatest amount of heat may be evolved from these fuels, it is necessary that the conditions necessary to secure their perfect ignition should be strictly observed; these have reference to an unobstructed circulation of air, that oxygen may be freely supplied to them. To this end the furnace should be kept clean, the bars of the grate unbroken, and a good draught obtained. The condition in which the fuel is applied will also modify the results: thus, for example, if the lumps are too large they will absorb heat, and caloric will be lost; if too small they will be too rapidly consumed. It is essential, also, to have the fuel as free as possible from dust and dirt, as these fine particles, in any considerable quantities, obstruct the draught, and prevent a thorough ignition of the mass. Coke, especially, should be preserved clean, and should be broken into fragments not larger than an inch or an inch and a half in diameter, and, as nearly as possible, in the form of blocks or cubes, as these leave more open spaces for the free circulation of the air.

SUPPORTS.

There are many processes in the dental laboratory requiring the application of heat, for which a suitable holder or support should be provided. A very convenient form of holder, used in soldering, may be made of a circular or semi-eliptical piece of heavy sheet iron, the margin being serrated and turned at right angles, forming a cup. To the under side and centre of this an iron rod, ten or twelve inches long, may be permanently riveted; or it may be made to revolve on the handle, so that the heat may be thrown directly upon any particular part of the piece to be soldered without disturbing the latter.

A small *hand-furnace* (Fig. 21) is sometimes used, and will be found a very convenient and useful apparatus, not only for soldering, but for preparatory heating. It consists of a funnel-shaped receptacle made of sheet iron, with a light grate or perforated plate of the same material adjusted near the bottom, and an opening on one side, underneath the grate, for the admission of air. The upper part of the holder is surmounted by a cone-shaped top, which may be readily removed by a handle attached to it; while to the bottom of the furnace is attached an iron rod, five or six inches long, and terminating in a wooden handle. The piece to be soldered is to be placed inside on a bed of charcoal, the top adjusted to its place, and the fuel ignited; when the operation is sufficiently heated the top may be lifted off, and the piece remaining in the furnace

FIG. 21.



soldered with the blowpipe in the usual manner, the furnace thus serving the purpose of a holder.

A support in very common use consists simply of a large close-grained piece of charcoal, invested in plaster one-half or three-fourths of an inch thick, one end or side being left open and scooped out to receive whatever is being heated. Or a plaster cup two or three inches deep may be made, and its interior partly filled with a mixture of plaster, sand, asbestos, and pulverized charcoal. Carbon blocks, suitably moulded, may also be used. They are cleanly, perfect non-conductors, and imperishable.

CRUCIBLES.

Crucibles are small conical-shaped vessels used by the dentist principally for the purposes of melting and refining metals used for plates, compounding metallic alloys, preparing and compounding the various ingredients employed in the manufacture of porcelain teeth and continuous gum work, etc. They combine in a high degree the properties of infusibility, exemption from the attack of substances fused in them, the power of resisting sudden alternations of temperature, and impermeability to fluids and gases. The Hessian crucibles, which are in most common use among dentists, are composed of silica, alumina, and oxide of iron. Plumbago crucibles are also made from special patterns, and expressly designed for Fletcher's furnaces. For a more particular description of the various components entering into the structure of crucibles, as well as the manner of manufacturing them, the reader is referred to Piggot's *Dental Chemistry and Metallurgy*, and other works treating more fully of the subject.

CHAPTER II.

GOLD.

GOLD has been known from a period of great antiquity, having, according to the writings of Moses, been wrought into articles of jewelry more than three thousand years ago. As a base or support for artificial dentures, it has entirely superseded the use of the various animal substances formerly employed, and, by the mass of practitioners at the present time, it continues to be the most highly esteemed metal for the purpose mentioned, notwithstanding the more recent introduction of approved processes in which, as a base, this metal is wholly discarded.

Gold is found only in the metallic state, and occurs either crystallized in the cube, and its allied forms, or in threads of various sizes, twisted and interlaced into a chain of minute octahedral crystals; also in spangles or roundish grains. These latter, when they occur of a certain magnitude, are called *pepitas*, some specimens of which have been obtained of great size. In 1810 a mass of alluvial gold weighing twenty-eight pounds was found in the gravel pits of the creeks of Rockhole, in North Carolina. A lump of gold ore weighing three cwt., was forwarded from Chili, South America, as a contribution to the World's Exhibition in London. New Granada, California, Russia, and Australia, have each produced pepitas or masses of gold weighing respectively twenty-seven and a half, twenty-eight, seventy, and one hundred and six pounds.

Geological Situations.—The crystalline primitive rocks, the compact transition rocks, the trachytic and trap rocks, and alluvial grounds, are the formation in which gold occurs. Unlike many other metals, it is never in such large quantities as to constitute veins by itself, but is either disseminated through the rocky masses, or spread out in thin plates or grains on their surface, or confined in their cavities in the shape of filaments or crystallized twigs. The minerals composing the veins are either quartz, calcspar, or sulphate of baryta. The ores associated with the gold in these veins are principally iron, copper, arsenical pyrites, galena, and blende. The most abundant sources of gold, however, are in alluvial grounds, where it is found distributed in the form of spangles in the sands of certain plains and rivers, especially at their re-entering angles, at the season of low water, and after storms and temporary floods. Sufficient reasons have been advanced in support of the belief that gold, found in alluvial situations, belongs to the grounds traversed by these rivers, instead of being washed, as was formerly supposed, from the mountains in which their waters have their origin.

Geographical Distribution.—The European mines, more particularly distinguished for their richness, are in Hungary and Transylvania, especially the former. Gold also occurs, but more sparingly, in Ireland, Sweden, Siberia, Germany, Russia, and Spain. In *Asia* and *Africa*, the mines which yield most abundantly, are situated in the southern portions of these continents. From the latter, the ancients derived the greater portion of their gold. Several of the *South American* provinces yield this metal in considerable quantities. Washings are also common in several States of the Union, but California stands unrivalled, except by Australia, in the immense productiveness of its mines, and its resources in respect to this rare and valuable metal are reckoned inexhaustible.

Properties of Gold.—Pure gold is distinguished from all other metals by its brilliant orange-red or yellow color, being the only simple metal that possesses this complexion. It is susceptible of a high polish, but is inferior in brilliancy to steel, silver, or mercury. Its specific gravity varies somewhat, according as it is fused or hammered; the former having a density of 19.26; the latter ranging from 19.4 to

19.65. It is only excelled in density, therefore, by platinum, the specific gravity of which is 21.25.

Gold surpasses all other metals in malleability. The average thickness of ordinary gold leaf is $\frac{1}{282000}$ of an inch, but the ultimate degree of attenuation of which pure gold is susceptible exceeds considerably this estimate. It is also distinguished for its ductility. A single grain of gold may be drawn into wire 500 feet in length, while an ounce may be made to extend 1300 miles. It is somewhat softer than silver, and possesses great tenacity, though inferior in this quality to iron, copper, platinum, or silver. A thread of gold $\frac{78}{1000}$ of an inch in diameter will sustain a weight of 150 pounds. Gold fuses at 2016° with considerable expansion, and, on cooling, contracts more than any other metal.

On account of the want of affinity of gold for oxygen, it remains unaltered in the longest exposure; it is incapable of being oxidized in any heat that may be applied to it, and is only volatilized with great difficulty in the resistless heat of the oxy-hydrogen blowpipe. It is unaffected by the most concentrated of the simple acids, but is readily soluble in *aqua regia* or nitro-muriatic acid, and nitro-fluoric acid.

It will thus be seen that gold possesses, in an eminent degree, those general properties which render it peculiarly fit for the purposes to which it is applied in the practice of dental prosthesis.

Influence of Alloying on the Properties of Gold.—The term *alloy* signifies a compound of any two or more metals, as brass, which is an alloy of copper and zinc.

Alloys, in respect to their uses, are practically new metals, and differ in many important respects, both in their chemical and physical characteristics, from the constituent metals of which they are composed. A more particular account of the influence of alloying upon the general properties of metals, and their management and behavior in the process of compounding, will be given under the head of alloys of the baser metals. As gold combines readily with most metals, some of the more prominent conditions which distinguish its alloys will be given.

The *malleability* of gold is, strictly speaking, always impaired by its union with other metals. This effect is eminently characteristic of certain contaminations, as those with arsenic, tin, antimony, bismuth, lead, etc.; while with certain other metals, as silver, copper and platinum, unless in excess, this property of gold is so little affected, as in no material degree to interfere with its being worked into any desired form for dental purposes. The *ductility* of gold is also usually diminished by its incorporation with foreign metals; sometimes in a remarkable degree. Gold is always rendered *harder*, and its *tenacity* is generally increased, by alloying, while its *density* varies with the particular metal or metals with which it is combined. Thus, the alloy of gold with either zinc, tin, bismuth, antimony or cobalt, has a density greater than that of the mean of its constituents, while the alloys of gold having a less specific gravity than the mean of their components are those with silver, iron, lead, copper, iridium or nickel. Gold is ordinarily more *fusible* when alloyed, the alloy always melting at a less heat than that required to fuse the most refractory constituent, and oftentimes less than the more fusible component. The alloy of gold and platinum furnishes an example of the former; the platinum, which in its uncombined state is infusible in the highest heat of a blast furnace, forming a fusible compound with gold, the melting-point of which is far below that of platinum. Gold solder, composed of gold, copper, and silver, affords a familiar illustration of the latter; the alloy melting at a less heat than that required to fuse its least refractory component, silver. Gold, which in its pure state has less affinity for oxygen than any other metal, is rendered more or less oxidable when combined with other metals.

That gold alloys tend to be formed in definite proportions of their constituents would appear from the phenomenon observed in the native gold of the auriferous sands, which is an alloy with silver in the ratio of 1 atom of silver, united to 4, 5, 6, 12 atoms of gold, but never with a fractional part of an atom. The same circumstance is noticed in connection with the amalgam of silver and mercury. But as alloys are generally soluble in each other, the definiteness of this atomic combination is obscured and disappears in most cases.

Properties of Particular Alloys of Gold.—The metals with which gold is liable to be contaminated in the dental laboratory are zinc, tin, lead, antimony, bismuth, iron or steel, mercury, and arsenic; as also excess of silver, copper, and platinum. As several of these metals when alloyed with gold, even in very minute quantities, are highly destructive in their influence upon those properties which adapt this metal to the various wants of the mechanical operator, and as their separation is often attended with considerable difficulty, annoyance, and loss of time, it is practically important that care should be taken to prevent, as far as practicable, the admixture of any one or more of them with the gold scrap, filings, or sweepings, which are to be re-converted into proper forms for use. The accidental intrusion of these metals, however, is, to some extent, unavoidable, and as an acquaintance with the more prominent characteristics or sensible properties of the resulting alloys sometimes furnishes valuable indications in the selection of the proper reagents employed in their purification, a description of individual alloys is introduced.

Tin, *antimony*, *bismuth*, *lead*, and *arsenic* are peculiarly prominent in their effects upon the malleability of gold; either of these metals in exceedingly minute quantities rendering gold intractable.

One part of *antimony* with nine parts of gold, forms a pale, brittle alloy, and in the proportion of one part of the former to 1920 of gold, the resulting compound is too brittle to admit of successful lamination.

An alloy of *arsenic* with gold containing $\frac{1}{240}$ of the former is a gray brittle metal, while in the proportion of $\frac{1}{900}$, the malleability of the gold is seriously impaired without suffering any change of color. So energetic is the influence of this metal on gold that the latter is rendered brittle when subjected even to the vapor of arsenic.

Tin, *lead*, and *bismuth* are somewhat analogous to arsenic in their influence upon the malleability of gold, either of them, in almost inappreciable quantities, rendering the latter metal unmanageable under the rollers. One part of lead or bismuth to 1920 of gold converts the latter into an unmalleable metal, while tin exceeds either in its remarkable tendency to render gold hard and brittle. Alloys of gold with tin are of a light color; those with lead are of a darker complexion.

Zinc with gold forms a brittle alloy, and when combined in equal proportions, is exceedingly hard, white, and brittle. Uniting or incorporating itself less intimately with the gold than either lead or tin, however, it not unfrequently happens that portions of the ingot will be brittle while others remain, in some degree, malleable; so that the bar, when rolled out in the form of plate, will be perforated or cracked at those points where the zinc preponderates, while remaining portions of the plate retain a moderate degree of softness and pliability.

The working properties of gold are not sensibly affected by the incorporation of very small quantities of *iron*, as an alloy of these metals, in the proportion of one part of the latter to eleven of gold, remains malleable.

Platinum, in itself a highly refractory metal, is, as before stated, rendered fusible in combination with other metals. When combined with gold in small proportions, the latter is rendered harder and more elastic without having its malleability practically impaired. Platinum very readily affects the color of gold, the smallest quantities rendering the alloy pale and dull-colored.

Silver unites with gold in every proportion, and is the chief metal employed in the reduction of gold to the required forms for dental uses. It renders gold more fusible, and imparts to it increased hardness without materially affecting its malleability. The alloy is light-colored in proportion to the amount of silver introduced.

Copper, like silver, is usually combined with gold in the formation of plate, solders, etc., and hardens and renders gold tougher without practically impairing its malleability. It imparts to the alloy a deeper red color, and in the form of plate is capable of receiving a polish excelling in richness and brilliancy any other metal.

The foregoing alloys of gold, it will be perceived, are such as result from the incorporation with gold of minute proportions of any one of the base metals mentioned, and possess certain physical characteristics that indicate, with tolerable certainty, the particular alloying component. Thus, for example, if the alloy is light-colored and very brittle, the presence of tin may be suspected; if brittle and dull-colored, lead is indicated; if grayish or dull-colored, but still malleable, tough and elastic, platinum is probably present; if unequally malleable, or brittle in spots, the presence of zinc may be inferred.

Alloys of gold, however, embracing several or all of these metals in varying proportions, are sometimes accidentally formed, in which case the more distinctive features which characterize the binary compounds are lost or obscured.

CHAPTER III.

REFINING GOLD.

Elements Employed.—The separation of foreign metals from gold by what is termed the "dry method," or *roasting,* is effected by the action on them of either oxygen, chlorine, or sulphur, converting them into oxides, chlorides, or sulphurets. Certain compound substances are used for this purpose which, when heated and decomposed, yield these elements in sufficient quantities for the purposes specified. The refining agents in common use are *nitrate of potassa* (nitre, or saltpetre), which yields oxygen; *chloride of mercury* (corrosive sublimate), which yields chlorine; and *sulphuret of antimony,* (crude antimony), which yields sulphur. Other compounds contain these elements, but those mentioned are generally preferred, because they contain them abundantly, are readily decomposed by heat, and do not materially interfere with the process of separation by the introduction of troublesome components into the alloy.

Before considering specifically the different modes of refining alloys of gold, it will be convenient to classify the different forms of gold as they occur in working this metal in the laboratory.

1. Plate-scrap or clippings, and plate-filings. These, if proper care is taken to prevent the introduction of fragments of platinum, impure filings, or particles of base metals, only require, provided they were originally of suitable fineness, to be remelted and again converted into plate or other forms for use.

2. Mixed filings, and fragments containing solder, platinum, etc. These, when melted alone, produce an alloy more or less impoverished in proportion to the quantity and quality

of the foreign metals introduced in finishing pieces constructed of gold, and should be either separately refined by roasting, or reduced to pure gold by the "humid method," to be described hereafter.

3. Sweepings. This form embraces many impurities, earthy and metallic, and should first be thoroughly washed to remove the earthy constituents, after which the remaining metals may either be mixed with class second, or separately refined. Another, and perhaps better, method, is to fuse together the sweepings and substances hereinafter mentioned, in the following proportions: Of sweepings, eight parts; chloride of sodium, four parts; impure carbonate of potassa, four parts; impure supertartrate of potassa, one part; and nitrate potassa, half part. Mix them thoroughly together, and melt in a crucible. The crucible with its contents should remain in the fire for some time, in order to secure a complete separation of the metals from extraneous matter.

It is evident from the above classification that much time and labor may be saved by preserving these forms of gold separately as they accumulate in the shop. Separate lapskins or receptacles, therefore, should be appropriated to the working of gold, one to receive scrap and unmixed plate-filings, which may be re-converted into plate without refining; another to collect the solder-filings, and such impure fragments as require purification.

Separation of Foreign Metals from Gold.—The most troublesome ingredients which find their way into gold alloys are what are commonly called *base* metals, as tin, lead, zinc, iron, antimony, bismuth, etc. In attempting to separate these metals from gold, it is not a matter of indifference what reagent is employed, inasmuch as distinct affinities exist, which may be advantageously consulted. If, for example, zinc or iron, or both of these metals are present in small quantities, any compound which yields oxygen will, by virtue of the affinity of the latter for these metals, effect their separation by converting them into oxides, hence, when these metals are to be got rid of, nitrate of potassa is employed. But oxygen has but a feeble affinity for tin, and when this metal is present, its separation is better effected by some compound which parts with chlorine in the act of decomposition; chloride of mercury is therefore used for the purpose. When the alloy of gold contains a number of these metals at the same time, and is very coarse, sulphuret of antimony, which is a very powerful and efficient reagent, should be resorted to, unless the operator should prefer, and which is the better way, to reduce the alloy to pure gold by the "humid method."

After all traces of iron or steel have been removed from the gold fragments and filings by passing a magnet repeatedly through them, the latter should be placed in a clean crucible, lined on the inside with borax, and covered either with a piece of fire-clay slab, or broken crucible. Sheet-iron has been recommended for the latter purpose, but should never be used, as, when highly heated, scales form on the surface, and are liable to drop in upon the fused metals. If the operation of roasting is likely to be protracted, an inverted crucible, with a hole in the bottom, may be securely luted to the top of the one containing the metals; the refining agents and fluxes being introduced through the opening in the upper crucible. These are then placed in the furnace on a bed of charcoal, or what is better, a mixture of charcoal and coke; the latter being built up around the crucible, and over it when covered with a second crucible; care being taken that no fragments of fuel are permitted to fall in upon the fused metals. Small portions of borax may first be added, and when the metals are fluid, the refining agents may be introduced in small quantities from time to time, and the roasting continued from half an hour to an hour, according to the coarseness of the alloy. The roasting may be conducted first with borax and nitre to effect partial separation, when the crucible may be removed from the fire, and the metals allowed to cool gradually. The crucible may then be broken, and the button of gold at the bottom removed and separated from the slag that covers it with a hammer. The button is then put into a fresh crucible and re-melted. If there is any known base metal present likely to render the gold brittle, the particular reagent which will most readily attack it may now be used. If, however, as is generally the case, the alloy is of uncertain composition, or contains various metals having distinct affinities, the process becomes, to some extent, experimental, and it may become necessary to use first one refining agent and then another, until sufficient separation is effected. Generally, it will be sufficient to use the nitrate of potassa alone, as most metals are oxidable. After roasting with nitre for half or three-fourths of an hour, adding small portions at a time, the melted metals may be poured into ingot moulds previously warmed and oiled. If, after hammering, annealing, and rolling the ingot, it should still be found brittle, it must be re-melted, and chloride of mercury used as the refining agent. This will remove any traces of tin which may be present.

If the alloy, however, is greatly impoverished, it may be more advantageously treated with sulphuret of antimony; in which case the metal should be melted in a large crucible with about twice or three times their weight of the native sulphuret, which should be added in small quantities at a time. The heat decomposes the sulphuret of antimony; the sulphur uniting with the base metals forming sulphurets, and the antimony uniting with the gold forming a leaden-colored alloy. The antimony may be parted from the gold alloy in the following manner: Place the mixture in a clean crucible, and when melted, force a current of air with a pair of bellows upon its surface; this oxidizes the antimony, which passes off in the form of vapor. The current should be mild at first, as too great a draught is apt to carry off portions of gold by a too hurried volatilization of the antimony. A current strong enough to produce visible fumes will be sufficient. When these cease, the crucible may be covered, and as the melting-point of the gold rises with the escape of antimony, the fire should be urged to a stronger heat, and before pouring, a forcible current of air should again be thrown upon the surface of the melted metals to effectually dissipate any remaining portions of the antimony.

If, after treatment with the reagents enumerated, the alloy should be found malleable, but stiff or elastic, and dull-colored, it is probably due to the presence of platinum; and any further attempts to reduce it by roasting will prove unavailing. It must then be subjected to the process which will be hereafter described for the separation of gold and platinum.

When it is desired to reduce the alloy to pure gold, which is generally advisable whenever the gold to be refined consists of very coarse filings, fragments of plate containing large quantities of solder, linings with platinum pins attached, particles of base metals, etc., the "humid process," as it is called, should be employed. The solvents in common use for this purpose are the nitric, sulphuric, and nitro-muriatic or hydrochloric acid; but as the desired results can be more conveniently and directly obtained by the use of the latter, or hydrochloric acid, this most available method alone will be given. The following practical remarks on the process are copied from an article on the "Management of Gold,"* by Professor George Watt.

"When the alloy is composed of metals differing but little in their affinities for oxygen, chlorine, etc., we resort to one of the 'wet methods.' And, in connection, we will only describe the one which we consider the most convenient and effectual for the practical dentist. It is effectual in all cases, as it always gives us pure gold.

"Let us, then, suppose that our gold alloy has become contaminated with platinum to such extent that the color and elasticity of the plate is objectionable. The alloy should be dissolved in nitro-muriatic or hydrochloric acid, called *aqua regia*. The best proportions for aqua regia are three parts of hydrochloric acid to one of nitric. If the acids are at all good, four ounces of the aqua regia will be an abundance for an ounce of the alloy. The advantage of using the acids in the proportion of three to one, instead of two to one, as directed in most of the textbooks, is, that when the solution is completed, there is but little, if any, excess of nitric acid.

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* Dental Register of the West, vol. xii, p. 251.

If the acids be 'chemically pure,' four parts of the hydrochloric to one of the nitric, produces still better results.

"By this process the metals are all converted into chlorides; and, as the chloride of silver is insoluble, and has a greater specific gravity than the liquid, it is found as a grayish-white powder at the bottom of the vessel. The chlorides of the other metals, being soluble, remain in solution. By washing and pouring off, allowing the chloride of silver time to settle to the bottom, the solution may be entirely separated from it.

The object is now to precipitate the gold while the others remain in solution. This precipitation may be effected by any one of several different agents, but we will mention only the protosulphate of iron.

"This salt is the common green copperas of the shops, and, as it is always cheap and readily obtained, we need look no farther. It should be dissolved in clean rain-water, and the solution should be filtered, and allowed to settle till perfectly clear. Then it is to be added gradually to the gold solution as long as a precipitate is found, and even longer, as an excess will the better insure the precipitation of all the gold. The gold thus precipitated is a brown powder, having none of the appearances of gold in its ordinary state. The solution should now be filtered, or the gold should be allowed to settle to the bottom, where it may be washed after pouring off the solution. It is better to filter than decant in this case, as, frequently, particles of the gold float on the surface, and would be lost in the washings by the latter process.

"Minute traces of iron may adhere to the gold thus precipitated. These can be removed by digesting the gold in dilute sulphuric acid; and, when the process is properly conducted, thus far, the result is *pure gold*, which may be melted, under carbonate of potash, in a crucible lined with borax, and reduced to the required carat."

CHAPTER IV.

Alloys of Gold for Dental Purposes.

Gold, in its pure state, is rarely employed by the dentist in laboratory processes on account of its softness and flexibility; it is, therefore, usually alloyed with such metals as impart to it—without practically impairing either its malleability, pliancy or purity—the degree of hardness, strength and elasticity necessary to resist the wear and strain to which an artificial piece constructed from it is unavoidably exposed in the mouth.

Reducing Metals.—The metals with which gold is usually combined are copper and silver. It is sometimes reduced with silver alone, many regarding the introduction of copper into the alloy as objectionable, as plate derived from it is supposed to be more readily tarnished and to communicate to the mouth a disagreeable metallic taste. This is unquestionably true, if, as is sometimes the case, the copper used is in excess; when, in addition to the effects mentioned, gold, so debased, may become a source of positive injury to the organs of the mouth, as well as to the general health. The small proportions of copper usually employed in forming gold plate, however, are not likely to produce, in any objectionable degree, the consequences complained of, unless the fluids of the mouth are greatly perverted. If gold coin is used in the formation of plate, it may be sufficient to add silver alone, inasmuch as copper is already present; though, usually, additional quantities of the latter metal are added.

Required Fineness of Gold Plate.—Alloys of gold to be permanently worn in the mouth, should be of such purity as will most certainly, under all the contingencies of health and disease, resist any chemical changes that would tend to compromise either the comfort or health of the patient. Evils of no inconsiderable magnitude are sometimes inflicted, either through ignorance, carelessness or cupidity, by disregard of this important requirement. If the general health of the patient remained always uniformly unimpaired, with the secretions of the mouth in their normal state, gold degraded to eighteen or even sixteen carats fine, would undergo no material changes in the mouth. But it must be remembered that, in addition to the corrosive agents introduced into the mouth from without, a variety of diseases, local and constitutional, effect important changes in the otherwise bland and innoxious fluids contained therein, which, from being alkaline or neutral, become more or less acidulated. Indigestion, with acid eructations; gastro-enteritis; ague; inflammatory and typhoid fevers; brain affections; eruptive diseases; rheumatism; gout, etc., are some of the local and constitutional disorders almost uniformly imparting to the mucous and salivary secretions an acid reaction. These readily attack the impoverished gold too frequently employed as a base for artificial teeth; and as a natural sequence to such practice we find supervening, inflammation of the mucous membrane and gums, with chronic periodontitis and loosening of the teeth; aphthous ulcers; gastric irritation; general nervous disorders; decay of the teeth; fœtid breath; disagreeable metallic taste in the mouth, etc. Gold plate intended to be introduced into the mouth, should not, therefore, as a general thing, be of a less standard of fineness than twenty carats. It may exceed this degree of purity in some cases, but will rarely or never, unless alloyed with platinum, admit of being used of a higher carat than the present American coin, which is 21.6 carats fine.

Formulas for Gold Plate used as a Base for Artificial Dentures.—Any of the following formulas may be employed in the formation of gold plate to be used as a base or support for artificial dentures. The relative proportions of the alloying components may be varied to suit the peculiar views or necessities of the manipulator. The estimated carat of the appended formulas are based on the fineness of the American gold pieces coined in 1837 and thereafter.

GOLD PLATE EIGHTEEN CARATS FINE.

Formula No. 1.

18 dwts. pure gold,
4 dwts. fine copper,
2 dwts. fine silver.

Formula No. 2.

20 dwts. gold coin,
2 dwts. fine copper,
2 dwts. fine silver.

GOLD PLATE NINETEEN CARATS FINE.

Formula No. 3.

19 dwts. pure gold,
3 dwts. copper,
2 dwts. silver.

Formula No. 4.

20 dwts. gold coin,
25 grs. copper,
40+ grs. silver.

GOLD PLATE TWENTY CARATS FINE.

Formula No. 5.

20 dwts. pure gold,
2 dwts. copper,
2 dwts. silver.

Formula No. 6.

20 dwts. gold coin,
18 grs. copper,
20+ grs. silver.

GOLD PLATE TWENTY-ONE CARATS FINE.

Formula No. 7.

21 dwts. pure gold,
2 dwts. copper,
1 dwt. silver.

Formula No. 8.

20 dwts. gold coin,
13+ grs. silver.

Formula No. 9.

20 dwts. gold coin,
6 grs. copper,
$7\frac{5}{7}$ grs. platinum.

GOLD PLATE TWENTY-TWO CARATS FINE.

Formula No. 10.

22 dwts. pure gold,
1 dwt. fine copper,
18 grs. silver,
6 grs. platinum.

The union of platinum with gold, as in Formula No. 10, furnishes an alloy rich in gold, while it imparts to the plate derived from it a reasonable degree of stiffness and elasticity;

preserves in a good degree the characteristic color of fine gold; and does not materially impair its susceptibility of receiving a high polish. The amount of gold coin given in Formula No. 9 may be reduced with platinum alone, adding to it from eight to twelve grains; in which case, although the carat of the alloy is lowered, its absolute purity remains unaffected, and plate formed from it will better resist any changes in the mouth than gold coin itself.

Formulas for Gold Plate used for Clasps, Wire, Stays or Linings, Metallic Pivots, etc.—Gold used in the formation of clasps, stays, etc., is improved for these purposes by the addition of sufficient platinum to render it firmer and more elastic than the alloys ordinarily employed in the formation of plate as a base. The advantages of this elastic property, in its application to the purposes under consideration, are, that clasps formed from such alloys will adapt themselves more accurately to the teeth, as, when partially spread apart on being forced over the crowns, they will spring together again and accurately embrace the more contracted portions. In the form of stays or backings, additional strength being imparted, a less amount of substance will be required; the elasticity of these supports, also, will not only lessen the chances of accident to the teeth themselves in mastication and otherwise, but preserve their proper position when temporarily disturbed by any of the forces applied to them. The same advantages last mentioned are obtained from this property in the use of metallic pivots.

Formula No. 1.	*Formula No.* 2.
20 dwts. pure gold,	20 dwts. coin gold,
2 dwts. fine copper,	8 grs. fine copper,
1 dwt. fine silver,	10 grs. silver,
1 dwt. platinum.	20 grs. platinum.

The alloy derived from either of these formulas will be twenty carats fine.

Gold Solders.—Solders are a class of alloys by means of which the several pieces of the same or of different metals are united to each other. They should be more fusible than the metals to be united, and should consist of such components as possess a strong affinity for the substances to be joined. They should also be as fine as the metals to which they are applied will admit of without endangering the latter. Solders of different degrees of fineness, therefore, should always be provided, from which the one most suitable for any given case may be selected.

The use of solders of doubtful or unknown composition should be avoided, and hence they should be compounded either from pure gold or gold coin.

The following formula taken from Prof. Harris's work on *Dental Surgery*, page 664, recipe No. 3, may be used in connection with eighteen or twenty carat gold plate, and is sixteen carats fine:

6 dwts. pure gold,
2 dwts. roset copper,
1 dwt. fine silver.

Recipes Nos. 1 and 2, page 663 of same work, are too coarse to be introduced into the mouth; the former being a fraction below fourteen carats, while the latter is still more objectionable, exceeding but little, twelve and one-half carats.

Formula No. 1 of the following recipes is a fraction over fifteen carats fine; and No. 2 furnishes a solder eighteen carats fine:

Formula No. 1.	*Formula No.* 2.
6 dwts. gold coin,	Gold coin, 30 parts.
30 grs. silver,	Silver, 4 "
20 grs. copper,	Copper, 1 "
10 grs. brass.	Brass, 1 "

Zinc, as will be observed by the incorporation of brass in the above formulas, is sometimes employed, principally with a view of rendering the alloy more fusible. Its employment under any circumstances is objected to by many on the ground that it more readily tarnishes in the mouth, is more brittle, and furnishes more favorable conditions for galvanic action. These objections only hold good when zinc is used in excess. When employed in quantities sufficient only to make the gold flow readily and evenly at a diminished heat, it is claimed that the base metal used in these alloys is chiefly consumed in the process of soldering, leaving a residuum of gold equal, or nearly so, in fineness to the plate. If such is the case, they are desirable alloys for soldering purposes, inasmuch as the importance of having the various parts of a piece of dental mechanism differ as little as possible in their affinity for the acids of the mouth is generally recognized.

Method of reducing Gold to a lower or higher standard of Fineness, and of determining the Carat of any given Alloy.— In the process of compounding gold for dental purposes, the manipulator should always aim at exactness in the quantity and relative proportions of the reducing components, and should be able to determine precisely the purity of the metals he employs. Gold alloys are too often arbitrarily compounded, and used without any adequate knowledge of their qualities or properties; and formulas, taken on trust, are employed without any certain knowledge of the quality of the alloys they produce.

That we may know certainly the quality of the gold alloys used in the laboratory without resorting to the inconvenient process of analysis or assaying, they should always be made either from pure gold or gold coin, the standard of these being definitely fixed. But as the process of procuring pure gold is somewhat tedious and troublesome, gold coin is very generally employed for the purpose. The amount of alloy necessary to reduce either pure or coin gold to any particular standard, whether higher or lower, and the method of ascertaining the carat or fineness of any given alloy, may be readily determined by a few simple rules. The following practical remarks on the method are copied from an article on "Alloying Gold,"* by Professor G. Watt.

"1. *To ascertain the carat of any given alloy.*—The proportion may be expressed as follows:

* Dental Register of the West, vol. x, p. 396.

"As the weight of the alloyed mass is to the weight of gold it contains, so is 24 to the standard sought. Take, for example, Harris No. 3 gold solder:

Pure gold,	6 parts.
" silver,	2 "
" copper,	1 "
Total,	9

"The proportion would be expressed thus,—

9 : 6 : : 24 : 16.

"From this any one can deduce the following

"RULE.—Multiply 24 by the weight of gold in the alloyed mass, and divide the product by the weight of the mass; the quotient is the carat sought.

"In the above example, 24 multiplied by 6, the quantity of gold, gives 144, which, divided by 9, the weight of the whole mass, gives 16. Hence, an alloy prepared as above, is 16 carats fine.

"As another example, under the same rule, take Harris's No. 1 solder.

22 Carat gold,	48 parts.
silver,	16 "
copper,	12 "
Total,	76

"Now, as the gold used is but 22 carats fine, one-twelfth of it is alloy. The one-twelfth of 48 is 4, which subtracted from 48 leaves 44. The statement then is:

76 : 44 : : 24 : 13.9.

"This solder, therefore, falls a fraction below 14 carats.

"2. *To reduce gold to a required carat.*—The proportion may be expressed as follows:

"As the required carat is to 24, so is the weight of the gold used to the weight of the alloyed mass when reduced. The weight of gold subtracted from this, gives the quantity of alloy to be added.

"For example, reduce 6 ounces of pure gold to 16 carats.

"The statement is expressed thus:

$$16 : 24 :: 6 : 9.$$

"Six subtracted from 9 leaves 3, which is the quantity of alloy to be added. From this is deduced the following

"RULE.—Multiply 24 by the weight of pure gold used, and divide the product by the required carat. The quotient is the weight of the mass when reduced, from which subtract the weight of the gold used, and the remainder is the weight of alloy to be added.

"As another example under the same rule, reduce 1 pennyweight of 22 carat gold to 18 carats.

"As the gold is only 22 carats fine, one-twelfth of it is already alloy. The one pennyweight, therefore, contains but twenty-two grains of pure gold. The statement is, therefore, thus expressed:

$$18 : 24 :: 22 : 29\tfrac{1}{3}.$$

"Twenty-two subtracted from $29\frac{1}{3}$ leaves $7\frac{1}{3}$. Therefore, each pennyweight of 22 carat gold requires $7\frac{1}{3}$ grains of alloy to reduce it to 18 carats.

"3. *To reduce gold from a lower to a higher carat.*—This may be done by adding pure gold or a gold alloy finer than that required. The principle of the rule may be set forth in the following general expression:

"As the alloy in the required carat is to the alloy in the given carat, so is the weight of the alloyed gold used to the weight of the reduced alloy required. The principle may be practically applied by the following

"RULE.—Multiply the weight of the alloyed gold used by the number representing the proportion of alloy in the given carat, and divide the product by that representing the proportion of alloy in the required carat; the quotient is the weight of the mass when reduced to the required carat by adding fine gold.

"To illustrate this, take the following example:

"Reduce 1 pennyweight of 16 carat gold to 18 carats.

"The numbers representing the proportions of alloy in this example are found by respectively subtracting 18 and 16 from 24. The statement is, therefore:

$$6 : 8 : : 1 : 1\tfrac{1}{3},$$

from which it follows that to reduce one pennyweight of 16 carat gold to 18 carats, there must be one-third of a pennyweight of pure gold added to it.

"But suppose that, instead of pure gold, we wish to effect the change by adding 22 carat gold. The numbers, then, respectively representing the proportions of the alloy would be found by subtracting, in the above example, 16 and 18 from 22, and the statement would be:

$$4 : 6 : : 1 : 1\tfrac{1}{2}.$$

"It follows, then, that to each pennyweight of 16 carat gold, a half pennyweight of 22 carat gold must be added to bring it to 18 carats.

"By the above rules we think the student will be able, in all cases, to calculate the fineness or quality of his gold, and to effect any reduction, whether ascending or descending, which he may desire."

To facilitate the student in accurately compounding gold alloys from coins of that metal, the following table, giving the weight in grains, fineness, and the value of the gold coins of different nations, is given in this connection.

TABLE OF COINAGE OF DIFFERENT NATIONS.

NATIONS.	Year.	Weight.	Fineness.	Value.		
ARGENTINE REPUBLIC.		Grains.	Thous.	d.	c.	m.
Doubloon, Province of Rio de la Plata.......	1828–32	418	815	14	66	
Doubloon, Province of Rio de la Plata.......	1813–32	415	868	15	51	
The same variation of fineness and weight in coins of the same date are to be found in the silver coinage of this republic.						
AUSTRIA.						
Ducat of Maria Theresa......................	1762	53.5	965	2	26	9
Sovereign of Maria Theresa..................	1778	170	917	6	71	3
Ducat of Leopold II.........................	1790	53.5	986	2	27	2
Ducat of Francis I..........................	1809–34	53.7	983	2	27	4
Quadruple of Francis I......................	1830	215.5	983	9	12	2
Sovereign of Francis I......................	1831	174.5	898	6	74	8
Sovereign of Ferdinand I....................	1838	174.5	901	6	77	1
Half-sovereign of Ferdinand I...............	1839	87	902	3	38	
Ducat of Ferdinand I........................	1838	53.7	985	2	27	8
Quadruple of Ferdinand I....................	1840	215.5	985	9	14	
Hungary ducat of Ferdinand I................	1839	53.7	986	2	28	1
BADEN.						
Ten guilder (five guilder same quality) of Louis, Grand Duke........................	1819	105.5	900	4	08	6
BAVARIA.						
Ducat of Maximilian Joseph and Charles Theodore....................................	1764–97	53	980	2	23	7
Ducat of Maximilian Joseph II...............	1800	53	984	2	24	6
Ducat of Louis..............................	1832	53.5	987	2	27	4
BELGIUM.						
Forty francs................................		199	895	7	67	
Twenty francs in proportion, same fineness. Sovereigns same as Austrian coinage.						
BOLIVIA.						
Doubloon....................................	1827–36	416.5	870	15	58	
BRAZIL.						
Moidore of Maria I, and John III............	1779	125.5	914	4	94	
Half-Joe of Peter II........................	1833–38	221.5	915	8	72	7
The other moidores and half-joes are of the same fineness with the moidore of 1779, varying slightly in weight.						
BRITAIN.						
The gold coins of this kingdom are of the uniform fineness of 915.5, but below the legal standard about one thousandth. The par value of the pound sterling is about $4.84. Sterling gold is worth 94.6 cents per pennyweight.						
BRUNSWICK.						
X. Thaler of Charles........................	1745	202	898	7	81	2
X. Thaler of Charles William Ferdinand......	1805	204	896	7	87	2
X. Thaler of Wm. Fred. and George Regent.	1813–19	204.5	896	7	89	1
X. Thaler of Charles........................	1824–30	205	896	7	91	
X. Thaler of William........................	1831–38	205	894	7	89	3
V. Thaler of Charles........................	1748–64	102	903	3	96	6

TABLE OF COINAGE OF DIFFERENT NATIONS (*continued*).

NATIONS.	Year.	Weight.	Fineness.	Value.		
CENTRAL AMERICA.		Grains.	Thous.	d.	c.	m.
Doubloons	1824-33	417	833	14	96	
CHILI.						
Doubloons	1819-24	417	867	15	57	
Doubloons	1835 & seq.	417	872	15	66	
COLOMBIA.						
Doubloon of eight escudos, Colombia, Bogotan Mint	1823-36	416.8	870	15	61	7
Doubloon of eight escudos, Popayan Mint.	1823-36	416.5	858	15	39	
Doubloon of New Granada, Bogota	1837	416.8	870	15	61	7
Half-doubloon of Ecuador, Quito	1836	209	844	7	59	6
Quarter-doubloon of Colombia, Bogota	1823-35	104	865	3	87	4
Quarter-doubloon of Ecuador, Quito	1835	104	844	3	78	
Eighth-doubloon of Colombia, Bogota	1823-36	51	865	1	90	
Eighth-doubloon of Colombia, Popayan		51	852	1	87	1
These last coins vary in fineness from 849 to 854, and in weight from 44½ to 61½. The sixteenth-doubloons are of the same quality.						
DENMARK.						
Specie ducat of Frederick V	1749	53.5	988	2	27	6
Specie ducat of Christian VII	1795-1802	53.7	979	2	26	4
Current ducat of Christian VII	1783	48	876	1	81	1
Christian d'or of Christian VII	1775	103	905	4	01	4
Double Frederick d'or of Frederick VI	1813-39	204.5	895	7	88	2
EGYPT.						
Sequin fundoukli of Achmet III	1115 (1703)	53	958	2	13	7
Sequin fundoukli of Mahmoud I	1143 (1730)	39	940	1	57	9
Sequin fundoukli of Mahmoud I	1143 (1730)	39	848	1	42	4
Sequin fundoukli of Mustapha III	1171 (1757)	39	781	1	31	2
Sequin fundoukli of Abdul Hamed	1187 (1773)	39	786	1	32	
Sequin fundoukli of Abdul Hamed	1187 (1773)	39	645	1	08	3
Sequin fundoukli of Selim III	1203 (1789)	39	690	1	15	9
Half-sequin fundoukli of Mahmoud II	1233 (1818)	18	670		51	9
Bedidlik, 100 piastres, of Abdul Majeed	1255 (1839)	132.2	874	4	97	6
Nusflix, 50 piastres, of Abdul Majeed	1255 (1839)	66.1	875	2	49	1
Kairia Hastreen, 10 piastres, of Abdul Majeed	1255 (1839)	27	874	1	01	7
The first date given above is the year of the Hegira, the second, the Christian era.						
FRANCE.						
Louis d'or of Louis XV	1726-73	124	897	4	79	
Louis d'or of Louis XVI	1786-92	116.5	900	4	51	6
Double Louis d'or of Louis XV	1744	250	902	9	71	1
Double Louis d'or of Louis XVI	1786-92	235	901	9	11	9
Napoleon, 20 francs, of Napoleon	1803-14	99.2	899	3	84	1
The subsequent gold coinage of France is of the uniform fineness of 899, except the twenty franc pieces of Louis Philippe, coined in 1840-41, which are 900.						
GREECE.						
Twenty drachms of Otho	1833	89	900	3	45	
HANOVER.						
Ducat of George III	1776	53.5	993	2	28	8

TABLE OF COINAGE OF DIFFERENT NATIONS (*continued*).

NATION.	Year.	Weight.	Fineness.	Value.		
HANOVER (*continued*).		Grains.	Thous.	d.	c.	m.
Pistole or five thaler of George III	1803	102	896	3	93	6
Pistole or five thaler of George III	1813–14	102	890	3	91	
Ten thaler of George III	1813–14	204.5	890	7	83	8
Ten thaler of William IV, and Ernst. August	1835 & seq.	205	895	7	90	2
HESSE.						
Ten thaler of Frederick II	1773–85	202	890	7	74	2
Five thaler of Frederick II	1771–84	101	893	3	88	4
Five thaler of William IX	1788–89	101.5	892	3	89	9
Five thaler of William I	1815–17	101.5	894	3	90	8
HINDOSTAN.						
Mohur of Bengal	1770	190	982	8	03	5
Mohur of Bengal	1787	191	989	8	13	4
Mohur of Bengal	1793	191	993	8	16	8
Mohur of Bengal	1818	204.7	917	8	08	4
Mohur of Madras	1818	180	917	7	10	9
Mohur of Bombay	1818	179	920	7	09	2
Half-mohur of Bengal	1787	95	984	4	02	6
Star pagoda of Madras		52.5	800	1	80	9
Pondicherry pagoda of Pondicherry		52.5	708	1	60	1
Porto Novo pagoda of Portuguese Comp'ny.		52.5	740	1	67	3
MECKLENBURG SCHWERIN.						
Ten thaler of Frederick Francis	1831	204.5	896	7	89	1
MEXICO.						
Doubloon of Mexico, Augustin, Emperor	1822	416.5	864	15	49	8
Doubloon of Mexico, Mexican Republic	1824–30	416.5	865	15	51	6
Other doubloons minted at Mexico weigh 417 grains, and are from 867 to 869 thousandths fine. The doubloon of Guanaxuato varies from 860 to 867 in fineness.						
Doubloon of Durango		417	868	15	58	8
Doubloon of Durango		417	865	15	53	4
Doubloon of Durango	1833–36	417.5	872	15	67	9
Doubloon of Guadalaxara		416	865	15	49	7
MILAN.						
Zecchino, or Sequin, of Maria Theresa and Joseph II	1770–84	53.5	990	2	28	1
Doppia, or Pistole, of Joseph II	1783	97.5	908	3	81	3
Forty lire of Napoleon	1805–14	199	899	7	70	6
Sovereign of Francis I	1831	174.5	898	6	74	8
Sovereign of Ferdinand I	1838	174.5	901	6	77	1
Half-sovereign	1839	87	902	3	38	
NAPLES AND SICILY.						
Six ducat, of Ferdinand IV	1783	135	893	5	19	2
Onzia of Sicily of Charles	1751	68	959	2	51	6
Onzia of Ferdinand I	1818	58	995	2	48	5
Twenty lire of Joachim Napoleon	1813	99	900	3	84	8
NETHERLANDS.						
Ducat	1770–1810	53.5	980	2	25	8
Ducat of William I	1833–39	53.7	981	2	26	9
Ten guilders of William I	1816–39	103.5	899	4	00	7

TABLE OF COINAGE OF DIFFERENT NATIONS (*continued*).

NATION.	Year.	Weight.	Fineness.	Value.		
PERSIA.		Grains.	Thous.	d.	c.	m.
Toman of Fatha Ali Shah, Kajar	1230–40 (1814–24)	71.2	991	3	04	2
Toman of Mohammed Shah, Shakinshah	1255 (1839)	53.7	965	2	23	3
Half-toman of Mohammed Shah	1252 (1837)	27	968	1	12	1
POLAND.						
Ducat of Stanislaus Augustus	1791	53.5	984	2	26	6
PORTUGAL.						
Moidore of Peter II	1689	165	908	6	45	2
Moidore of Peter II	1705	165	928	6	59	4
Moidore of John V	1714–26	165	913	6	48	8
Half-joe	1727–77	217	914	8	62	
Half-joe of Maria I, and Peter III	1778–85	220	913	8	65	
Half-joe of Maria I	1787–1804	221	914	8	69	9
Half-joe of John VI	1822–24	221	909	8	65	2
Joannese of John V	1730	439	912	17	24	2
Crown of Maria II	1838	148	912	5	81	3
PRUSSIA.						
Frederick d'or of Frederick II	1752–82	102	901	3	95	8
Frederick d'or of Frederick William II	1795–96	102	897	3	94	
Frederick d'or of Frederick Wilhelm III	1799–1812	102	901	3	95	8
Double Frederick d'or of Fred. Wilhelm III.	1800–11	205	898	7	92	3
Double Frederick d'or of Fred. Wilhelm III.	1831	205	903	7	97	2
Ducat of Frederick William II	1787	53.5	979	2	25	6
ROME.						
Sequin of Pius VI	1775–83	52.5	996	2	25	2
Doppia of Pius VI	1777–86	84	906	3	27	8
Doppia of Pius VII		84.5	901	3	27	9
Gold scudo of Republic	1799	910	833	32	64	6
Ten scudi of Gregory XVI	1836	267.5	900	10	36	8
RUSSIA.						
Imperial of Elizabeth	1756	253	915	9	97	
The gold coins of Russia, though irregular in weight, are of the same standard fineness during the reigns of Elizabeth and Catharine II.						
Ducat of Paul I	1798	66	969	2	75	4
Three roubles of Nicholas	1838	60.5	917	2	38	9
Half-imperial of Nicholas	1839	100.5	917	3	96	9
SARDINIA.						
Pistole of Victor Amadeus, etc		148	905	5	76	8
Carlino (island) of Victor Amadeus, etc	1773	247	890	9	46	7
Marengo of Republic	1800	98	898	3	79	
Eighty lire		398	898	15	39	2
Genovine of Ligurian republic (Genoa)	1798	388	908	15	17	2
SAXONY.						
Double August d'or of Fred. August. III	1784–1817	204.5	896	7	89	1
Double August d'or of Fred. August. III	1826	205	898	7	92	8
Double Anton d'or of Anthony	1830–36	205	900	7	94	6
Ducat of Anthony	1830	53.7	979	2	26	4

TABLE OF COINAGE OF DIFFERENT NATIONS (*continued*).

NATION.	Year.	Weight.	Fineness.	Value.		
SPAIN.		Grains.	Thous.	d.	c.	m.
Cob doubloon of Philip V, American	1733–44	416	895*	16	03	4
Doubloon of Ferdinand VI, American	1751	416	908	16	26	5
Doubloon of Charles III, American	1772–84	416	843†	16	00	
Doubloon of Charles III, Spanish	1786–88	416	890	15	58	7
Doubloon of Charles IV, and Ferdinand VII, American	1789–1821	416.5	868	15	57	
Pistole of Philip V, Spanish	1745	103	909	4	63	2
Pistole of Charles III, American	1774–82	103	895	3	97	
Pistole of Ferdinand VII, American	1813–24	104	872	3	90	6
Escudo of Charles III, Spanish	1786–88	52	874	1	95	7
Escudo of Charles IV	1789–1808	52	868	1	94	4
Escudo of Ferdinand VII, American	1809–20	52	851	1	90	6
Half-doubloon of Charles III, Spanish	1780–82	206	896	7	95	
Half-doubloon of Charles IV, American	1789–1808	208	870	7	79	3
Half-doubloon of Ferdinand VII, Spanish.	1810–24	208	865	7	74	8
SWEDEN.						
Ducat of Gustavus III, and Gustavus IV	1777–1800	53	977	2	23	
Ducat of Charles John XIV	1838	54	975	2	26	7
SWITZERLAND.						
Pistole of Berne	1796	116	901	4	50	1
Pistole of Basle	1795	118	891	4	52	8
Pistole of Soleure	1798	116	898	4	48	6
Pistole of Helvetian Republic	1800	116	897	4	48	1
Ducat of Berne	1794	52.5	974	2	20	2
Ducat of Basle		53	943	2	15	2
TUNIS.						
Half-sequin of Abdul Hamed	1773	19	885		72	4
TURKEY.						
Sequin fondouk of Selim III	1789	52.5	800	1	80	9
Sequin zermahboub of Selim III	1789	36	800	1	24	
Ohikilik of Mahmoud II	1822–24	25	833		89	7
Twenty piastres, of Mahmoud II	1827	27.5	875	1	03	7
Yirmilik, 20 piastres of Abdul Medjid	1840	24.5	832		87	7
TUSCANY.						
Ruspone of Francis III, to Leopold III	1738–1800	160	997	6	87	
Ruspone of Louis I, and Charles I	1801–07	161	998	6	91	9
Ruspone of Leopold II	1824–34	161	999	6	92	5
Sequin of Leopold	1765–79	53	997	2	27	6
Sequin of Leopold II	1824–34	53.5	999	2	30	1
UNITED STATES.						
Eagle	1792–1834	270	916.7	10	67	4
Eagle	1834–37	258	899.2	9	99	7
Eagle	1837 & seq.	258	900	10		
WURTEMBERG.						
Ducat of Charles	1790–1818	53	980	2	23	7

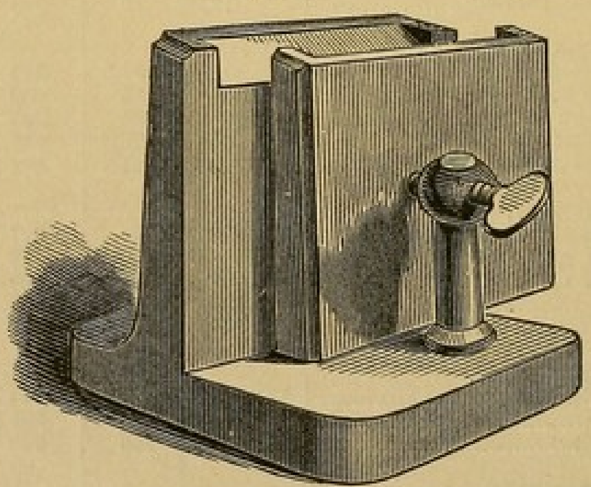
* Varies from 893 to 898. † Varies from 883 to 893, the oldest pieces being the best.

CHAPTER V.

Method of Converting Gold Alloys into the Required Forms for Dental Purposes.

Manner of Procuring an Ingot.—The gold, with its alloying constituents, is put into a clean crucible, lined on the inside with borax, and placed in the furnace. When the contained metals are perfectly fused, the crucible should be removed from the fire with a pair of tongs, and the contents poured quickly but carefully into the ingot moulds; the latter being placed conveniently near the mouth of the furnace, as the molten metals soon become chilled on exposure to the open air. Before pouring, the moulds, if made of iron, should be moderately heated and oiled, or coated with lamp-smoke by

Fig. 22.

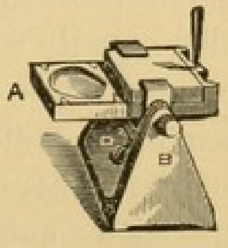


holding their inner surfaces over the flame of an oil-lamp or gas-jet.

Ingot-moulds are constructed of various substances, but those in most common use, and, at the same time, most convenient, are formed of iron, and, for gold, are generally about two inches square and from one-eighth to one-sixth of an inch thick. (Fig. 22.) They should be slightly concave on their inner surfaces to compensate for the greater shrinkage of the gold in the centre than at the margins of the ingot.

A very ingenious, convenient, and useful contrivance, combining crucible and ingot-mould, and by the use of which ingots of gold, silver, etc., may be quickly obtained without the use of a furnace, is shown in Fig. 23. The crucible (A) is of moulded carbon, and is supported in position by an iron side-plate. The ingot mould is indicated by the letter C. The letter D shows clamp holding crucible and ingot mould in position, and swivelling on the cast-iron stand, B.

FIG. 23.



The metal to be melted is placed in the crucible, and the flame of a blowpipe is directed on it until it is perfectly fused. The waste heat serves to make the ingot mould hot, and the whole is tilted over by means of the upright handle at the back of the mould. With this simple instrument a sound ingot may be obtained at any time in about two minutes.

Soapstone is sometimes employed for the same purpose, and is preferred by many. It should also be warmed and oiled before pouring the metals. Moulds made from charcoal are also sometimes used, but, as they require to be frequently renewed, are not generally employed. Moulds are formed from this latter substance by selecting two pieces with even surfaces or dividing a single piece with a saw, when either the required size and shape of the mould may be cut out in one half, or a strip of sheet-iron a little broader than the required thickness of the ingot, being bent into proper form, is placed between, and the edges partially imbedded in the two pieces of charcoal, and the latter secured by binding them together with wire. Moulds made from this material do not require to be either heated or oiled.

It not unfrequently happens that, at the first pouring, the metals arrange themselves in the ingot in accordance with the density of the several components; those of greater specific gravity passing to the bottom, and the lighter metals remaining above. Whenever this occurs the ingot must be broken into pieces and remelted; this should be repeated, if necessary, until the alloy assumes a perfectly homogeneous appearance. It should then be annealed in hot ashes, which softens the gold and removes the adhering grease.

Forging.—Before laminating the ingot it should be reduced somewhat in thickness by placing it on an even-faced anvil or other equally smooth and resistant surface, and subjecting it to repeated blows with a tolerably heavy hammer. It should be frequently annealed, and the process of forging continued, alternately hammering and annealing, until the ingot is reduced one-half or more in thickness.

Laminating or Rolling.—The reduced ingot, well annealed, is next laminated or spread out into a sheet of greater or less thinness by passing it repeatedly between two strong, highly-

Fig. 24.

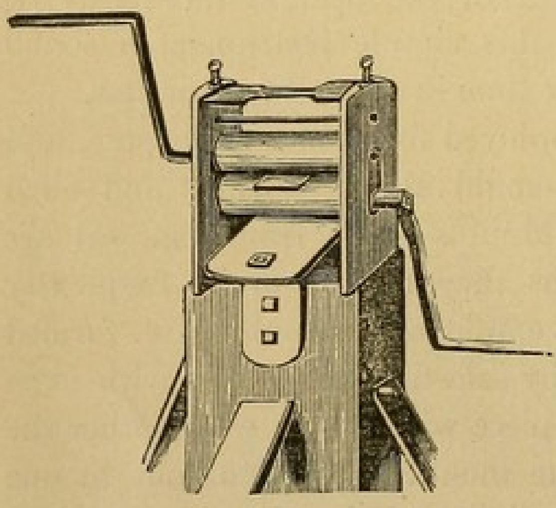
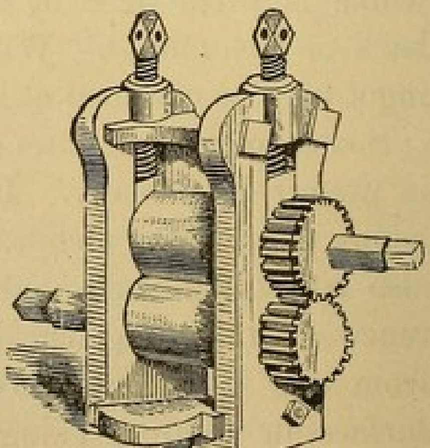


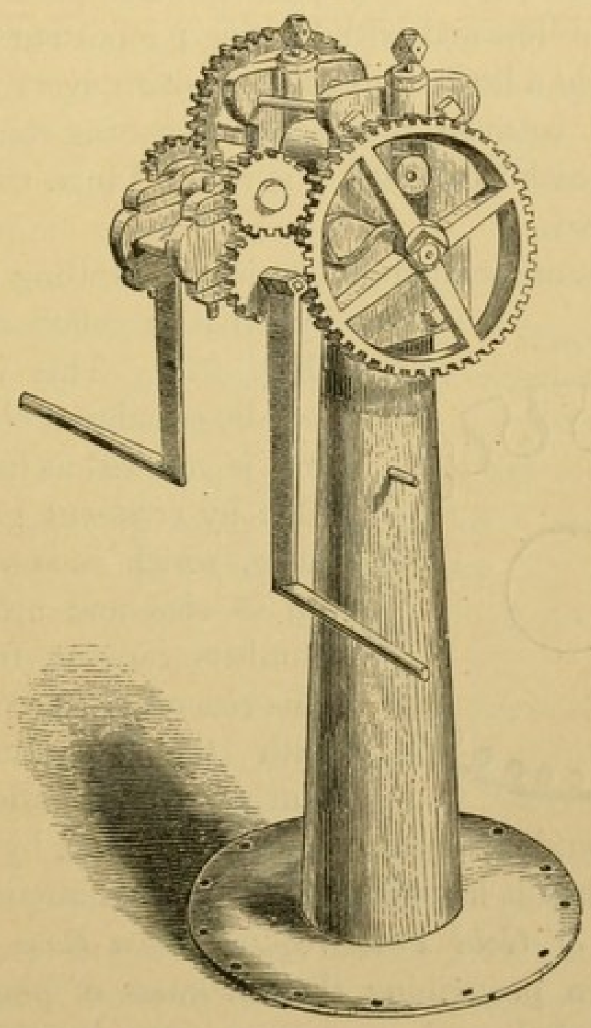
Fig. 25.



polished, cylindrical steel rollers. The mills used for the purpose are variously constructed, the plainest forms (Fig. 24) being very simple in their mechanism, while others, or geared mills, are more complicated, and are constructed with a view to a greater augmentation of power, and precision, and certainty of action. The latter (Figs. 25, 26), if of approved pattern, materials, and manufacture, are, upon the whole, more economical and reliable than the cheaper varieties. The rollers, for the purposes of the dentist, should be from three to four inches in length.

In laminating, the rollers should first be adjusted equidistant at both ends, and this uniformity, as they are approximated from time to time, should be preserved throughout. At every passage of the gold bar between the rollers the distance between the latter should be diminished, care being taken that the approximation be not sufficient to clog or impede the

Fig. 26.



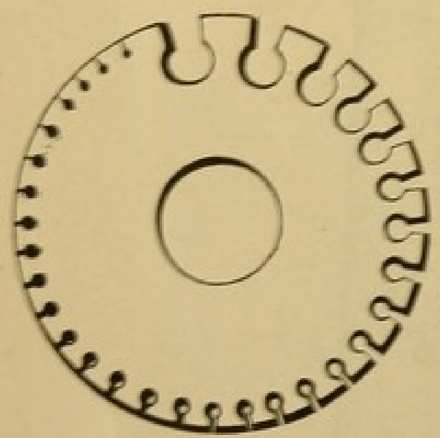
free action of the mills. The gold, which, in time, becomes hard, and brittle, and liable to crack in the mills, should be frequently and well annealed by bringing it to a full red heat; this restores the pliancy of the gold and facilitates the operation in the press.

When the ingot has been extended in one direction as far as may be desired, it should always be re-annealed before turning it in the mills; a neglect of this precaution will seriously interfere with the working of the gold by twisting or doubling the plate upon itself; and in some instances, provided the gold has not been well annealed throughout the operation, or is in any considerable degree unmalleable, the plate will be torn across and rendered unfit for use.

A thin or retreating edge may be given to the plate at any desired point or points by passing such portions part way between the rollers and withdrawing; repeating this, with the rollers brought a little nearer to each other every time the plate is introduced between them, and decreasing the distance the plate passes each time until it is reduced to as thin an edge as may be desired.

The degree of attenuation obtained by rolling is determined by what is called a *gauge-plate*, (Fig. 27.) This instrument is usually circular or oblong in form, and is marked at intervals on its edge by cross-cut grooves or fissures, which successively diminish in size and are indexed by numbers ranging from 6 to 40. The size of the grooves diminish with the ascending numbers. During the operation of rolling, the plate should be tested, from time to time, by the gauge, to determine when it has undergone sufficient attenuation.

Fig. 27.



Thickness of Gold Plate required as a Base for Artificial Dentures.—In prescribing the thickness of plate proper for the purpose indicated, no estimate can be given that will apply to all cases, as certain conditions of the mouth, to be mentioned hereafter, will suggest some modifications in this respect. Usually, however, plate for entire upper sets should correspond in thickness with number 26 of the gauge-plate; for the under jaw, number 24 may be used; while for partial upper pieces, an intermediate number may be chosen, unless atmospheric-pressure plates are used, when the number recommended for full upper sets may be employed.

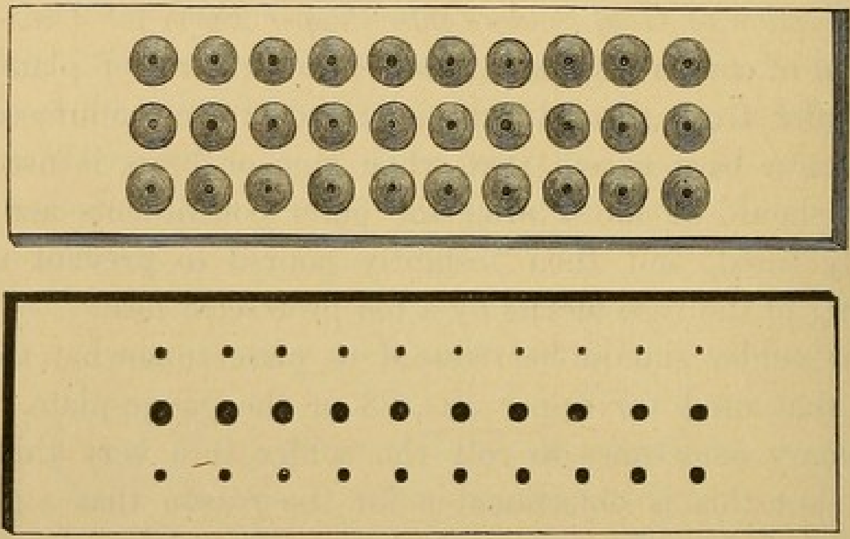
Thickness of Plate for Clasps, Stays, etc.—Plate for these purposes should correspond with from 20 to 22 of the gauge; a less amount of substance, as before stated, being required when the alloy has incorporated with it a small proportion of platinum.

Reduction of Gold Solders into Proper Form for Use.—The method of converting gold solders into the form of plate, does not differ from that already described in the manufacture of plate as a base, except that when zinc or brass is used, the latter should be added after the other constituents are completely fused, and then instantly poured to prevent undue wasting of the base metals by a too protracted heat.

The solder should be reduced to plate somewhat thinner than that used for upper sets, 28 of the gauge-plate. It is customary sometimes to roll the solder into very thin ribbons, but this is objectionable for the reason that a greater amount of the alloying metals being exposed in a given surface to the action of the heat in soldering, are burnt out or oxidated, which interrupts the flow and weakens the attachment between the solder and plate.

Method of Obtaining Gold Wire.—To convert gold or its alloys into the form of wire, the operator should be provided with a draw-plate, a vice, and a pair of hand-pincers. A draw-plate (Fig. 28) is an oblong piece of steel pierced with a regular gradation of holes, or a series of progressively diminishing apertures, through which the gold bar, reduced to a rod, is forced and made to assume the form and dimensions of the hole through which it is last drawn. The holes are formed with a steel punch, and are enlarged on the side where the wire enters and diminish with a gradual taper to the other side. A *draw-bench* is sometimes employed in extending the wire, the power being applied by a toothed wheel, pinion, and rack-work, and is moved by the hands of one or two persons. For the purposes of the dentist, however, it will be sufficient to fix the draw-plate securely between the jaws of a bench-vice, and, by seizing hold of one end of the gold rod with a strong pair of clamps or hand-pincers, serrated or cut like a file on the inside of the jaws, the wire may be drawn steadily through the plate, passing from the larger to the smaller holes until a wire of the required size is obtained.

Fig. 28.



In drawing the wire, the motion should be steady and uniform, for if drawn interruptedly or by jerks, the wire will be marked by corresponding inequalities. The gold rod should also be annealed from time to time, and the holes kept well greased or waxed.

The process described above will answer equally well in reducing any of the ductile metals to wire, as silver, copper, platinum, etc., so that any further description of the method, in connection with these metals, will be unnecessary.

Method of Constructing Spiral Springs.—Inasmuch as spiral springs have been, to a great extent, superseded by more approved agencies employed in the retention of artificial teeth in the mouth, and as all the principal dental furnishing houses are suppled with these appliances already prepared for use, the author does not deem it necessary to enter into a description of the various apparatuses used in making them.

The following simple contrivance will meet the limited requirements of those who are obliged or prefer to manufacture their own springs. The wire, obtained as already described, is held between two blocks of wood fastened between the jaws of a bench-vice. By means of a small hand-vice, one end of the wire is clamped to a uniformly cylindrical and well-tempered steel rod or wire four or six inches long, and about the size of a small knitting needle, and which being made to revolve while resting on the blocks of wood, the wire is wound firmly and compactly around it, producing a uniform coil.

CHAPTER VI.

SILVER.

General Properties of Silver.—Pure silver, when planished, is the brightest of the metals. Fused, or in the form of ingot, its specific gravity is 10.47; but when hammered or condensed in the coining press, its density is increased, and its specific gravity becomes 10.6. It fuses at an extreme red heat, generally estimated at 1.873° Fahrenheit. It is remarkably laminable and ductile; yielding leaves not more than $\frac{1}{100000}$ of an inch thick, and wire 400 feet of which may be drawn weighing but a single grain. It exceeds gold in tenacity or cohesion, but is inferior to platinum in this respect. A silver wire .078 of an inch in diameter will sustain a weight of 187.13 pounds. Fine silver is unaffected by moisture or pure atmospheric air, but is readily tarnished with a film of brown sulphuret by exposure to sulphuretted hydrogen. The sulphuret of silver thus formed may be easily removed by rubbing the metal with a solution of *cameleon mineral*, prepared by calcining equal parts of black or peroxide of manganese and nitre. Unlike gold and platinum, it is readily soluble in nitric acid; this and sulphuric acid being the only simple ones that dissolve it. Silver becomes very brilliant when heated; boils and vaporizes above its fusing-point; and when cooled slowly, its surface presents a crystalline appearance.

Alloys of Silver.—Silver combines readily with most metals, forming compounds of variable degrees of malleability, ductility, density, etc.

Tin, zinc, antimony, lead, bismuth and arsenic, render it brittle. A very minute quantity of tin is fatal to the ductility of silver. Silver does not easily combine with iron, although the two metals may be united by fusion. Gold, copper, platinum, iridium, steel, manganese, and mercury, also form alloys with silver.

An alloy of nine parts of silver and one of copper is the Government standard of the United States coinage since 1837. To this, three-cent pieces form an exception; these being composed of three parts silver and two of copper. The coins of silver having a greater average fineness than those of our own country, are Brazil, Britain, Chili, France, Greece, Hindostan, Persia, Portugal, Rome, and Tuscany. A common impression prevails that the Mexican silver coin contains more than an average percentage of silver, and is therefore sought after on account of its supposed purity. This is true of some pieces coined at different periods, but the average fineness of the Mexican, as well as Spanish coins, is exceeded by those of the United States mints.

Reduction of Silver to the Required Forms for Dental Purposes.—Owing to the very soft and flexible nature of silver in its pure state, it is usual, when converting it into plate or other forms for use, to employ an alloy of the metal. Hence silver coins, which are made harder by the copper they contain, are generally selected for the purpose. The employment of silver, thus debased, as a base for dental substitutes is regarded by many as unsafe and injudicious. Although the influences of an alloy so readily acted upon as this by the various agents which affect it chemically, cannot always be certainly predicted in every case, yet no reasonable doubt can be entertained but that, under the favoring conditions which usually exist in the mouth, the evils accruing, directly and indirectly, to the organs of the mouth, and through them to the general system, are positive and undoubted. If used at all, therefore, it should be alloyed with the least practicable amount of copper, or what is better, pure silver should be reduced with platinum alone, in sufficient quantities to impart to the plate an adequate degree of strength and elasticity. The tendency of silver to tarnish in the mouth when alloyed with copper, may be diminished by boiling the finished piece in a solution of cream of tartar and chloride of soda, or common salt, or by scrubbing it with aqua ammonia, which removes the superficial particles of copper, and exposes a surface of fine silver. When platinum is introduced as the sole alloying component, the purity of the silver is not only preserved, but the alloy is less easily acted on chemically, while the plate derived from it is rendered sufficiently inflexible and elastic. From three to five grains of platinum may be added to one pennyweight of pure silver.

On account of the strong affinity of sulphur for silver, the fuel most proper to be used in melting it is charcoal. The various processes employed in the conversion of silver into the required forms for use are similar to those described for gold, and need not be recapitulated.

Formulas for Silver Solders.—Silver solders are usually composed of silver, copper, and zinc, in variable proportions. Alloys formed from the following formulas are such as are generally employed in soldering silver plate derived from the coins of that metal. Three-cent pieces, composed of two parts silver and one of copper, may also be used for the same purpose.

Formula No. 1.		*Formula No.* 2.	
Silver, . .	66 parts.	Silver, . .	6 parts.
Copper, . .	30 "	Copper, . .	2 "
Zinc, . .	10 "	Brass, . .	1 "

When the material to be united is composed of pure silver and platinum, silver coin alloyed with one-tenth zinc may be used as a solder.

In compounding silver solders, the silver and copper should be first melted, and the zinc or brass afterwards added, when they should be quickly poured to prevent undue waste, by oxidation, of the more fusible component. The ingot when cold, should be rolled into a plate a little thicker than that recommended for gold solder.

CHAPTER VII.

PLATINUM AND THE PLATINOID METALS.

PLATINUM is a grayish-white metal, resembling in some measure polished steel. It is harder than silver, and has a density greater than any other known metal, its specific gravity being 21.25. It remains unaltered in the highest heat of a smith's forge, and can only be fused by means of the oxy-hydrogen blow-pipe and galvanism. A white heat does not tarnish it, nor is it in any way affected by exposure either in the air or water. It is insoluble in any of the simple acids; nitro-muriatic acid being the only one that dissolves it. It is sufficiently malleable to be hammered into leaves so thin as to be blown about by the breath. It may be drawn into wire the two-thousandth of an inch in diameter, and a still greater attenuation may be obtained by coating the wire with silver, drawing it out, and dissolving off the latter metal.

Platinum is very soft and flexible, and when rolled into thin sheets, say 28 or 30 of the gauge-plate, and well annealed at a strong white heat for eight or ten minutes, it may be readily forced into all the inequalities of a zinc die without producing any appreciable change in the face of the latter.

The following interesting and practical observations on the method of melting and welding platinum scraps are taken from a recent dental publication,* by E. A. L. Roberts. By this process, the operator will be enabled to re-convert his waste scraps of platinum into convenient forms for use, and which he could not otherwise avail himself of on account of the infusible nature of this metal in its uncombined state.

"Platinum used by dentists should be soft, tough, and without flaws. These qualities can be attained only by

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* Dental Instructor, vol. i, p. 10.

thorough melting and welding. The welding must be done at a white heat. When the surface is cool enough to be visible, the metal is too cool to be welded, and every blow is injurious, because it has a tendency to shatter and shake it to pieces. The necessary delicacy of this process, and the uncertainty of success, has led some writers to declare that platinum is incapable of being welded. The platinum must be perfectly clean, and must be heated in a muffle. When welded, the metal should be handled with tongs plated with platinum, and hammered with a clean hammer on a clean anvil, both of which should be as hot as possible, without drawing the temper of the steel. The hammer used in welding should weigh about a pound, to prevent drawing the metal; but when welded, the metal may be forged with a heavier hammer.

"The scraps or sponge should be condensed in a square mould, very compactly, two pieces of which, weighing from ten to twenty ounces, may be put into a muffle together. When the heat becomes so great that on opening the door the metal becomes invisible, bring one of the pieces in the tongs quickly to the anvil, give it three or four quick, sharp blows, in rapid succession. Return the piece to the muffle, and proceed with the other piece in like manner, and thus alternately till both are thoroughly welded.

"We use one of our improved tooth-furnaces of the largest size, fourteen by ten inches, inside measure.

"Platinum should never be thrown into water while hot, as that tends to make it crystallize. It should be thoroughly hammered, as it makes it tough and fibrous. The following process gives the best results in melting this metal. Condense the scraps, sponge or filings in an iron mould. Lay the condensed mass on a concave fire-brick, and heat it to whiteness. Take the brick from the muffle, and place it in a sheet-iron pan, coated with plaster and asbestos. The pan should be deep enough and broad enough to catch all the globules and other loose particles of the metal. Place it under the jet of the oxy-hydrogen blowpipe, in the following manner:

"The pan is provided with a handle, opposite to which is a ring, which is to be attached to an iron hook and rod, suspended from the ceiling by a slip of india-rubber, which enables the operator to hold the pan conveniently at any distance from the jet of the burning gases. The hydrogen is first lighted, and gives a powerful flame, but as the oxygen combines with it, the flame subsides into an intense focus of heat, in which the metal is soon brought to a state of fusion. Begin at one end and melt along towards the other, till the whole is fused in one mass. The platinum in this condition, when cool, is quite crystallized and sonorous. It breaks very easily, like spelter-zinc. Heat it very hot and forge it. A continuation of this process renders it soft, tough, and fibrous. When reduced to the width desired, and to the thickness of one-fourth of an inch, it should be made very hot, and passed instantly through the rollers."

Platinum, in mechanical practice, is chiefly employed as a base for continuous gum work; it is also used as a coloring ingredient of porcelain, and for pins in the manufacture of mineral teeth; and, to a limited extent, in some of the minor operations of the shop.

Pure gold is the only proper solder for this metal.

Alloys of Platinum.—Platinum unites with most of the base metals, forming alloys of variable degrees of hardness, elasticity, brittleness, color, fusibility, etc., but their practical value to the dentist is not sufficient to justify a separate description of their properties.

Alloyed with *gold* it forms a straw-colored alloy, the shade depending on the quantity of gold added. *Silver* hardens it, the resulting alloy being unaffected by sulphur.

Platinoid Metals.—The platinoid metals, palladium, iridium, osmium, rhodium, and ruthenium, are native contaminations, the alloys of these metals having a close general resemblance to platinum.

Among the platinoid metals, palladium is the only one that has been used for dental purposes, and that only to a limited extent. It is of a steel-gray color, and when planished, is a brilliant steel-white metal not liable to tarnish in the air. Though closely resembling platinum, it may be readily distinguished from the latter metal by the following tests: 1. It has little more than one-half the density of platinum. 2. If a piece of it is heated to redness, it assumes a bronze-blue shade of greater or less intensity, as it is cooled more or less slowly; but if it is suddenly chilled by immersing it in cold water, it instantly resumes its original lustre. 3. When a drop of the tincture of iodine is let fall upon its surface and evaporated over the flame of a lamp, a black spot remains, which does not occur with platinum. Palladium melts at about 9500° Fahrenheit, and does not oxidize at a white heat. Its specific gravity is from 11.8 to 12.14.

CHAPTER VIII.

Aluminum.

Aluminum is the metallic basis of alumina, the latter being the characteristic ingredient of common clay. It is only within the past few years that the attention of chemists has been directed to the production of this remarkable metal with a view to its general introduction into commerce and the arts. Prior to the researches of M. Deville, who, under the patronage of the then Emperor of the French, commenced his researches in 1854 for the production of this metal on a large scale, the small quantities produced and the corresponding exorbitant prices it commanded, rendered it entirely unavailable for other purposes than merely scientific experiment. The improvements in the methods of obtaining it, however, which have been recently introduced, cannot fail, by rendering its production more economical, to supply it in much larger quantities and at a corresponding reduction in the cost of the metal.

The following account of the properties of this metal is taken from a paper read before the Society of Arts, London, by its Secretary, P. Le Neve Foster. It embodies the most authentic and complete description of the properties of aluminum that has yet been published.

"One of the most striking properties of aluminum is its extreme lightness, its specific gravity being 2.6, nearly that of glass, whilst that of platinum is 21.5, gold 19.5, silver 10.5, copper 8.96, zinc 7.2, tin 7.3.

"The metal is malleable, ductile, almost without limit; it can be reduced to very thin sheets, or drawn into very fine threads. Its tenacity, though superior to that of silver, is less than that of copper; but no very accurate experiments have been made in this respect.

"When pure it is about as hard as silver. Its elasticity is not great. It files readily, and is said not to injure the file. It conducts electricity with great facilty, so that it may be considered as one of the best conductors known, almost equal in this respect to silver, and more than eight times a better conductor than iron. It melts at a temperature a little above that of zinc, between zinc and silver. In its chemical qualities it would seem to take an intermediate rank between what are termed the noble metals and the common metals, being, as Deville states, one of the most unalterable of metals.

"It might be imagined that it would as readily reassume its oxygen as it parted with it with difficulty when in its state of oxide. This, however, is not the case; it appears to be as indifferent to oxygen as either platinum or gold. In air and in oxygen it undergoes no sensible alteration, and it even resists it at the highest temperature which Deville could produce in a cupelling furnace, a temperature higher than that employed in assaying gold. Water has no action, according to Deville, on aluminum, neither at its ordinary temperature, nor when boiling, nor even upon the metal at a low red heat, near its melting-point. According to Professor Crace Calvert, this statement must be received with some degree of caution, as in experiments he has made he considers that oxidation does take place slowly when the metal is immersed in water for any considerable length of time. It is not affected by sulphur or sulphuretted hydrogen, like silver, nor is it acted upon to any considerable degree by any of the oxy-acids in the cold; nitric acid, whether strong or weak, at its ordinary temperature, in no way affects it, though when boiling it acts upon it slowly. Small grains of aluminum, plunged in sulphuric acid for three months, remained apparently unaltered. The vegetable acids, such as acetic, oxalic, and tartaric acids, have scarcely any effect on it at all. The true solvent of the metal is hydrochloric acid, which attacks it rapidly. It appears to resemble tin when brought into contact with hydrochloric acid and the chlorides. Its absolute harmlessness permits of its being employed in a vast number of cases where the use of tin would not be desirable on account of the extreme facility with which that metal is dissolved in the organic acids.

"Figuier, in his scientific *Year Book* for 1858, just published, states that the caustic alkalies, potash, and soda, and even ammonia, dissolve aluminum sensibly. He also states that common salt and acetic acid (vinegar), especially when mixed, attack and dissolve aluminum. He adds, that the mixture of salt and vinegar for seasoning a salad, made in a spoon of aluminum, feebly but inevitably attacks it.

"All these points, however, deserve to be inquired into, as there seems some discrepancy between different writers on them."

Alloys.—"Aluminum, like iron, does not unite with mercury, and scarcely at all with lead. It, however, forms a variety of alloys with other metals. It can be alloyed with iron, and when aluminum becomes cheaper, it will be curious to see what effect mixtures of this metal with iron will have upon its quality, whether for good or for evil. It seems to unite readily with zinc, and these have been found to give the best promise as solders for aluminum; but, unfortunately, when melted, neither of them are sufficiently liquid, and does not run readily. The joints will not bear a blow. A variety of alloys with nickel have been made, and that consisting of 100 parts of aluminum and 3 of nickel, is found to work readily, and to have gained hardness and rigidity, as compared with the pure metal. The alloys, however, with copper are the most striking; they are light and very hard, and capable of a fine polish. In the same degree that copper adds to the hardness of aluminum, so does the latter, when used in small quantities, give hardness to copper, without, however, injuring its malleability. It renders it susceptible of a fine polish, and, according as the proportions are varied, the color of the alloy becomes deep or pale gold. Alloys of copper with five and ten per cent. of aluminum, resemble gold perhaps more than any other metallic alloy hitherto employed. They do not tarnish sensibly by exposure to the air. Aluminum can be deposited by the battery, and by the same agent it can be gilt or silvered."

Some attempts have been made to render aluminum available as a base for artificial teeth, but with only partial success. When in the form of plate, no suitable solder has yet been discovered by which the several parts of a dental appliance may be securely united to each other; and experiments in casting this metal have practically failed, owing to its extreme lightness and consequent want of fluidity, and great contraction. More experience in its proper management, and a further acquaintance with its capabilities in yet unknown forms of combination with other metals, may ultimately demonstrate its general applicability to dental purposes.

At the present time, its use is rarely attempted except as a base in connection with rubber or celluloid, the latter substances being employed as a means of attaching teeth by a method similar to that described in another place when gold or silver plate is used.

CHAPTER IX.

Copper, Zinc, Lead, Tin, Antimony, and Bismuth.

COPPER.

Copper is one of the metals most anciently known; is of a brownish-red color, with a tinge of yellow; has a faint but nauseous and disagreeable taste, and imparts, when exposed to friction, a smell somewhat similar to its taste. Its specific gravity ranges from 8.8 to 8.9. It is both malleable and ductile, but excels in the former property, finer leaves being obtained from it than wire. It is inferior to iron in tenacity, but surpasses gold, silver, and platinum in this respect. Copper melts at 1996° Fahrenheit.

Alloys of Copper.—Copper unites readily with most metals, forming alloys of great practical value in the arts, but which have but a limited application in dental laboratory processes. Many of these alloys are curious and instructive as illustrating the singular and unaccountable influence of alloying upon the distinctive properties of the component metals. Copper and tin, for example—the former of which is highly ductile, and the latter equally malleable—when combined in the proportion to form speculum metal (9 C — 1 T), forms an alloy distinguished for its extreme brittleness, with a surface hardness almost equal to steel. By increasing the quantity of tin until the compound assumes the proportions constituting gun-metal (C 2 — T 1), the alloy, though neither malleable or ductile, becomes eminently tough and rigid. Other prominent examples might be given, showing how completely this combining influence defies all calculations in regard to ultimate results. The following summary embraces the names and composition of the more familiar alloys of copper, omitting, as unnecessary in this connection, a description of their individul properties.

Alloys of Copper with Zinc.—*Brass* is an alloy of uncertain and variable composition, consisting usually, however, of 2 to 5 parts of copper and one of zinc. Brass melts at 1869° Fahr. *Prince's metal*, and its allied compounds, *Pinchbeck*, *Similor*, and *Manheim gold*, consist of nearly equal parts of copper and zinc. *Mosaic gold* consists of 100 parts of copper and from 52 to 55 of zinc. *Dutch gold*, from which foil of that name was formerly obtained, is formed of 11 parts of copper with 2 of zinc. *Bath metal* is composed of 32 parts of brass and 9 of zinc.

Brass solder consists of 2 parts of brass and 1 of zinc, to which a little tin is occasionally added.

Alloys of Copper with Tin.—*Bell metal* usually consists of 100 parts of copper with from 60 to 63 parts of tin. *Cannon metal* is compounded of 90 parts of copper with 10 of tin. *Cymbals* and *gongs* contain 100 parts of copper and 25 of tin. *Speculum metal* consists of two parts of copper and 1 of tin.

Copper and arsenic form a white-colored alloy, and in the proportion of 9 parts of copper and 1 of arsenic, is white, slightly ductile, and is denser and more fusible than copper.

Genuine *German silver* is composed of copper, 40.4; nickel, 31.6; zinc, 25.4; iron, 2.6; but the proportions of the metals of this alloy differ according to the various uses to which this compound is applied.

Chinese packfong consists of 5 parts of copper alloyed with 7 parts of nickel and 7 parts of zinc.

A very useful alloy, employed in making plummer blocks, bushes, and steps for the steel and iron gudgeons and pivots of machinery to run in, is said to consist of 90 parts of copper, 5 of zinc, and 5 of antimony.

ZINC.

Zinc is a bluish-white metal, possessing considerable lustre when broken across. The commercial variety is always impure, containing traces of iron, lead, cadmium, arsenic, carbon, etc. It does not easily tarnish in dry air, but soon becomes dull on exposure to moisture. In the condition in which it ordinarily occurs it is a brittle metal, but may be rendered malleable by annealing it at certain temperatures. This change in its condition is effected by subjecting it to a heat of from 220° to 300°, at which temperature it may be rolled into sheets, and retain its malleability when cold. The best annealing temperature for zinc is about 245°. A knowledge of this fact will enable the operator to avail himself of the advantages of this property by annealing his zinc die, by which its liability to crack or part under the hammer is diminished.

The specific gravity of zinc varies from 6.9 to 7.2. It melts at about 773°, and when heated much above this point with contact of air, it burns with a brilliant greenish-white flame, while woolly-looking flocculi rise from the vessel in which it is being heated and float in the air.

Zinc has been long and almost exclusively employed in the formation of dies used in swaging metallic plates employed in mounting artificial teeth, and experience has very justly accorded to it undisputed pre-eminence above all other unalloyed metals for the purpose. A more particular account of its peculiar fitness for dental purposes will be given under the head of Metallic Dies and Counter-Dies.

LEAD.

Lead has a grayish-blue color, with a bright metallic lustre when melted or newly cut, but it soon becomes tarnished and dull-colored when exposed to the air. The specific gravity of commercial lead, which is usually contaminated with other metals, is 11.352. It fuses at 612°. Exposed to a high heat, it absorbs oxygen rapidly, forming on its surface a gray film of protoxide and metallic lead. It is both malleable and ductile, but soft and perfectly inelastic.

Lead, either in its pure state or when alloyed with certain other metals, serves important purposes in the laboratory. In its simple or uncombined state it is useful only in forming counter-dies. Alloyed with antimony in the proportion of from $\frac{1}{4}$ to $\frac{1}{8}$ of the latter, with the addition sometimes of very small portions of copper, tin, and bismuth, it forms different grades of *type-metal*, which is harder than lead, and very brittle, and is sometimes used for dies; and sometimes, though very rarely, for counter-dies. When used as a counter to a zinc die, it is improved for the purpose by adding to it an equal quantity of lead; it may also be used in the form of a die in connection with a lead counter after rough stamping with zinc.

The alloy known as Rose's *fusible metal* is composed of 2 parts of bismuth to 1 of lead, and 1 of tin, and melts at about 200°. A still more fusible alloy is composed of lead 3 parts, tin 2 parts, and bismuth 5 parts, which fuses at 197°. There are other alloys of lead, to be mentioned hereafter, melting at from 200° to 440°, which may be advantageously employed in forming dies to be used after zinc, where the latter, from its greater shrinkage, fails to bring the plate into accurate adaptation to the mouth.

Soft solder is an alloy composed of lead and tin in the proportion of two parts of the former to one of the latter.

TIN.

Tin is a brilliant, silver-white metal, the lustre of which is not sensibly affected by exposure to the air, but is easily oxidized by heat. It has a slightly disagreeable taste, and emits, when rubbed, a peculiar odor. It is soft, inelastic, and, when bent, emits a peculiar cracking sound called the *creaking of tin*. It is inferior in tenacity and ductility, but is very malleable, and may be beaten into leaves the $\frac{1}{2000}$ of an inch in thickness; ordinary *tin foil* being about $\frac{1}{1000}$ of an inch thick. It fuses at 442°; boils at a white heat, and burns with a blue flame to binoxide.

The more common alloys of tin with other metals have already been noticed. It was at one time used as a base for artificial teeth; and, more recently, it has been introduced as a component of "cheoplastic" metal, a compound used for the same purpose. In its pure state, it is sometimes used for counter-dies, and occasionally for dies. When employed for the latter purpose in connection with a lead counter, the latter should not be obtained directly from the die, as the high temperature of melted lead would produce, when poured upon tin, partial fusion of the latter and consequent adhesion of the two pieces. When tin is used in the formation of a die, therefore, either a counter previously obtained from a zinc die should be used, or the "dipping" method employed, by which the counter-die is first obtained from the plaster model, and a die from the counter.

ANTIMONY.

Antimony is of a silver-white color, with a tinge of blue, a lamellar texture, and a crystalline fracture. It is brittle and easily pulverized. The specific gravity of the purest variety is 6.715. It fuses at about 810°, and when heated at the blowpipe, it melts with great readiness, and diffuses white vapors, possessing somewhat of a garlic smell.

Antimony enters as an ingredient into the composition of type and stereotype metal, music plates, and Britannia metal. It is also a component of certain fusible alloys analogous to those already mentioned under the head of lead, and which, in the form of a die, are sometimes used on account of their slight degree of shrinkage.

BISMUTH.

Bismuth is a white-colored metal resembling, in some degree, antimony. It is soft, but so brittle as to be easily pulverized. Its specific gravity is 9.83, which may be increased somewhat by hammering. It melts at 480° Fah., and may be cooled six or seven degrees below this point without fixing; but the moment it begins to solidify the temperature rises to 480°, and continues stationary till the whole mass is congealed. When the temperature of the metal is raised from 32° to 212° it expands $\frac{1}{720}$ in length.

Bismuth has the property, in a high degree, of increasing the fusibility of the metals with which it is incorporated, and is a common ingredient of the more fusible alloys, some of which melt in boiling water. One part of bismuth with 24 of tin is malleable, but the alloy of these metals becomes brittle by the addition of more bismuth. Bismuth unites readily with antimony, and in the proportion of one part or more of the former to two of the latter, it expands in the act of cooling.

There are many other metals and alloys besides those already enumerated, but which have not been particularly described on account of their inutility in the laboratory for dental purposes. Among these may be mentioned *iron, brass, bronze*, etc., which are only employed for auxiliary purposes, and are both inconvenient and impracticable for dies on account of their infusible nature and consequent contraction; *nickel*, on account, also, of its extreme infusibility and its tendency to render the alloy, of which it is a component, less fusible; *sodium*, on account of the changes produced on it by exposure to the air; *potassium*, on account of its extreme sensitiveness to the influence of low temperature, being semi-fluid at 60° Fah., nearly liquid at 92°, and entirely so at 120°; *arsenic*, because it volatilizes before fusing; *cadmium*, with no advantages above tin, on account of its scarcity and costliness; etc.

CHAPTER X.

General Properties of Alloys, and their Treatment and Behavior in the Process of Compounding.

All alloys possess metallic lustre, are opaque, conduct heat and electricity, and, in a greater or less degree, are ductile, malleable, elastic, and sonorous. Some alloys, as brass and gong-metal, are usually malleable in the cold, and brittle when hot.

Metals sometimes unite in atomic ratios, forming compounds of definite or equivalent proportions of the component metals, as certain alloys of copper and zinc, gold and copper, gold and silver, mercurial alloys, etc., while, on the other hand, many are formed in all proportions, like mixtures of salt and water.

Metals differ in respect to their affinity for each other, and do not, therefore, alloy with equal facility; thus it is difficult to unite silver and iron, but the former combines readily with gold, copper, or lead.

The ductility of an alloy is, in general, less than that of its constituent metals, and this difference is, in some instances, remarkably prominent, as in the case of certain alloys of copper and tin, already mentioned.

An alloy is generally harder than the mean hardness of its components, a property which, when taken in connection with their increased fusibility, gives to alloys peculiar value in the formation of dies for stamping purposes. To the rule stated, amalgams, or mercurial alloys, are cited as exceptions.

The density of an alloy varies with the particular metals composing it, being generally either greater or less than the mean density of its several components.

It is impossible to predict with certainty the melting-point of an alloy from that of its separate constituents, but, generally, the fusibility of the alloy is increased, sometimes in a most remarkable degree. The alloy of 5 parts of bismuth, 3 of lead, and 2 of tin is a striking example of this fact, this compound melting at 197°, while the mean melting-point of its constituents is 514°. Silver solder is also a familiar illustration of the influence of alloying on the fusibility of metals, copper melting at 1996°, and silver at 1873°, when combined, fuse at a heat much below that required to melt silver, the more fusible component of the alloy. Again, iron, which melts at a little less than 3000°, acquires almost the fusibility of gold when alloyed with the latter. Examples might be multiplied, but it will be sufficient to add that, in general, metallic alloys melt at a lower heat than is required to fuse the most refractory or infusible component, and sometimes than the most fusible ingredient.

The color of an alloy cannot, in general, be inferred from that of its component metals; thus it would be conjectured that copper would be rendered very much paler by adding to it zinc in considerable quantities, but the fallacy of such an inference is at once shown by an examination of some of the rich-looking gold-colored varieties of brass, as Prince's metal, pinchbeck, and similor, composed each of nearly equal parts of copper and zinc; and manheim gold, compounded of 3 parts copper and 1 of zinc.

The affinity of an alloy for oxygen is greater than that of the separate metals, a phenomenon that is ascribed by Ure to the increase of affinity for oxygen which results from the tendency of one of the oxides to combine with the other; by others it is attributed to galvanic action. According to Faraday, 100 parts of steel, alloyed with one of platinum, is dissolved with effervescence, in dilute sulphuric acid too weak to act with perceptible energy on common steel. It is offered, in explanation of this fact, that the steel is rendered positive by the presence of platinum. A similar illustration is afforded by the action of dilute acid on commercial zinc, which is usually an alloy of zinc with other metals.

The action of air is, in general, less on alloys than on the separate metals composing them. To this, however, there are exceptions, as the alloy of 3 parts of lead and 1 of tin, which, when heated to redness, burns briskly into a red oxide.

Some points of practical interest suggest themselves in connection with the behavior and proper management of alloys in the process of compounding.

As metallic alloys can only be formed by fusion, and as the affinity of the metals composing them for oxygen is greatly increased by heat, especially those denominated base, it is important that this tendency, which is incompatible with the proportional accurateness of the compound, should be, as far as practicable, guarded against. Hence, various substances having a greater affinity for oxygen than the metals to be united, as oil or grease, rosin, powdered charcoal, etc., are generally added, coating the surface of the liquid metals, and which, by affording a protective covering, preserves, with little change, the proportions of the alloy.

Some difficulty is occasionally experienced in obtaining a perfectly uniform alloy on account of the different specific gravities of the metals composing it—each metal assuming the level due to its density. This partial separation is common to gold and silver, provided they have not been adequately stirred before pouring. This result is not so likely to occur when the metals employed are in small quantities and are suddenly cooled, but when used in considerable masses and allowed to cool slowly, it is much favored by permitting the metals to fix themselves in the order of their separate densities. Hence, whenever a notable difference in the specific gravity of the metals exists, the fused mass should be briskly stirred immediately before the instant of pouring it, and should be made to solidify quickly. If uniformity be not obtained in this manner, it will be necessary to remelt, and repeat the process, if necessary, until the alloy is rendered sufficiently homogeneous.

In alloying three or more metals differing greatly in fusibility, or that have but little affinity for each other, it is better to first unite those which most readily combine, and, afterward, these with the remaining metal or metals. If, for example, it is desired to unite a small quantity of lead with brass or bronze, some difficulty would be experienced in forming the alloy by direct incorporation of the metals, but union could be readily effected by first melting the lead with zinc or tin, and then adding the melted copper.

PART SECOND.

ARTIFICIAL DENTURES.

Before considering particularly the distinct and special methods employed in the construction of artificial dentures, such preliminary processes as are common, in some degree, to all, will, for the sake of convenient arrangement, and the avoidance of unnecessary repetition hereafter, be first considered. These processes relate: 1. To the treatment of the mouth preparatory to the insertion of artificial teeth. 2. The manner of obtaining impressions of the mouth. 3. The manner of procuring and forming plaster models of the mouth. 4. Metallic dies and counter-dies.

CHAPTER I.

Treatment of the Mouth preparatory to the Insertion of Artificial Dentures.

It rarely occurs that all the structures of the mouth are in such condition as will render it proper to insert an artificial appliance without some preparatory treatment. This important requirement cannot, in any material respect, be disregarded by the practitioner without endangering the utility and permanence of the substitute, and inflicting upon the patient a train of consequences alike distressing and pernicious. Every experienced dentist is familiar with the fact that an artificial substitute resting upon diseased roots of teeth and impinging continually upon gums already irritable and inflamed, soon becomes a source not only of annoyance and discomfort to the patient, but is rendered, in a great degree, inefficient in the performance of some of its more important offices. There is, besides, a perpetual and cumulative aggravation of the morbid conditions, and, sooner or later, irretrievable destruction of the remaining natural organs will be induced. These consequences cannot be wholly averted by the most skilful manipulation, but they may be greatly magnified by a defective execution of the work or by a faulty adaptation of the appliance to the parts in the mouth.

Patients not unfrequently attempt, by every artifice or pretext that caprice or timidity may suggest, to persuade the operator to violate his own clear convictions of duty, but, unless under circumstances of peculiar exigency, he should be careful to guard himself against the imputation of incompetency or bad faith by being peremptory and unyielding in his demands upon the patient to submit to the necessities and just requirements of the case, and no ordinary circumstance should influence him in opposition to his better informed judgment.

The conditions, usually met with, to which it will be necessary to direct attention in the treatment of the mouth, are, the presence of useless and diseased remains of teeth; accumulations of tartar; diseased states of the gums and mucous membrane; and caries.

Useless and Diseased Remains of Teeth.—It may be stated, as a general rule of practice, that all the remaining natural teeth that are not susceptible of being restored to a state of comparative health and usefulness, should be removed before inserting an artificial substitute. Especially should this course be pursued whenever the remaining roots are found partially or wholly necrosed, and the peridental membranes and surrounding tissues inflamed and suppurating. Such should be extracted if for no other reason than that they are offensive in the mouth, and tend, in a greater or less degree, to compromise the general health.

In respect to the utility, comfort, and permanence of a dental appliance, the expediency of removing the roots of teeth prior to the introduction of the former, is apparent. If a dental substitute is adapted with necessary accuracy to all the parts which it covers, it will be plainly seen that the forces applied to the base at every occlusion of the jaws in the act of mastication, instead of being equalized or diffused, will be expended mainly on the roots, inasmuch as they afford so many fixed points of resistance, whilst the adjacent soft tissues, yielding to the pressure, permit the artificial piece to bear with undue and unequal force upon the former. The consequences of this action are inevitably pernicious. In a comparatively short time, inflammation and suppuration are induced about the roots, which ultimately become loosened and painfully sensitive to the slightest pressure; the secretions of the mouth, becoming more and more acrimonious, act persistently and with increasing energy on oxidable materials present in the mouth, as well as upon the remaining natural teeth, inducing rapid and general decay; contiguous parts, through their immediate connection or sympathetic relations with the structures of the mouth, respond to the local disturbances, and the case, in time, becomes complicated with those various distressing maladies about the head and face so commonly associated with diseased conditions of the buccal cavity. At last, the patient, no longer able to endure the offensiveness and distress arising from the presence of the substitute in the mouth, or to properly masticate his food, is compelled to have the offending organs removed. The absorption of the gums and processes which follow this operation, and the corresponding changes which occur therefrom in the form of the alveolar ridge, make it imperative in all cases either to reconstruct the same piece or to supply the patient with an entirely new substitute; whereas, if due regard is had to the proper preparation of the mouth in the first instance, the patient may be spared such inflictions, and the operator the discredit which almost invariably attaches to the neglect of the measures recommended.

An additional reason why roots of teeth should be extracted is, that their presence prevents, in some degree, an accurate and uniform adaptation of the appliance to all the parts on which it is designed to rest, and this is particularly true of those cases where atmospheric pressure is made available in the retention of the substitute. Any condition of the mouth that prominently modifies the natural and uniform pliancy of the soft parts will, just to that extent, weaken the attachment of the plate. This fact is made obvious when we reflect that it is only the soft and yielding condition of the mucous membrane and gums that permits the adhesion of the artificial appliance for a single moment by atmospheric pressure; for it will be readily comprehended that, if the tissues on which it rests were as hard and unyielding as bone, a dental substitute, though it were moulded directly to the parts, would not be sustained for an instant by the external pressure of the air.

The retention of every root that may, by treatment or otherwise, be secured in good condition, has been insisted on by a few in the profession, on the ground that they afford a fixed and permanent basis for the dental appliance, and preserve, without change, the customary fulness and contour of the mouth. Individual instances doubtless occur that render this course admissible, but as a rule of practice, it is exposed, though in a less degree perhaps, to the same objections which have been adverted to in connection with diseased roots. However carefully or skilfully such roots may be treated and prepared, or the substitute applied, entire success and permanent benefit to the patient cannot be reasonably anticipated. It rarely happens that the roots of teeth, whose crowns have been destroyed by caries or accident, are found without having suffered, at some time and in some degree, from disease of the investing membranes and surrounding structures, and although these conditions may have apparently subsided, or may have been temporarily subdued by treatment, yet observation of such cases leads to the conclusion that, however free from indications of active disease they may appear at the time, the latent predisposition favoring a recurrence of the morbid action usually exists in such cases, and it will require no greater provocation than the continued and unequal action of an artificial fixture on them to awaken this predisposition into active development.

From the views here expressed, we are convinced that as a principle of practice, the roots of teeth, however apparently free from disease, should be extracted in the first instance. There are, nevertheless, circumstances which clearly justify a departure from the rule we have endeavored to enforce; as in the process of engrafting an artificial crown upon a well-conditioned root; or supplying the loss of one or more of the front teeth by attaching the artificial organs to a plate and fixing the latter in the mouth by pivoting to one or more of the natural roots. Either of these methods may, under certain circumstances and within certain limitations, be preferable to extracting the roots of such teeth and supplying the vacuities by other means.

Removal of Salivary Calculus or Tartar.—The deposits of tartar which so frequently collect at the necks of the teeth and under the free margins of the gum, not only promote inflammation and absorption of the investing membrane and contiguous soft parts, but involve, by degrees, the alveolar processes in the destructive action; so that teeth originally firm become loosened in their sockets, and thus, in their turn, become additional sources of diseased action in the surrounding structures. Hence it becomes absolutely necessary, as it relates to the general health of the mouth, to thoroughly remove, with suitable instruments, all traces of this concretion from the teeth.

If any considerable number of the teeth are found coated with tartar, and it is deposited in large quantities, it will be impracticable, as a general thing, to remove thoroughly all remains of it at a single sitting. The operation should be repeated, therefore, from time to time, until every portion of it is completely separated from the teeth; the latter should then be well polished with suitably shaped burnishers, and the gums, if highly inflamed and turgid, may be either freely scarified at those points where they dip between the teeth, or cleansed and treated with appropriate detergent and remedial agents.

Diseased Conditions of the Mucous Membrane and Gums.—It will seldom be necessary to institute treatment for the reduction of inflammation and ulceration of the soft tissues of the mouth after the removal of diseased roots and tartar, inasmuch as these conditions being generally provoked by, and associated with, the latter, will spontaneously subside with the removal of the exciting causes. If, however, there are other morbid conditions of the soft tissues or osseous structures of the mouth not immediately arising from the presence of diseased roots and tartar, they should be treated in accordance with the particular pathological conditions present.

Caries or Decay of the Remaining Teeth.—In order that all the teeth which it is deemed advisable to retain in the mouth may be permanently preserved, it will be necessary to fill, or otherwise treat, such as may be affected by caries. This operation will be attended with more satisfactory results and be accompanied with less pain to the patient, and diminished risk of failure, when performed after the removal of the roots of teeth and tartar, and the restoration of diseased conditions of the mouth to health, as, in this case, there will be less irritability of the general system, and reduced sensitiveness of the teeth operated on.

Surgical Treatment of the Mouth after the Extraction of Teeth.—In the preparation of the mouth for entire sets of artificial teeth, it frequently becomes necessary to extract the remains of all or nearly all of the teeth of one or both jaws. In such cases, the ridge is left ragged and broken, with flaps of gum lying in loose folds along the border, and the exposed margins of the alveolar processes projecting from underneath. These parts, if left in this condition, will be productive of more or less inconvenience to the patient; for as the gums close over and contract upon the cutting edges of the processes, irritation and inflammation will be induced at those points where they are most prominent. Immediately after the extraction of the teeth, therefore, any flaps of gum hanging loosely around the sockets should be clipped off, and sharp and protruding portions of processes cut away with excising forceps. If, in the course of a few weeks, prominences still remain, over which the mucous membrane is stretched and irritated or inflamed, as is more frequently the case around the sockets of the cuspidati, the membrane should be divided over such points with a lancet, and the sharp points of bone underneath broken down with suitable cutting instruments.

Time Necessary to Elapse after the Extraction of Teeth before Inserting Artificial Dentures.—The time that should elapse after extracting the natural teeth, before replacing them with artificial substitutes, will depend upon various circumstances. If the appliance is only intended to meet the wants of the individual until all the changes effected by absorption of the gums and processes are fully completed, it may be inserted in from one to three weeks, depending somewhat upon the number of teeth extracted, the extent of the injuries unavoidably inflicted upon the parts, and the virulence of the diseased action present in the structures of the mouth at the time of the operation. If there are no unusual complications, and the space or spaces to be supplied are such as are made by the loss of only one or two teeth at intervals, the parts quickly assume their normal condition, and the piece to be temporarily worn may be applied within a few days. If, however, a greater number or all of the teeth have been removed, more or less inflammation and tenderness will be present for from ten days to two or three weeks, and which will render the wearing of an artificial piece uncomfortable to the patient, and in some degree mischievous, by aggravating the morbid conditions already existing. Another objection to the too early introduction of artificial substitutes into the mouth arises from the fact that the changes which occur in the ridge are much more rapid within the first few weeks after the extraction of the teeth than at any subsequent period, so that the plate, if inserted immediately or within a few days after such operation, will soon lose its bearing upon the ridge and become inefficient for masticating purposes, or may even fail to be retained in the mouth without much annoyance to the patient. Two or more weeks, therefore, should elapse before applying the substitute. In the meantime, the patient should be seen frequently, and such medical or surgical treatment adopted from time to time as the case may demand.

The time occupied in the *completion* of those changes which occur in the alveolar border after the extraction of all or any considerable number of the teeth, cannot be definitely stated, but will range from five to eighteen months or more, according to the amount of superfluous structures to be removed, the density of the osseous tissues, and the functional activity of the absorbents. In all cases, ample time should be permitted to elapse in order that no appreciable change in the form of the parts may take place after the appliance has been permanently adjusted.

CHAPTER II.

Materials and Methods Employed in Obtaining Impressions of the Mouth.

In the process of constructing a dental substitute, it is of the first importance that as accurate an impression as possible should be obtained of all those parts of the mouth with which the appliance is in any way connected. If this important preliminary step is, in any essential respect, imperfectly performed, the ultimate utility of the artificial fixture will either be greatly impaired or wholly destroyed, notwithstanding all the subsequent manipulations may be most carefully and skilfully performed. The operator, therefore, should avail himself of every appliance and facility that will enable him to attain, in this respect, the most perfect results.

The materials ordinarily employed for this purpose are, wax; combinations of wax and paraffin and gutta-percha; modelling composition; gutta-percha; and plaster of Paris.

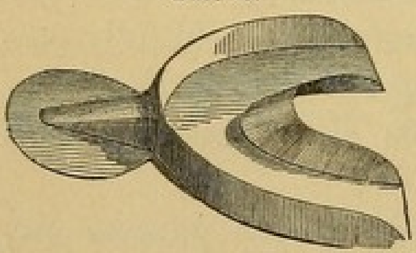
Wax.—There are two varieties of this substance in common use, the *yellow* and *white* wax. The yellow variety is esteemed preferable to the white on account of its superior toughness; the latter being, to some extent, disintegrated, or rendered less tenacious in the process of bleaching, but is frequently used and is preferred by many on account of its color. The more desirable properties of the yellow wax are often impaired by the admixture with it of tallow, with which it is, for mercenary purposes, frequently contaminated. The presence of tallow may be detected by its characteristic odor, and by the whitish or pale-yellow color it imparts to the wax, which in its pure state, is of a deep, bright straw-color.

Wax used for impressions should always be kept in convenient form for immediate use, and may be prepared either by warming it until sufficiently soft and then rolling or pressing it into thin sheets; or having melted it in a properly formed vessel, immerse in it a strip of thin board, previously moistened, and withdraw, quickly; this is repeated as the successive layers cool, until a coating of sufficient thickness is obtained. The latter is a convenient method of obtaining sheets of wax of a uniform thickness, a form frequently required for various purposes in the dental laboratory.

The following directions in the use of wax will apply also to its combinations with paraffin and gutta-percha, and also to modelling composition.

Manner of Obtaining an Impression of the Mouth in Wax for Partial Upper Dentures.—Until within the past few years, wax has been used almost exclusively for the purpose of obtaining an impression of the mouth in those cases where any number of the natural teeth remain in either or both jaws, and, for this purpose, is ordinarily more convenient and manageable than plaster, and, if carefully manipulated, will secure in most cases a sufficiently accurate impression of the parts.

FIG. 29.



Before preparing the wax, a suitable cup or holder should be selected for the particular case in hand. These appliances are usually constructed either of plate or block-tin, Britannia metal, or silver, and a sufficient number of the various forms required should be provided to meet perfectly every requirement in respect to the size and form of the jaws of individual cases.

For upper partial or broken sets, the form of cup represented in Fig. 29 may be used. It should be large enough to embrace the alveolar ridge, leaving a space of nearly a fourth of an inch between its outer rim and the external border of the gum. If it is designed to employ an atmospheric pressure plate covering nearly or quite all of the hard palate, a cup of the same general form, but with its central portion extended posteriorly, may be used; or a full cup, like that represented in Fig. 31, may be employed. Having selected a cup of the proper form and size, the wax should be warmed in a spirit flame until it acquires about the consistence of freshly made putty. Wax is sometimes softened by immersing it in hot water, but the dry heat is preferable, as the former seems to impair, to some extent, its toughness and continuity. In taking the impression the operator should place himself behind and to the right of the patient, and should be sufficiently raised above the latter to enable him to manipulate with the greatest ease and certainty, and at the same time to command as full and unobstructed a view of the interior of the mouth as possible. The cup with the wax arranged should then be introduced into the mouth without unnecessary delay. To do this properly, and without subjecting the patient to annoyance, will occasionally require some care and expertness, on account of the disproportionate size of the cup and orifice of the mouth. An ample and expanded jaw, for example, is frequently associated with a small mouth, and if in addition to this the sphincter muscle of the mouth happens to be rigid and unyielding, the introduction of a cup of sufficient size may be attended with some little difficulty and embarrassment. This impediment, however, may be readily overcome in most cases by presenting the cup obliquely to the mouth, one side resting against, and pressing outward, the corner of the mouth, while—as the opposite corner is extended with the first and second fingers of the left hand—the cup is passed in with a rotary movement.

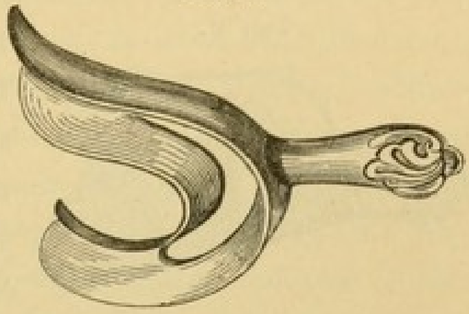
When the cup is within the mouth it should be carefully adjusted over the ridge before pressing it up, so that no portions of the rim may cut into the soft tissues of the mouth, an accident liable to happen without care, and which will make it necessary, in most cases, to withdraw the cup before the impression is complete. The proper position of the cup in the mouth secured, it should be held firmly with the thumb resting on the handle above, and two or more of the fingers on the under surface, when it is slowly but steadily and forcibly pressed against the parts above until the ridge is completely imbedded, and the wax carried closely against the roof of the mouth. The cup should then be held stationary with one hand, while with the fingers of the other the wax around the margins of the cup should be pressed closely into all the depressions occurring on the outside of the ridge between the remaining teeth, or wherever irregularities may present themselves on the external border of the jaw. The finger should also be passed to the roof of the mouth at the central and posterior edge of the cup, making pressure against the protruding wax upward and forward into the anterior and deeper portions of the palatal arch. When the operation has been conducted thus far, and before removing the cup, gentle upward pressure upon the latter may again be made—not enough to move the entire body of wax, but only sufficient to correct any partial displacement that may have happened from accidental tilting or lateral movement of the cup during the concluding manipulations.

After the wax has remained in the mouth long enough to become in some degree hardened, it should be carefully detached by gentle traction upon the cup, and removed from the mouth in the same manner in which it was introduced; care being taken not to displace the wax or otherwise mar the impression. More or less dragging of the wax, however, will unavoidably occur in proportion as the teeth are irregularly arranged in the arch, or have contracted necks. Imperfections occurring from these sources may be remedied with tolerable accuracy by subsequent carving of the plaster model, but the better plan, where these conditions prevail to any considerable extent, is to substitute gutta-percha for wax, the elasticity of this substance enabling it to regain the form it acquires in the mouth after having been temporarily disturbed or changed in the act of detaching it from the teeth.

Inasmuch as it is necessary, in constructing partial sets of teeth, to be provided with two or more plaster models, and as the latter cannot well be obtained in perfect condition from a single impression, it is better that at least two of the latter should be secured in the first instance.

Manner of Obtaining an Impression of the Lower Jaw in Wax for Partial Dentures.—If the case is one where teeth at intervals are to be supplied, the form of cup used in taking an impression for an entire lower denture (Fig. 33) may be employed; or if the vacuity exists in the front part of the ridge only, then one like that represented in Fig. 29 will answer the purpose. If, however, as is more generally the case, the front teeth remain,

FIG. 30.

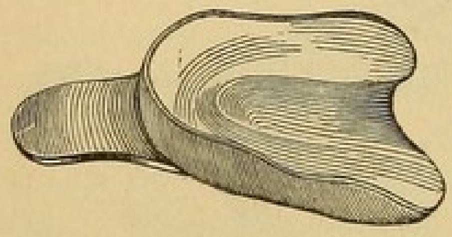


and those posterior to the cuspids or bicuspids are to be replaced, the form of cup exhibited in Fig. 30 should be used; a portion being cut out from the front part of it, forming a vacuity which receives and permits an unobstructive passage of the front teeth. As the latter are often very long, it is difficult, with the ordinary form of cup, to press the wax down fairly upon the ridge behind without bringing their cutting edges prematurely in contact with the floor of the cup in front. Instead of the opening represented in the cup, however, it will be sufficient in most cases to have it formed with a depression in front of adequate depth to receive the points of the anterior teeth.

In taking an impression of the lower jaw, after having prepared and arranged the wax by softening and filling the groove of the cup flush with the margins, the operator may first take a position to the right and back of the patient, and introduce the cup into the mouth in the manner heretofore described, when he should pass to the front of the patient, and having adjusted the cup properly over the ridge, the first two or three fingers of each hand should be placed upon the top of each side of the cup, and a thumb upon each side and underneath the jaw, and firm and steady pressure made until the ridge is wholly imbedded. The wax may then be pressed in around the margins of the cup, and the impression carefully removed from the mouth in the manner before indicated.

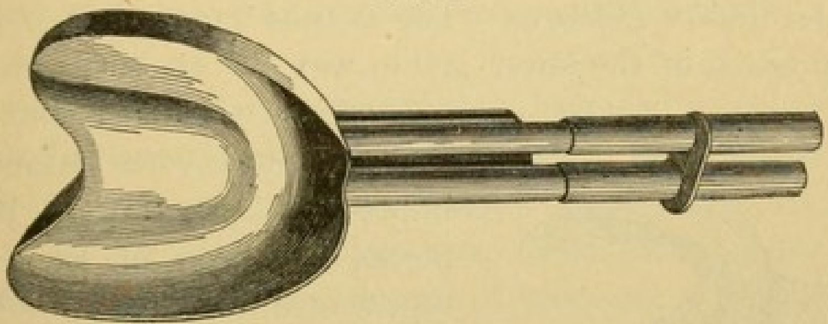
Manner of Obtaining an Impression of the Mouth in Wax for Entire Upper Dentures.—The form of cup employed in taking an impression of the upper jaw in the absence of all the natural teeth, is seen in Fig. 31. A number of these, corresponding as nearly as possible in form and size to the various modifications in the configuration and dimensions of the maxillary arch, should be kept conveniently at hand. If the teeth have been recently extracted, the wax should be prepared somewhat softer than usual to prevent displacement of the gums, which, in their unabsorbed condition, possess more or less mobility. The cup should be filled flush with the edges, and built up in the centre if the depth of the palatal vault requires it, and the wax properly trimmed; it is then introduced into the mouth and adjusted to the ridge, as already described, and pressed to the jaw with sufficient force to fully encase all the parts to which the substitute is ultimately to be applied. The wax, as the cup is pressed up, has a tendency to roll out at its edges and thus depart from the upper and outer portions of the ridge; hence care must be taken to press the wax in around the marginal portions of the cup, filling up any depressions or fosses that may occur on the external border of the jaw. It is particularly necessary to observe this precaution whenever the ridge overhangs, as is prominently the case for the first few months after the extraction of the teeth.

Fig. 31.



If the impression is an accurate one, some difficulty is occasionally experienced in detaching it from the mouth on account of the thorough exclusion of air from between it and the mouth, the wax being held firmly in place by atmospheric pressure; in which event it is only necessary to admit the air between the two, and this may generally be readily effected by placing the finger against the jaw on one side and above the wax, pressing firmly toward the centre of the arch and upward, dragging the mucous membrane somewhat from the edge of the cup, and at the same time depressing the latter on the same side. A small portion of air being admitted, it will soon diffuse itself between the adhering surfaces and allow the wax to be readily detached. To harden the wax, and thereby prevent it from dragging at those points where the ridge overhangs, or to prevent any change of form on the application of sufficient force to detach it from the mouth when it adheres with great tenacity, a cup has been constructed with a chamber underneath into which a stream of cold water is admitted. Two short pipes, as will be seen by reference to Fig. 32, communicate with the chamber, and these again connect with a

FIG. 32.



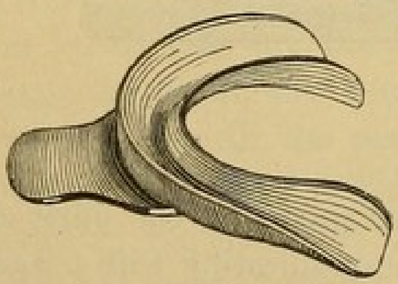
double tube fitting them closely, and united at the other end with two gum-elastic tubes—one communicating with a vessel of water conveniently placed and provided with a stop-cock, the other leading to a spittoon or other waste place. The two portions of pipe may be disconnected when not in use. After taking an impression with this cup, and before removing the wax from the mouth, the two portions of pipe are connected and a continuous current of cold water passed through the chamber by turning the faucet connected with the tank; when sufficiently hard, the wax is removed from the mouth before disjointing the pipes, to prevent the water from flowing upon the patient.

To provide more perfectly against failure of the wax being carried closely against the roof of the mouth in cases where the palatal vault is very deep, a piece may be cut from the central part of the cup, the wax being pressed at this point upward and forward into the deeper portions of the palatal fossa.

The author would express, in this connection, his conviction that it is impracticable, in most cases, to obtain a faultless impression of the mouth in wax for full upper dentures. There are points, not readily accessible to the fingers, where the wax departs from the external and posterior borders of the jaw, and is not, therefore, susceptible of easy correction; besides, when reached and the remedy applied, there is no certain assurance that in pressing the wax in at one point we are not displacing it at another. For this reason, we invariably use plaster in these cases, and we have sufficient reason to believe that the results are more uniformly successful.

Manner of Obtaining an Impression of the Lower Jaw in Wax for Entire Dentures.—The method pursued in securing an impression of the lower jaw in wax for an entire denture differs in no essential respect from that described when taking an impression for lower partial pieces, the form of cup being represented in Fig. 33. When the parts are imbedded in the wax, the latter should be pressed in around the inner border of the holder, but more especially near the posterior part of the ridge on each side where the latter overhang and approximate each other, forming corresponding excavations underneath. After adjusting the wax to the ridge along the border of the cup, the latter should again be pressed directly down upon the jaw before removing it, to correct any partial deformity that may have occurred during the previous manipulations.

FIG. 33.



Gutta-percha.—This material is rarely used except in obtaining impressions for partial pieces, and is more particularly indispensable whenever a perfect representation of the parts in plaster is essential to the success of any method in which the base is moulded or cast upon the model, as in the use of rubber, celluloid, etc. It takes the form and position of the teeth readily, and preserves them unchanged, by virtue of its elasticity, when removed from the mouth.

The general management of this substance in the process of obtaining an impression with it, is in most respects similar to that of wax, when used for the same purpose. It should, however, be prepared by softening it in hot water, but as the heat required to render it sufficiently plastic is greater than could be well endured without inflicting injury upon the soft tissues of the mouth, and subjecting the patient to pain in its application, it is customary, after having heated it sufficiently and packed the cup, to chill the surface by plunging it into cold water, and then introduce it quickly into the mouth. When the impression is secured, and the gutta-percha has become somewhat rigid in the mouth, it should be removed and filled immediately with plaster, as it contracts rapidly in cooling.

Plaster of Paris, or gypsum, or technically, calcium sulphate, has been long employed in taking impressions of the mouth for entire dentures, and more recently and to a limited extent, for partial or broken sets. For entire pieces, it has almost wholly superseded the use of wax, and is better adapted for receiving an accurate impression of the mouth, whenever it is desired to secure a copy of all its parts in their undisturbed relation to each other, than any material that has yet been employed.

When used for this purpose, it should be of the best quality, finely pulverized and well sifted, and should always be kept in a closed vessel, as the moisture which it attracts from the atmosphere impairs its property of hardening quickly when prepared for use. If impregnated with moisture, it should be first dried in a shallow vessel over a moderate heat before being used.

It is prepared for use by mixing with it a sufficient quantity of water to form a batter of about the consistence of very thick molasses, in which condition it hardens by a species of crystallization in from three to five minutes. The condensation of the plaster mixture is hastened somewhat by the admixture of a small quantity of sodium chloride or common salt. The best method of preparing plaster, however, for the purpose under consideration, is to combine water with it in sufficient quantity to form, in the first place, a very thin batter, and then to stir or beat it constantly with a small spatula until it becomes sufficiently thickened to admit of its adhering in a body to the vessel in which it is mixed when the latter is inverted, and when one portion will retain nearly its form when heaped upon another. By this process of protracted beating, calling sometimes "tempering," it is made tough and pasty, without having its plasticity impaired, and when introduced into the mouth in this condition, it adapts itself readily to the parts, hardens quickly, and is not liable, with ordinary care, to incommode the patient by running back into the fauces. So quickly, indeed, does it condense, that unless expeditiously introduced into the mouth, it will begin to "set" before the parts are fairly imbedded. When preparing it for use, therefore, the plaster should be mixed at the chair with the cup conveniently at hand, while the patient should be in proper position and in immediate readiness for the operation.

In view of the liability of the plaster to run back into the fauces when the cup is pressed to its place in the mouth, producing nausea and involuntary retching, and which is very liable to occur whenever the mixture is too thin or is improperly manipulated, it is recommended to instruct the patient to avoid swallowing while the plaster is in the mouth. Patients are also advised to breathe through the nostrils, but we see no good reason for this injunction. It should be remembered that, in the act of breathing through the nose, the velum palati or soft palate is depressed to cut off the passage of air through the mouth, and that it is thus brought more immediately in contact with any portions of plaster that may be protruding from the heel of the cup. The stimulus of contact will tend to produce involuntary contractions of the muscles of the soft palate and fauces, and thus portions of soft, or fragments of hard, plaster will be worked or drawn back into the fauces, producing the very evils it is designed to avoid. If, therefore, patients are instructed at all in this respect, they should be advised to breathe naturally through the mouth, this channel affording less obstruction to respiration than that through the nostrils in the act of taking an impression.

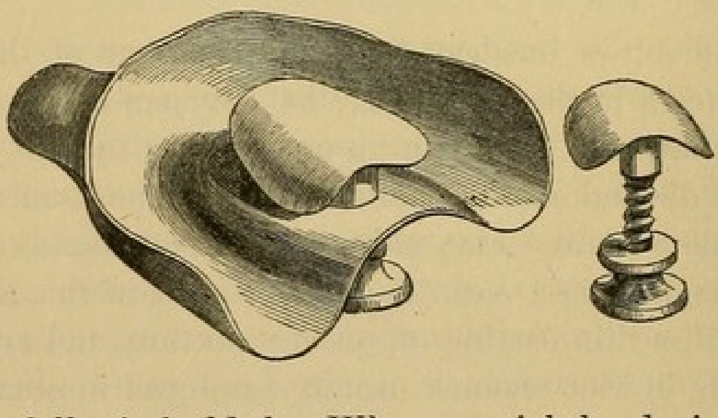
Manner of Obtaining an Impression of the Mouth in Plaster for Partial Upper Dentures.—There are conditions of the mouth, incident to the presence of natural teeth within it, which would seem to preclude the use of plaster in taking an impression of the parts. Thus, if any number of the teeth remaining are small at the necks with enlarging crowns, or if they are irregularly arranged in the circle, having either an anterior, posterior, or lateral obliquity, it would not only be difficult to detach hardened plaster from teeth so circumstanced, but the force necessary to remove it would inevitably break away portions of plaster from around the teeth. Another apparent objection to the use of plaster in these cases consists in the difficulty with which the impression is separated from the plaster model, it being necessary to cut away the former by piecemeal, as it would be impossible to separate the two in the ordinary way.

The difficulties incident to the detachment of the plaster from the teeth in the mouth may be obviated in either of the following ways: 1. Take an impression first in wax, and with a metallic die and counter, obtained from a model of the parts, swage a plate of tin, brass, zinc, or silver, of the size and form of the intended base; coat the palatal surface of this temporary holder with a thin coating of plaster mixture, and apply it to the mouth in the manner usually employed in obtaining an impression.

2. Take an impression of the parts in wax and cut away from the latter all those portions indented by the teeth, leaving only so much of the wax surface as corresponds with the palate and interspaces in the ridge; use this as a holder, and secure the impression by coating its surface, as before, with a thin layer of plaster batter. By either of the above methods an impression of those parts, only, on which the substitute is designed to rest, can be taken; the form and position of the teeth must be secured in a separate impression either with wax or gutta-percha.

Notwithstanding the obvious objections already stated, many operators prefer, in taking impressions for partial cases, to imbed all the parts in plaster in the same manner as when wax is used, being careful to remove the plaster from the mouth before it has acquired the usual hardness. If the remaining teeth have contracted necks, or are placed irregularly in the arch, they may be partially encased in wax before applying the plaster; this will facilitate the withdrawal of the impression and preserve the form of the teeth; the wax, receiving the impress of the teeth, coming away with the plaster. The form of the cup used in these cases is the same as that represented in Fig. 31, the edge of which may be turned in a little at points to prevent the plaster from being dragged from the cup. The cup being filled with the plaster mixture is introduced into the mouth and carefully pressed up until all the

Fig. 34.



parts are fully imbedded. When partial hardening of the plaster has occurred, sufficient tractive force should be judiciously applied to the cup to separate the plaster from the teeth and soft parts, when it should be carefully removed from the mouth. If any portion of the plaster, essential to the form of the impression, should break away, the fragment or fragments may be secured and afterwards applied to the fractured surfaces.

Considerable force is sometimes necessary to separate the plaster from the teeth, and in the effort to remove the former, it is liable to part from the cup and remain fixed in the mouth; in which case it will be necessary to cut it away by piecemeal.

This casualty may be effectually prevented by employing the form of cup shown in Fig. 34, contrived by Dr. Samuel Wardle, of Cincinnati, and used by him with entire success. It will be seen to consist of an ordinary holder, the cup portion perforated in the centre, through which a small rod passes with a screw cut on one end, and the other surmounted with a concave flange, around and underneath which the plaster collects. The rod is formed with a shoulder resting on the palatal face of the cup, and is fixed in position by screwing the tap against the lower surface of the holder. A number of these centrepieces, with shafts of various lengths, should be provided, in order that any desired elevation may be given to the cap or flange; for the latter is designed not only to confine the plaster, but also to carry it up into the roof of the mouth where the latter is very deep.

An admirable expedient for securing an impression with plaster for partial cases is thus described by Professor Charles J. Essig:

"An impression cup should first be selected of the proper size and shape,—those with the flat floor are best for partial cases; the plaster should be mixed thin, almost as thin as water, adding chloride of soda to facilitate setting. Plaster mixed in this manner does not become as hard and unyielding as that mixed merely to saturation. Now oil the cup so that it will readily separate from the impression when hard, fill the cup as soon as the plaster thickens sufficiently, then, with a small spatula, place a layer of the soft plaster in upon the palatine surface, otherwise by inclosing the air in the deep portion of the arch the accuracy of the impression may be impaired. After this precaution, the cup is placed in the mouth, and gently pressed up until its floor comes in contact with the teeth. When the plaster is sufficiently hardened, remove the cup, which, from its having been oiled, is done without difficulty; with the thumb and index finger break off the outside walls; the portion covering the palatine surface is then removed by the use of a blunt steel spatula, curved at the end in the form of a hook. The pieces are then placed back into the cup, where they will be found to articulate with perfect accuracy.

"Should the first attempt be rendered futile, by the tendency to nausea, or troublesome gagging on the part of the patient, camphor-water, as recommended by Dr. Louis Jack, may be used as a gargle, which will in nearly every case, prove an effectual remedy."

Manner of Obtaining an Impression of the Mouth in Plaster for Entire Upper Dentures.—The form of cup used in securing an impression of the upper jaw for entire sets of teeth, differs in no essential respect from that recommended when wax is used for similar purposes. If the external border of the alveolar ridge is very deep, or there is considerable space intervening between the heel of the cup and the floor of the palate, a rim of wax may be placed along the outer margin of the cup, and extended across its posterior border, in order more effectually to confine the plaster within the cup and prevent its escape into the back part of the mouth before it has fairly reached the palatal vault. If the latter is very deep, with a marked excavation in its central and anterior portion, or if it presents somewhat the form of a deep fissure, the plaster may fail to be carried perfectly against the floor of the palate, or the air becoming confined within the central portion of the arch, when the plaster is pressed up, may displace the latter and form corresponding chambers in the impression. If these imperfections are but slight, they may be subsequently remedied either by filling up the cavity or cavities in the impression, or by trimming away at these points from the model. The better plan, however, where these conditions of the vault prevail, is to take up a small portion of plaster on the end of a spatula and apply it to the deeper portions of the arch just before introducing the cup.

The patient being seated as nearly upright in the chair as possible, with the head inclined slightly forward, the cup is filled with the plaster mixture and introduced quickly into the mouth, when it is pressed up slowly and gently until the parts are completely encased and portions of plaster are seen to protrude from all parts of the margins of the cup, otherwise the impression is liable to be imperfect either on its outer borders or on its palatal face. Immediately after introducing and pressing up the cup, the lip in front should be extended and drawn down over the cup, when gentle pressure, as the plaster is hardening, may be made upon the outside of the lip in front and at either side of the mesial line to force the plaster more perfectly into the fosses which exist at these points.

It is essential to perfect success in this operation, that the cup, after the parts are once imbedded, should be held perfectly stationary until the plaster becomes fixed, as the slightest movement, when the plaster is in the act of consolidating, will derange the impression and render it faulty. Again, if after the parts are imbedded, the operator discovers that they are not sufficiently encased, and the plaster has partially set, no further effort should be made to press the plaster up upon the parts, but the cup should be withdrawn and the operation repeated with fresh plaster.

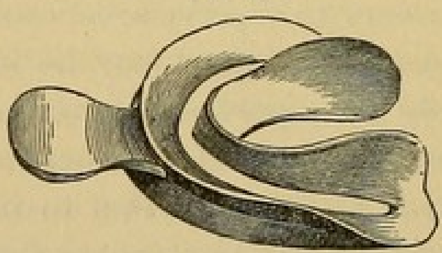
If the operation has been successfully conducted, the plaster will adhere to the mouth, in most instances, with great tenacity, and it will be necessary to observe some caution in removing it, for, if forcibly detached, injury may be inflicted upon the soft parts by tearing away portions of mucous membrane; or the impression may be fractured or otherwise impaired. In addition to the means already adverted to in connection with the method of separating wax impressions from the mouth, resort is sometimes had to the following expedient: The central portion of the cup being pierced with two or three small holes, a blunt-pointed probe is passed at these points through the plaster, before the latter has hardened perfectly, to the roof of the mouth. Into these passages the external air passes and diffuses itself between the surface of the plaster and the palate, when the impression may be readily detached. The author has succeeded best in detaching impressions in such cases, by upward and interrupted traction upon the handle of the cup, which, by depressing the heel of the same, more readily permits the introduction of air than by either of the methods commonly employed.

Manner of Obtaining an Impression of the Mouth in Plaster *for Entire Lower Dentures.*—Until recently, wax has been almost invariably used in taking impressions of the lower jaw. Plaster, however, may be used for the same purpose, and, by some, is esteemed superior to the former. The ordinary wax-holder as shown in Fig. 32 may be used, and which, being filled with the plaster batter thoroughly beaten until quite tough and pasty, is inverted and quickly introduced into the mouth and pressed down upon the ridge until the latter is completely imbedded; when sufficiently hard it should be removed in the ordinary way.

In securing an impression of the lower ridge in plaster, better results can, in many cases, be obtained by first taking the impression in wax, enlarging the impression thus secured with suitable instruments, and using this as a tray for plaster.

A form of tray, contrived expressly for the use of plaster by Dr. B. W. Franklin, is exhibited in Fig. 35. It consists of two chambers, or a double groove, communicating with each

Fig. 35



other by a fissure running from heel to heel of the cup. The groove corresponding with the curvature of the lower jaw is filled with plaster properly prepared, inverted, passed into the mouth, and pressed down upon the parts. As the cup is pressed down, portions of plaster will be forced through the fissure into the upper chamber,—this should be pressed down at all points along the groove with the finger, securing more perfectly, in this manner, the intrusion of the plaster into any irregularities or depressions that may occur in the ridge. Or, the empty cup may be placed in its proper position over the jaw and the plaster introduced into the upper groove and pressed down with the fingers through the fissure on to the ridge, filling the depending chamber.

CHAPTER III.

PLASTER MODELS.

AFTER an impression of the mouth has been secured in either of the ways mentioned in the preceding chapter, the next step in the process of constructing an artificial denture is to procure from the impression a representation of the parts in plaster. The copy thus secured is called a MODEL, and, if correctly obtained, is a true counterpart or fac-simile of all parts of the mouth represented in the impression.

Manner of Obtaining a Plaster Model from an Impression in Wax for Partial Dentures.—The impression in wax should be first trimmed by cutting away superfluous portions that overhang the borders of the cup, care being taken not to mar any essential part of the impression. The surface of the wax imprinted should then be uniformly smeared with a thin coating of oil applied with a camel's-hair brush. The oil should not be of too thick a consistence, nor applied in too large quantities, as it will collect in the more depending portions of the impression, and failing to be displaced by the plaster, will leave the model imperfect at these points, especially at the coronal extremities of the plaster teeth. The cup is now surrounded by some substance that will confine the plaster and give proper form to the body of the model. For this purpose any material that is easily shaped may be used, as a thin sheet of lead or wax, paper, strips of oil or wax cloth, etc.

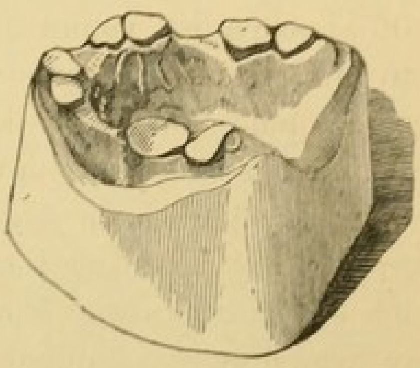
Before pouring the plaster, if it is desired to strengthen any of the plaster teeth—as those adjoining the vacuities in the jaw, or such as are to be used in adjusting clasps, and thus secure them against accident in handling—adequate support may be imparted to them by placing short pieces of stiff wire vertically in the depressions made in the wax by the teeth, and which may be supported in an upright position by imbedding one end in the wax in the centre of the bottom of each cavity.

When the cup is properly inclosed a batter of plaster, of somewhat thinner consistence than that used for impressions, is poured in upon the surface of the wax in sufficient quantity to give to the body of the model a depth of from one to three inches, according to the particular requirements of the case. The plaster should not be poured directly or hastily into the cavities formed by the teeth, but upon points contiguous to them, and from which it should be allowed to run slowly into the depressions, expelling the contained oil or air, and filling them perfectly. When the plaster has become sufficiently hard, any portions overlapping the borders of the wax, and not essential to the form of the model, should be cut away, and the two separated either by immersion in warm water, or by placing the model over the flame of a spirit-lamp or upon a heated surface, until the warmth imparted to the model renders the wax sufficiently soft to allow the former to be removed without fracturing the plaster teeth. The latter methods should be adopted whenever it is desired to obtain duplicate copies from the same impression, as by the use of hot water the impression is destroyed, the latter, however, being generally used when gutta-percha is employed. When separated from the impression, the model should be properly trimmed and shaped with a knife-blade.

The general form of the body of a model is shown in Fig. 36. The walls, as it will be seen, are made as nearly vertical or parallel as will admit of the model being readily detached from the sand in the process of moulding; for if made too flaring or divergent, the metallic die obtained from it will be more liable to crack or spread apart under the repeated strokes of a heavy hammer, or to rock under one-sided blows.

During the process of stamping or forcing a metallic base into adaptation to the die—which is a metallic counterpart of the model—the plate, when cut to the exact pattern of the parts to be covered by it, is frequently forced or dragged back toward the heel of the die, and is thus drawn from the teeth at the sides and in front. This displacement of the plate may be prevented by cutting away all of the plaster teeth from the model, leaving, however, enough of them remaining where they unite with the body of the model to form a shoulder to each tooth, as in Fig. 36. In this case the plate should be sufficiently ample in its dimensions to partially overlap the border, when, as it is forced into adaptation, distinct indentations will be made in it, corresponding exactly with the palatal curvatures of the teeth; the portions of the plate covering the cut ends of the teeth are then cut away with plate forceps or other instruments. If, however, the plate is of the exact size required before stamping, one or two plaster teeth upon each side of the model may be allowed to remain, against the anterior face of which the plate is made to rest holding it stationary.

Fig. 36.



Manner of Obtaining a Plaster Model from an Impression in Wax for Entire Dentures.—The same general method is pursued in obtaining a plaster model from an impression in

Fig. 37.

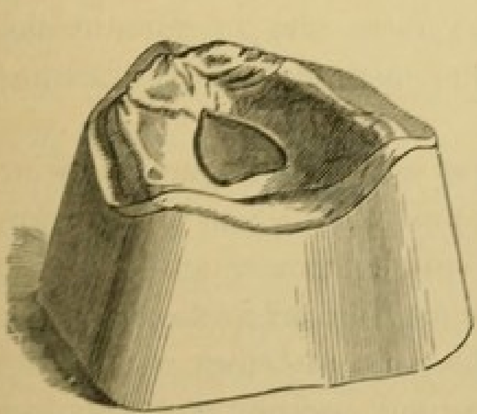
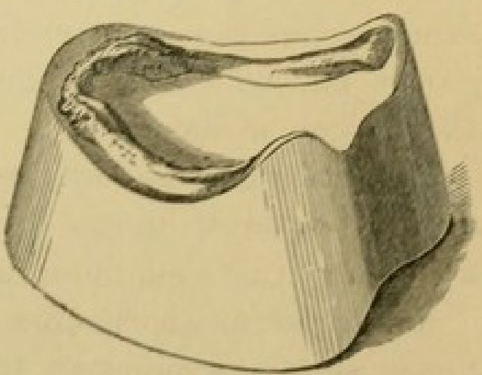


Fig. 38.



wax of either the upper or lower jaw for entire dentures, as that employed in partial cases. The general form of these pieces is represented in Figs. 37 and 38.

If it is desired to swage a rim to the plate, forming a groove or socket into which the plate extremities of the teeth are received, the model should be formed in the manner represented in the annexed cuts; in which it will be seen that an abrupt shoulder is formed on the external border of the model of the upper jaw (Fig. 37), but which on the lower (Fig. 38), is extended round the inner border also, as it is desirable, in the latter case, to give a rounded edge to the lingual border of the plate, and which is accomplished in part by swaging in the first instance and afterwards by turning the edge down upon the plate with pliers or by other means. The model is prepared by adjusting a strip of softened wax around the border and cutting away from its upper surface in such a way as to form a groove, the bottom of which shall be on a line with the extreme edge of the base or plate, and which should be indicated upon the model with a pencil-mark before applying the roll of wax. Plaster may be substituted for wax, and should always be used whenever heat is applied to the model in the process of obtaining a metallic swage, as by the "dipping" method.

If the model is to be used in moulding, the groove should be sufficiently open to permit the ready withdrawal of the sand, otherwise the die at this part will be imperfect; if, however, the face of the model is to be immersed in molten metal, securing first the counter-die, any form may be given to the groove that will best facilitate the operation of overturning the margins of the plate.

Rimmed plates are only required when single gum teeth or sectional or entire blocks are employed, or when plate teeth are mounted on a platinum base with continuous gum.

Whenever an air-chamber is to be stamped in the base, the model should be prepared for the purpose before casting the metallic swages. The general form and position of the central cavity or chamber in the arch is represented in Fig. 37. The model may be prepared in either the following ways: 1. The form of the chamber may be cut from the wax or plaster impression; in which case the plaster will be raised at a corresponding point or points upon the model, and will have exactly the same form and depth as the cavity in the impression.

2. Cover the palatal face of the model with a sheet of wax equal in thickness to the required depth of the chamber, and cut out from this, at the desired point, the form of the cavity; fill the latter with plaster, and when hard remove the wax and trim the raised portion to the proper form. 3. Cut a pattern chamber, of the required form and thickness, from sheet wax or lead; place it in proper position in the arch and press down with the fingers or burnisher until it conforms to the contour of the palate; it is then fixed in place either by confining it with a small piece of wire or tack driven through it into the plaster, or by interposing softened wax or other adhesive material between the chamber and model. A small brush loaded with a varnish mixture passed round the edge of the chamber will insure sufficient adhesion of the latter.

The same general method as that when central chambers are formed is pursued in the preparation of the model when it is desired to construct lateral cavities in the plate. The form and position of these on the model will be indicated by inspection of the form of "lateral cavity" plates as exhibited in the chapter on "Entire Dentures."

There are other modifications in the form of cavity plates, some of which are obsolete; that known as "Cleveland's chamber" is still in limited use, and will be described in a subsequent chapter, but does not require a model differing in form from the one described in connection with full dentures with central chambers.

Manner of Obtaining a Plaster Model from an Impression in Plaster for Partial Dentures.—The surface of the impression in plaster should first be rendered hard by applying to it, with a camel's-hair brush, a uniform coating of varnish to prevent adhesion of the model. Two kinds of varnish are in common use—a transparent and colored. The former is preferred for the reason that it penetrates the plaster more thoroughly, giving to it a greater depth of surface hardness, while the latter, if not sufficiently fluid, forms a somewhat superficial incrustation, which is liable to peel off in handling, leaving portions of the model unprotected. Either, however, if properly prepared and applied, may be employed.

Formula No. 1.		Formula No. 2.	
Transparent Varnish.		*Colored Varnish.*	
Gum sandarach, .	5 oz.	Gum shellac, . .	5 oz.
Alcohol, . . .	1 quart.	Alcohol, . . .	1 quart.

The sandarach and shellac should first be freed from all impurities by careful picking and washing; they are then added to the alcohol and digested over a moderate heat until thoroughly dissolved. Other substances, as gum elemi, Venice turpentine, etc., have been recommended as additional ingredients, but they are not indispensable, and may be omitted without sensibly impairing the properties of the varnish.

After glazing the surface of the plaster impression with varnish a thin and uniform coat of oil should be applied; it is then enveloped, and the model procured in the same manner as when wax is used.

The following method of preparing the plaster impression before it is filled in for the model is recommended by Dr. C. W. Spalding: "After the impression has become hard, coat the surface with a lather of soap and water; wash this off and immerse the model in water. This expels air and avoids liability to porosity of the surface of the model. Again coat the surface with a strong lather of soap and water, and wash off as before, when the impression is ready to receive the plaster for the model. I prefer this method to varnishing for the reason that the varnish used is not always of uniform consistence."

In separating the model from a plaster impression, for partial cases, it will be necessary to cut the latter away in pieces, as any attempt to separate the two in the ordinary manner would inevitably break away the plaster teeth from the model. The impression should be chipped away with great care, to avoid defacing the model. To provide more perfectly against this accident, it is better to coat the impression with colored varnish,* as this will indicate with greater certainty the line of contact or union between the two pieces. When separated, the model should be trimmed and formed in the manner heretofore described.

Manner of Obtaining a Plaster Model from an Impression in Plaster for Entire Dentures.—The preparation of a plaster impression of either the upper or lower jaw for full dentures, and the method of procuring a model therefrom, differ in no essential respect, except in the mode of separation, from the manipulations required when the impression has been taken in plaster for partial pieces. A model can, ordinarily, be readily detached from an impression of the lower jaw, but is not always so easily effected in the case of the upper. To accomplish this in the latter case, the model may be taken in the hand and the back of the handle of the cup tapped lightly with an instrument; or, a small, wedge-shaped instrument may be carefully forced between the model and impression at the posterior border of the latter until they part slightly, when they may be easily detached; before doing which, however, any overlapping portions of the model which may tend to bind the two pieces together should be trimmed away. If any portion of the heel of the model is defaced by the introduction of the wedge, it may be afterwards remedied by restoring the contour of the parts with either wax or plaster.

After obtaining a model in either of the ways mentioned, the entire body of it should be glazed and hardened by applying to it a uniform coat of varnish. This protective covering will prevent the surface from wearing, render it more pleasant to the touch, facilitate its withdrawal from the sand, and give a more perfect mould. A model may be better prepared for permanent preservation by immersing it for a short time in a solution of carbonate of soda, by which its surface is converted into carbonate of lime, and thereby rendered hard and durable; care must be taken not to introduce any of the bicarbonate of soda into the solution.

* The author is indebted to Dr. Spalding for a simple and admirable device for the same purpose, which consists in coloring the water used to mix plaster for the impression with aniline red.

CHAPTER IV.

Metallic Dies and Counter-Dies.

A metallic die is a *fac simile* or transcript of the mouth in metal, and is also a copy or likeness of the plaster model.

A metallic counter-die is a copy of the impression, and is a reversed image of the die and plaster model.

Manner of Obtaining a Metallic Die.—Two general methods are employed in procuring a metallic counterpart of the model; first, by *moulding;* secondly, by a process termed "*dipping.*"

Moulding.—For this purpose the best material is marble-dust, though other substances—as sand, Spanish whiting, etc. —have been recommended. Marble-dust has the advantage of being always ready for use, as it absorbs sufficient moisture from the atmosphere to render it cohesive, is cleanly, and gives a smooth and uniform surface to the die. When sand is used it should be fine and even-grained, the best for the purpose being that used by brassfounders. It is prepared by mixing with it sufficient water to render its particles somewhat adherent, so that when portions of it are pressed in the hand and then parted with the fingers it will break away in well-defined fragments. Excess of water should be avoided, as the vapor formed by the molten metal, when poured upon it, will displace portions of the latter, and form cavities or blisters in the face of the die; nor should the sand used be too dry, as in that case it will crumble away in detaching the model.

Oil has been proposed as a substitute for water, in which case it is recommended to add one quart of the former to a peck of sand. It is claimed that the sand so prepared is always in immediate readiness for use.

The moulding material properly prepared, the model is next placed with its face uppermost, on the moulding-board, and surrounded with a metallic ring. A common "wagon-box," of which two or three sizes should be had, will answer every purpose. If sand is used it should first be well sifted to remove the coarser particles, and then filled into the ring, packing it closely with the fingers around and over the model until even with the upper edge of the box. Some care must be observed in the management of the moulding material when packing it, for, if made too compact, the vapor formed in pouring hot metal, failing to pass out readily, will be confined within the cavity, and form imperfections in the face of the die; or, if too loosely packed, the fluid metal, when poured into the mould, will, to some extent, permeate the pores of the sand or other material, and render the face of the die rough and imperfect.

The box, with the model encased, is then lifted above the board and the model dislodged by tapping it gently underneath with a small mallet or hammer until it parts from the mould. The uncertain and hazardous method, sometimes resorted to, of detaching the model by pressing it alternately backward and forward until loosened, and then lifting it out, should never be practiced, as more or less deformity of the mould is unavoidably produced thereby.

It not unfrequently happens that the ridge on the plaster model of the upper jaw overhangs, forming corresponding depressions above, the excavations occurring more commonly in front and on each side of the mesial line. Whenever this form of the model exists, it will be impracticable to obtain a correct mould in the manner just described, since the sand becoming impacted in these excavations will be broken away and remain with the model when the latter is dislodged.

The difficulty mentioned, however, may be readily overcome in all cases by employing the sectional moulding flask invented by Dr. G. W. Hawes, the several parts of which are represented in the accompanying cuts.

Fig. 39 represents the lower ring, composed of three movable pieces with flange extensions, which project in toward the centre. When used, this portion of the flask is closed and the sections kept in place by pins passing through the joints. Inside of this ring the model is placed face upward, the ridge extending a little above the upper plane of the ring. Sand, well sifted, is then packed in around the model on a level with the most projecting points on the outside of the ridge, as indicated by the dotted line in Fig. 41. The surface of the sand should be trimmed smoothly, and should be cut squarely and at right angles with the ridge, to prevent the sand from breaking away when the model is withdrawn. Very finely pulverized charcoal contained in a loose muslin bag is now sifted

Fig. 39.

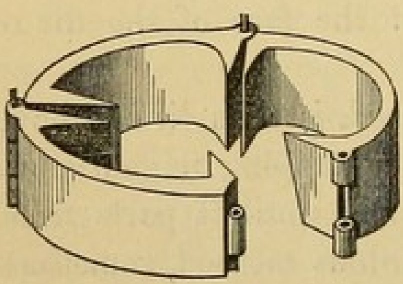


Fig. 40.

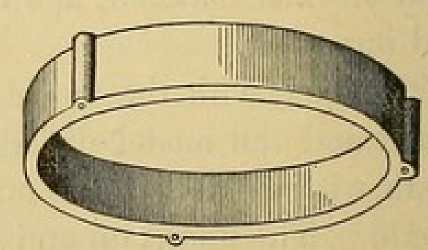
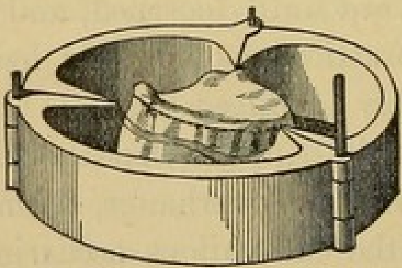


Fig. 41.



over the exposed surface of the sand, to prevent the next portion contained in the upper ring from adhering. The plain ring (Fig. 40) is then placed over the one containing the model, and is filled with sand well packed over the face of the die. The upper ring is now carefully lifted from the lower one on a line with the pins, thus separating the two portions of sand, and again exposing the uncovered face of the model. One of the pins should then be drawn from the lower ring; the sections of the latter carefully unfolded, and the model withdrawn; when the ring may be again closed and confined by replacing the pin. The upper ring is then readjusted in its proper relation to the lower one, and the flask inverted; when the mould, if the process has been accurately conducted, will be found perfect.

In the absence of the "Hawes" flask, the same results may be attained by employing the following simple method, recommended by Dr. Berhard, and substantially described as follows: "The plaster model being prepared in the usual manner for moulding, varnish the front (or the whole) with a thin solution of shellac. When dry, apply a mixture of plaster of proper consistence to the front of the model from the bottom up to the edge of the alveolar line, spreading it on both sides so as to entirely fill up the depression around, making the bottom half an inch thick, and sloping off toward the alveolar ridge. When this has hardened, separate it from the model, and draw the top of it over sandpaper to obtain a flat edge, and let it dry. Readjust this front piece to the model; procure a mould in sand or other material in the usual way; place the extra piece back in its proper position in the mould, and proceed to cast for the die."

In obtaining a mould from the model of a lower jaw, but little difficulty will ordinarily be experienced in obtaining it perfect in the manner first described. The depressions at the posterior and inner border of the ridge are the points most liable to drag or displace the sand, and when the latter occurs, the surplus metal in the die at such points must be cut away with suitable instruments; or the cavities in the model may be so filled out with wax before moulding as to permit the ready separation of the model without displacing the sand, in which case, also, it will be necessary, afterward, to trim the redundant metal from the die.

A die is more readily and accurately obtained from a model for partial dentures by cutting away the plaster teeth as before described. The displacement of sand where the ridge overhangs will, as a general thing, be unimportant in these cases, as the base but rarely more than partially overlaps the border.

When whiting or marble-dust is used in moulding, it is unnecessary to mix water with them, as the moisture which they absorb from the atmosphere will give to them the proper consistence.

Having obtained a mould in either of the ways mentioned, the metal designed for the die should be melted and poured carefully in upon the more prominent portions on the face of the former. If the metal is raised much above its fusing-point, or the sand is quite damp, the former should be poured very slowly into the mould. It is better, however, that the sand should be partially dried before pouring the metal, and the die cast on the instant of the metal becoming sufficiently fluid. An observance of these precautions will protect the sand from the overaction of heat, prevent ebullition of the fused metal from the too rapid decomposition of the water of the sand, and will give a smoother face to the die, and secure the metal or metals from undue waste by oxidation. The opinion is entertained by some that greater shrinkage of the die occurs when the metallic substance of which it is composed is poured at a temperature much above its fusing-point; the fallacy of this is made obvious by a moment's reflection, as a simple example will show that any change affecting the face of the die, as a consequence of contraction, can only occur in the metal between its point of solidification or liquefaction—for they are identical—and its working temperature. Zinc, for example, melts at 773°. Now if its temperature be raised to 1200°, it will remain fluid until it reaches 773°, and in passing through the intermediate degrees of heat, it will, in obedience to gravity, adapt itself perfectly to all parts of the more depending portions of the mould; and this perfect continuity of the two surfaces will remain unaffected by the contraction of the metal until the latter commences to "set," or solidify (773°), after which, and not until then, the zinc begins to part from the face of the mould by contracting upon itself between 773° and the mean temperature of the air. So far as any change, by contraction, in the face of the die is concerned, therefore, it is obviously immaterial whether the zinc be poured on the instant of melting or at 1200°; the result will be the same in either case.

The author is indebted to Dr. B. W. Franklin for the following method of securing metallic dies and counters by a process which greatly facilitates the operation and insures accurate and satisfactory results: "I take all impressions, full and partial, in plaster. A small hole, less than $\frac{1}{16}$ inch, is drilled through the highest point of the palatal surface of the impression through cup and all; into this place two or three broom splints, cutting them off even with the surface of the plaster, to allow any vapors to pass off. I sometimes smoke the surface of the impression. Around the impression place sufficient putty to form a ring the size and height required for the die. Into this pour, at as low heat as consistent with the mobility required for sharp castings, the bismuth alloy known as Sir Isaac Newton metal, or, which is better in some respects, 8 parts bismuth and 4 parts each of tin and lead—the latter composition being a little harder. If a little judgment is exercised in pouring either of the above alloys, a perfect die will be secured from moist plaster impressions without any drying. As the bismuth is expansive and the alloy is hard and somewhat brittle, I run only a thin casting, not more than $\frac{1}{2}$ inch in thickness, over the highest portion of the impression. I have cast-iron or brass heads made $3\frac{1}{4}$ inches in length, 3 inches in diameter at large end, and 2 inches at the other; the large end is flat, and well coated with common tinman's solder. This head is heated until the solder begins to soften; it is then placed in a pan or other convenient vessel, and the die, face side up, is placed upon the tinned surface. When the die begins to melt, and perfect union is secured, cold water is dashed upon the die and head; and thus we have a sharp die, with an iron head, to sustain the force of the blow in stamping the plate, and by this means preventing any spreading of the face of the die or liability of breaking in the process of swaging.

"I now take sheet-lead of the thickness of about No. 24, standard gauge, and adapt it to the face of the die by means of a wooden mallet or burnisher, or other convenient means. Trim the lead plate to the size required for the plate to be stamped; when the lead plate is nicely fitted, remove it carefully from the die and place it in a ring or narrow moulding-flask, the palatal side up; now gently stamp moulding-sand into the plate and flask up level with the edges of the flask; then reverse the flask and cut the sand away *clean* for ½ inch or more down to the edge of the lead plate all around. Around the plate place a common moulding-ring sufficiently large to form the counter, which is made by pouring melted tin or lead (or any alloys of these metals) on to the lead plate, being careful not to run the metal so hot as to melt the lead plate. When the counter is cool enough to handle, the adhering sand is brushed or washed away; the die is then placed into the bed or counter, and, with a moderate-sized hammer, give one or two sharp blows to bring the die and counter together. In swaging gold plates, two or three, or more dies may be required; these may be made either by running the die-metal into the impression (if not broken) or by running into lead plates, gotten up as before described, reserving, of course, the first die and counter for the final swaging of the plate. I have gotten up a die and counter from the impression, with the aid of an assistant, in the foregoing manner, in twelve minutes. I usually get out my die immediately after taking the impression; adapt a wax or gutta-percha plate to the die, and get the articulation before the patient leaves the office."

Dipping.—By this process the counter-die is first obtained, and from this the die. For the purpose, two or three sheet-iron pans, varying in size, should be provided, measuring from three to five inches in diameter and from two to three inches in depth, the open ends of which should be somewhat larger than the bottoms. The metal for the counter is melted and poured into the pan, and, immediately before "setting," the model, being unvarnished and previously well dried, is immersed, face downward, until all parts of the palatal arch and ridge are imbedded in the metal. The chamber, as well as the groove around the outside of the ridge concerned in the formation of a rim to the plate, should, in this case, be formed in plaster.

Ordinarily, the conformation of the ridge above and below is such as to render it impracticable to remove the model from the metallic matrix without injury; hence two or more models will be required whenever this method is practiced.

After the counter-die and model are separated, all traces of plaster should be carefully washed from the matrix and the latter surrounded with a sheet-iron ring forced slightly into the counter immediately outside of the cavity formed by the model; into this the metal for the die is poured, filling the matrix and ring.

If the metal or alloy forming the die fuses at the same or a higher heat than that composing the counter, the matrix should be protected from adhering to the die by coating its surface uniformly either with lamp-smoke or a thin mixture of whiting and water or alcohol.

Counter-die.—A counter to the die is generally obtained directly from the latter, and may be procured in either of two ways. 1. The die is placed, face upward, upon the moulding-board, and sand, prepared as in moulding, built up around it, leaving only the ridge and palatal face exposed. It is then encircled with a cast- or sheet-iron ring two or three inches deep, its edge imbedded in the sand to prevent the escape of the fluid metal; into this the metal for the counter is poured until nearly or quite full. 2. The metal for the counter may first be poured into a sheet-iron vessel of proper size, and, immediately before setting, the face of the die is immersed in the liquid mass and held perfectly stationary until solidification of the counter takes place. The method of procuring a counter-die directly from the plaster model, as in the process of dipping, has already been described.

The metal commonly employed for the counter is lead, although other substances, as tin, type-metal, some of the more fusible alloys hereafter to be mentioned, etc., are sometimes employed. When the counter is taken by pouring the metal or metals composing it upon a die fusing at a low heat, some caution should be observed lest the two pieces adhere by partial fusion of the die. In such cases the surface of the die should be well protected with lamp-smoke or whiting; the lead should be poured at the lowest practicable temperature, and the conduction of heat facilitated by surrounding the die with a heavy cast-iron box or ring. To avoid incurring any risk, however, the counter-die, if composed of a less fusible metal or compound than the die, may be first obtained directly from the model, and the die obtained from this, as in the process of dipping; or, a counter of lead, previously taken from a zinc or other more infusible die, may be used.

During the process of forcing a plate into adaptation to the form of the mouth with swages, it not unfrequently happens that the marginal portions of the former become wedged or immovably fixed between the outer border of the die and corresponding portions of the counter before its central portion is forced into contact with the palatal surface of the former, thus rendering it difficult to conform the plate accurately to the parts without the application of sufficient force to deface or otherwise mar the form of the die. In such cases the central portion of the plate may be first swaged with a *partial counter*, which is made to receive only the palatal portion and upper surface of the ridge of the die. After forcing the central part of the plate into adaptation with the partial counter, the process may afterwards be completed with a full counter after having turned the edges of the plate down upon the outer border of the ridge with a mallet and pliers.

As before remarked, preference is usually given to lead in the formation of a counter-die, mainly on account of its greater softness. This property in a counter is practically important. In the process of forcing a metallic plate into adaptation to the mouth, partial displacement or yielding of either the die or counter, or of both, necessarily occurs, and it is scarcely necessary to remark that whatever change of form is produced should take place wholly in the counter, otherwise deformity of the die must ensue.

Essential Properties of a Die.—There are certain properties which it is indispensable that a metallic die should possess more or less perfectly in order to answer fully the requirements of the dentist.

1. A die should be sufficiently *hard* to resist any necessary force applied to it in stamping the plate without suffering any material change in the form of its face, by which latter term is meant that portion of the die with which the plate is brought into contact. This property is most indispensable in those cases where the arch of the mouth is very deep, the ruga prominent and sharply defined, and where the alveolar ridge is marked by angular and abrupt prominences and depressions. In such cases, if the die is not sufficiently resistant, the points most prominent upon its face will be bruised or battered down, while the plate will fail to be forced perfectly into the cavities or depressions, and its coaptation to the mouth, to that extent, rendered faulty. The cases in which a less degree of hardness is admissible is where the arch of the mouth is broad and shallow, the ruga imperfectly defined, and the ridge regular and symmetrical. The conformation of the mouth, therefore, will, in respect to the property of hardness, admit of some latitude in the choice of the metal or alloy employed in the formation of a die.

2. Another important property of a metallic die is *non-contraction*, so far, at least, as this is attainable. Inasmuch as the successful adaptation of the plate depends, in a great measure, upon an accurate representation of the precise form of the mouth in the die, it is of the first importance that the latter, other essential requisites being secured, should be composed of some metal or metals having the least possible contraction in cooling. Contraction is, in varying degrees, common to all metals exposed to a decreasing temperature, and it is impossible, therefore, to obtain a perfectly faultless copy of the mouth in metal. Fortunately, as well for the expert as the unskilled manipulator, the unavoidable shrinkage incurred is partially or wholly compensated for by the expansion of the plaster and the yielding condition of the soft tissues of the mouth, but under no circumstances should the accommodation

afforded by the condition last mentioned encourage negligence or unskilfulness in the use of all available means necessary to secure the most accurate adaptation of the base. Ordinarily, a moderate degree of contraction will not materially impair the fit of a plate; on the contrary, in the case of the upper jaw, it sometimes favors its adhesion and retention in the mouth. Cases, on the other hand, frequently occur where the least practicable amount of shrinkage, even at the partial sacrifice of other properties, becomes indispensable in the die.

3. A third important requisite of a die is *fusibility*. Aside from the convenience incident to the use of metals which fuse at a low heat, there is another consideration favoring this property of more practical importance. It is well known that all metals expand by heat and contract by cold. In obedience to this law, metals fusing at a high heat suffer a greater aggregate contraction than those melting at a lower temperature, and, as between two metallic bodies of equal dimensions, liquefying at different temperatures, the difference in contraction will correspond exactly with the difference in the number of degrees through which each passes from the point of solidification to the mean temperature of the air, allowance being made for the difference in their ratios of contraction. Two dies, one composed of copper and the other of zinc, will serve to illustrate. Fused copper solidifies at 1900°. In cooling, therefore, it contracts through over 1800° to reach a working temperature, while zinc, fusing at 773°, contracts through only about 700° to reach the same temperature. As before stated, the difference in the contraction of metals will be somewhat modified by that in their ratio of contraction, but it will always be found that the more fusible metals have the least aggregate shrinkage whenever any considerable disparity exists between their fusing-points. It is in accordance with the principles here set forth that the more fusible alloys, some of which melt at remarkably low temperatures, are employed whenever it is important to obtain a die as nearly the exact counterpart of the model as possible.

4. Finally, a die should be sufficiently *cohesive* to resist the

repeated blows of a heavy hammer without parting or cracking. Many metals, as antimony, bismuth, etc., in other respects suitable for dies, are objectionable on account of brittleness. But it must not, therefore, be inferred that all metals that are denominated brittle are inadmissible for this purpose; for zinc, which, in its ordinary condition, is ranked as a brittle metal, and type-metal, which is always so, are in no danger of being forced asunder or of suffering displacement when in the compact form of a die, provided the force used in swaging is judiciously applied or proper form and sufficient depth are given to the body of the die.

To recapitulate briefly: a die should be formed of some metal or alloy that has a surface hardness sufficient to resist compression; that fuses at a low temperature; that does not, in any material degree, contract in the act of cooling; and whose particles adhere with sufficient cohesive force to maintain perfectly its integrity of form under the hammer. Any one or two of these properties are readily attainable in the same die, but no one known metal or alloy combines all of them perfectly. Thus either cast iron, brass, bronze, or cannon-metal would form an excellent material in respect to surface hardness, and in the compact form of a die, would be sufficiently cohesive, but few enjoy convenient facilities for melting them; besides, their great contraction consequent upon their high fusing-point would render their employment entirely inadmissible. Again, certain alloys, as those composed of lead, tin, and antimony or bismuth, are eminently suitable on account of their extreme fusibility and comparative exemption from shrinkage, but they gain these properties at the expense of that degree of hardness necessary to resist compression. Tin in its uncombined state is ordinarily sufficiently fusible, tenacious, and non-contractile, but is too soft and yielding when forcibly compressed. Antimony and bismuth are sufficiently hard, fusible, and non-contractile, but are objectionable on the score of extreme brittleness.

Any metallic substance that combines most perfectly the several properties referred to is, therefore, best adapted to the necessities of the mechanical operator, and experience has universally accorded pre-eminence in this respect to zinc. It presents a more resistant surface to the blow of a hammer than either copper or brass, three times more so than that of tin, and more than double that of type-metal. As it usually occurs in commerce it may be classed as a brittle metal, but when annealed it is tough and malleable. It melts at a heat (773°) which may be readily commanded, and contracts but little in cooling. The late Professor Austen demonstrated by actual experiments that an average-sized zinc die, measuring two inches transversely, contracts 27-1000ths of an inch from outside to outside of the alveolar ridge, being equivalent in thickness to three ordinary leaves of a journal. Professor Austen remarks: "In the first case (upper jaw) the plate would 'bind,' and if the ridge were covered by an unyieldlng mucous membrane, it would prevent accuracy of adaptation. In the second case (under jaw) the plate would have too much lateral 'play,' and consequently lack stability. Again, in a moderately deep arch, say a half inch in depth, the shrinkage between the level of the ridge and the floor of the palate will be nearly 7-1000ths —rather more than one leaf of the journal. In the deepest arches this shrinkage becomes a serious difficulty; in the shallower cases it is not of much moment, as there is no mouth so hard as not to yield the 1 or 2-1000ths of an inch."

As before stated, a moderate degree of shrinkage in the die may, in certain conditions of the mouth, practically favor the adhesion and permanent retention of a plate applied to the upper jaw. The conditions alluded to, and which prevail in a greater or less degree in all cases, are soft and yielding ridge and comparatively hard and unimpressible palate. Now, if in the first instance the plate is swaged into uniform contact with all parts of the jaw, it will be readily perceived that if pressure is made over the ridge on one side the latter will yield, while the central portion of the plate, meeting with a fixed point of resistance at the floor of the palate, will "ride" upon the latter, and thus throw the plate from the ridge on the opposite side of the jaw. If, however, a space equal to one or two thicknesses of the plate exists between the latter and the roof of the mouth, as a consequence of contraction in the die, the plate, as it is carried against the palate, in the act of exhausting the air from beneath it, will at the same time forcibly compress the ridge, securing thereby a more resistant basis along the border, and providing more certainly against displacement of the base on the application of forces brought to bear upon it in mastication.

The extent to which the shrinkage of a die may be admitted in any given case, will depend partly upon difference in the conditions heretofore mentioned in the soft parts of the mouth, and in part, also, upon the general configuration of the jaw. In a medium-sized mouth, with a depth of say half an inch to the arch, a moderately soft ridge and resisting palate, the shrinkage incident to zinc will be unimportant, and in many cases will be advantageous. If, however, the vault is very deep, even though there be a yielding ridge, the unavoidable contraction of a zinc die will throw the plate so far from the arch as to render it difficult for the patient to exhaust the atmosphere from between it and the floor of the palate, and even when the latter is practicable, the plate will bind with such force upon the outer border of the ridge as not only to produce pain and irritation of the compressed parts, but the resistance afforded at these points will be sufficient, in many cases, to break up the adhesion and force the plate from the palate. Again, as an extreme case, if the ridge and palate are somewhat uniformly unyielding, and the palatal vault is, at the same time, very deep, a zinc die can only be made available in bringing the base as nearly into adaptation as possible, after which the operation may be completed with a swage having a less degree of shrinkage, and which, as a mere finishing die, need not necessarily be so hard as zinc.

In conforming a plate to the lower jaw, the die should be as free as possible from contraction in all cases. The greatest shrinkage in such cases will be between the posterior extremities of the ridge, giving too much lateral play to the plate; in addition to which the posterior and inner edge of the base, projecting out from the ridge, will obstruct the free action of the tongue, while the latter will tend to lift it from the ridge and render it unstable. These conditions may be partially remedied by turning the edge of the plate in against the ridge with pliers; but this expedient should never be resorted to in any case whenever it is practicable to secure a correct adaptation by swaging.

In all cases in which a zinc die fails to bring the plate into proper adaptation to the parts, either of the following metallic compounds may be used to complete the process after partial stamping with zinc.

Type-Metal.—Lead, 5 parts; antimony, 1 part. Fuses at 500°; contraction less than one-half that of zinc; more compressible than the latter, and very brittle.

Babbitt, or Anti-friction Metal.—Copper, 3 parts; antimony, 1 part; tin, 3 parts. First fuse the copper, and then add the antimony and tin. Melts at a moderately low heat; contracts but little; is brittle, but may be rendered less so by adding tin.

Zinc, 4 parts; *tin*, 1 part. Fuses at a lower heat, contracts less in cooling, and has a less surface hardness than zinc.

Tin, 5 parts; *antimony*, 1 part. Melts at a lower heat than either of the preceding alloys; contracts but slightly in cooling; is harder than tin, and sufficiently cohesive. It is readily oxidized, and should be poured as soon as melted.

Fusible Alloys.—The following tabular view of the more fusible alloys, the respective properties of which are deduced from actual experiments, was given by Professor Austen, in a paper on "Metallic Dies."* Zinc is introduced into the table for the purpose of comparison.

* American Journal of Dental Science, vol. vi, p. 367.

	Melting point.	Contractility.	Hardness.	Brittleness.
1. Zinc	770°	.01366	.018	5
2. Lead, 2, Tin, 1	440°	.00633	.050	3
3. Lead, 1, Tin, 2	340°	.00500	.040	3
4. Lead, 2, Tin, 3, Antimony, 1	420°	.00433	.026	7
5. Lead, 5, Tin, 6, Antimony, 1	320°	.00566	.035	6
6. Lead, 5, Tin, 6, Antimony, 1 Bismuth, 3	300°	.00266	.030	9
7. Lead, 1, Tin, 1, Bismuth, 1	250°	.00066	.042	7
8. Lead, 5, Tin, 3, Bismuth, 8	200°	.00200	.045	8
9. Lead, 2, Tin, 1, Bismuth, 3	200°	.00133	.048	7

Professor A., in commenting on the preceding table, observes: "The last column contains an approximate estimate of the relative brittleness of the samples given. As in the other columns, the low numbers represent the metals, so far as this property is concerned, most desirable. Those marked below 5 are malleable metals; those above 5 are brittle; zinc, marked 5, separates these two classes, and belongs to one or the other, according to the way in which it is managed." Allusion is here made to the process of annealing zinc, and which has already been adverted to when considering the latter metal in the former part of the work. The special method employed is thus described by the author already quoted. "The simplest way to anneal a zinc die is to place it in the melting ladle with about a tablespoonful of water, removing it in thirty seconds after the water has boiled away. If the fire is a very hot one, remove it immediately on the disappearance of the water. It will often happen that the die is annealed in the process of taking the counter-die. This will more certainly occur when Nos. 7, 8, or 9 (see table), are used for the counter. For example, take tin, using a mass twice the size of the die, should it be heated to 540° (100° above melting-point), it would not, allowing for loss of heat by radiation and contact with the cast-iron ring (if one be used), heat the zinc beyond 330°. Lead, cast as cool as it could possibly be poured, unless in a very heavy ring (such as a 'cart-wheel box'), or in quantity too small for a well-shaped counter, would be apt to raise the zinc at least to 400°, and so impair its malleability, whilst, if poured as hot as many are in the habit of doing, the zinc will remain as brittle as when first cast."*

* To Professor P. H. Austen, whose various contributions relating to the mechanical department of practical dentistry have done much to unfold and elucidate the principles involved in the practice of this important specialty, the author would acknowledge his indebtedness for many of the valuable data and practical suggestions that may be found embodied in the foregoing chapter; and, had not the limited space assigned us compelled a condensation of his views on the subject of metallic dies and counters, we might have done the reader an essential service by transferring to our pages many of his eminently practical observations on the subject entire.

CHAPTER V.

Partial Dentures.

The almost unlimited modifications in the form of substitutes designed to supply the loss of a portion only of the natural teeth, and the difficulties oftentimes incident to a harmonious arrangement of the teeth of replacement, as well, also, as the impracticability of always securing a perfectly satisfactory and efficient antagonism or closure of the artificial with the natural organs, frequently surround this process with peculiar embarrassments, and often render their successful application extremely difficult. They will, accordingly, be found to demand of the operator the exercise of greater skill, ingenuity, and discrimination than are usually required of him in the construction and application of entire dentures.

The various means employed in fixing or retaining partial sets of teeth in the mouth will be first considered. Either of the following methods may be adopted according to the preferences of the operator, or the requirements of individual cases. 1. *Pivoting an artificial crown to the root of a natural tooth.* 2. *Clasping to the natural teeth.* 3. *Wood pivots adjusted to tubed plates.* 4. *Pivoting plate to the roots of the natural teeth.* 5. *Atmospheric pressure.*

PIVOTING ARTIFICIAL CROWNS.

The process of pivoting or grafting an artificial crown upon the root of a natural tooth has been long practiced, and, when skilfully performed with intelligent views of the various conditions which recommend and justify the operation, affords a valuable and unobjectionable means of substitution. The success of the operation will be greatly modified by the following circumstances:

1. *The Condition of the Root, its Appendages, and Surrounding Structures.*—If the root to be pivoted is strong, well formed and securely attached to the jaw, a living, healthy pulp present, and the peridental membrane free from disease, the operation will be attended, in a large preponderance of cases, with the happiest results, and in respect to utility, comfort, and appearance, is superior to any other mode of substitution. If, however, the pulp of the tooth has been previously destroyed by disease, and inflammation and suppuration of the adjacent tissues have supervened, the probabilities of complete success will be somewhat modified; for although these latter conditions may ordinarily be subdued by appropriate treatment, yet that a latent predisposition favoring their recurrence exists is manifested by the unfavorable results which sometimes follow the operation of pivoting under apparently favorable circumstances.

In no case, we are convinced, unless under circumstances of peculiar exigency, should an artificial crown be attached to a root whenever the latter is complicated with incurable disease of the investing membrane or alveolar abscess. It may be safely affirmed that the failures so common to this method, and the consequent disrepute into which it has deservedly fallen, as ordinarily performed, is fairly chargeable not so much to unskilful manipulation as to a want of proper appreciation of the pathological conditions which clearly contraindicate its employment. The facilities enjoyed by the dentist of the present day in the employment of the various approved methods of replacement, other than the one under consideration, no longer make it either necessary or pardonable to subject the patient to a course of treatment which unavoidably necessitates a perpetual drainage of depraved and offensive pus either through fistulous openings in the gum or through channels provided by art.

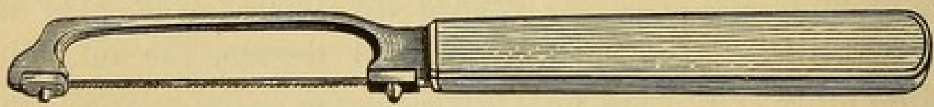
As respects the surrounding structures, it is well, with a view of removing any disturbing causes, to institute a careful examination of the mouth before inserting pivot teeth, and if any of the remaining teeth are found carious or incrusted with tartar, or the mucous membrane and gums are inflamed or otherwise diseased, they should be treated in accordance with the indications furnished by the particular morbid conditions present.

2. *Diathesis of the Patient.*—Cases frequently occur where there exists a marked constitutional predisposition to inflammation, and where, from the operation of very slight causes, injuries inflicted upon any portion of the body tend to terminate in suppuration of the tissues involved. Whenever this predisposition exists in any marked degree, the operation, though other conditions may favor success, is liable at all times to terminate unfavorably, and, therefore, if performed at all, it should be done in the most careful manner and only under circumstances that promise the best chances of success. In such cases not more than one tooth should be inserted at a single sitting, and it will be prudent, in many cases, after having prepared the root, to defer the completion of the operation for a few days, or to adjust a tooth temporarily with a pivot loosely fitted, until the irritation, unavoidably produced by filing, drilling, etc., has completely subsided.

3. *Manner of Performing the Operation.*—The healthy condition of the root and contiguous parts, and the ultimate utility of the substitute, may be very materially prejudiced by careless, hurried, or injudicious manipulation; as where the remaining portions of the natural crowns of the tooth are violently removed with excising forceps, or by the unskilful use of files in dressing the root, or drills in enlarging the central cavity, or by undue or misapplied force in the final adjustment of the artificial crown, or finally, by a faulty position of the tooth of replacement by which the root is subjected to injurious strain either by lateral pressure or premature closure against those of the opposite jaw. By the operation of either or all of these causes, disease of a more or less intractable character may be induced which will impair the usefulness of the artificial organ and subject the patient to much present and future distress and annoyance.

Preparation of the Root.—In the process of preparing the root for the attachment of an artificial tooth, all remaining portions of the natural crown should first be removed with suitable instruments. If the cervical portion of the tooth is comparatively sound and unbroken this may be most expeditiously accomplished, and with less risk of injury to the root, by employing a very fine saw attached to a steel frame or carrier, as shown in Fig. 42. The saw should be narrow enough

FIG. 42.

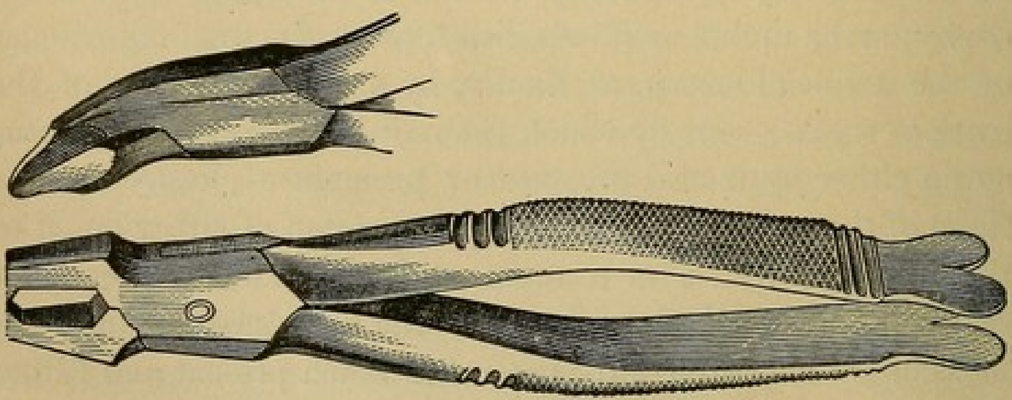


to enable it to take a curvilinear direction in cutting, as this will enable the operator to separate the crown nearly or quite on a line with the arched margin of the gum, thus dispensing, in a great measure, with the use of other instruments in the final dressing of the cut end of the root.

The saw should be passed along the side of the tooth to the gum, and the crown separated either by cutting directly across to the opposite side, or as nearly on a line with the curvature of the anterior and posterior margins of the gum as possible without wounding the latter. During the operation the saw should be kept constantly wet, and the crown should be supported by the fingers.

If the remains of the crown are friable, or if they consist of but fragmentary portions of enamel, they may be readily cut

FIG. 43.



away with excising forceps, two forms of which are exhibited in Fig. 43. The one having square, transverse cutting-edges, closing at right angles with the shaft is generally employed. Serious, if not irreparable, injury may be inflicted by the careless or unskilful use of this instrument, either by producing so violent a concussion as to induce, in some instances, incurable disease or absolute necrosis of the root; or by fracturing the latter in such a way as to unfit it for the reception of the pivot-crown. The forceps, therefore, should never be used to excise the crown with a single cut whenever any considerable portion of the root at the gum remains unaffected by disease, and even when the latter is friable or partially destroyed by decay, they should be used with great caution, cutting or chipping away small portions at a time until as much of its substance is removed as is practicable with the forceps.

After the use of the saw or excising forceps, any remaining portions projecting beyond the free margins of the gum should then be removed and proper shape given to the end of the root. A half-oval file, with a sharp and tolerably fine cut running obliquely across its convex surface, or suitably formed corundum burrs or disks are the best for the purpose, and, when in use, should be kept constantly wet and free from clogging particles of bone. The end of the root should be dressed down, anteriorly, at least, a little below the free margin of the gum, care being taken not to lacerate its peridental attachment; in this way the artificial crown, when adjusted to the root, will unite so intimately with the gum in front as to render exposure impossible. The surface of the root, prepared in this manner, will present a concavity corresponding with the festoon of the gum.

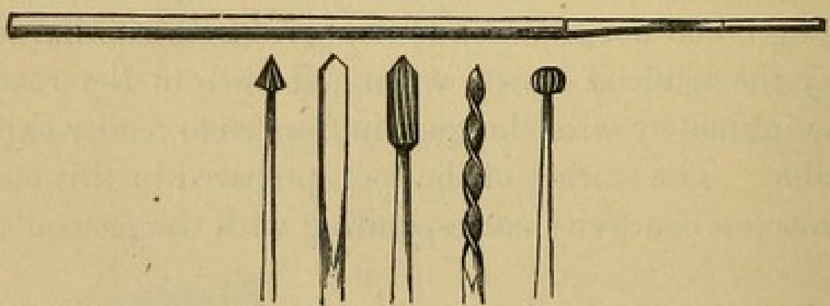
If a living pulp remains in the root, it will not ordinarily be practicable, unless there is partial obliteration and consequent recession of the pulp-cavity as the result of ossific deposits, either to saw off the root on a line with the gum, or even transversely, or to dress the root even with the gum, without inflicting insufferable pain. It will be necessary, therefore, either to extirpate the pulp through the carious opening in the crown before the latter is removed, or, if not exposed by the operation of sawing or filing, through an opening into the pulp made with a drill or cutting instrument after excision.

Arsenic may be employed for the purpose of devitalizing the pulp preparatory to its removal, or its extirpation may be effected by direct operation with suitable instruments. By the latter method the vitality of the root, through its peridental circulation, will be better preserved. Its extirpation may generally be readily effected with the use of a three or four-sided, barbed, untempered broach, which, being small enough to penetrate freely to the apex of the root, is thrust quickly to the bottom of the canal, rotated, and withdrawn; when, if the entire pulp does not come away adherent to the broach, the operation may be repeated, with comparatively little pain, until all portions of it are removed.

After the removal of the pulp, the apical foramen should be thoroughly closed by any method usually employed in root-filling. A neglect of this important measure will greatly endanger the success of the operation.

The proper treatment and preparation of the root having been thus far accomplished, the canal of the latter should next

Fig. 44.



be enlarged for the reception of a pivot. This is effected with a suitable broach or with drills of various forms. When the canal presents the form of a cleft or fissure, a spherical or cone-shaped burr-drill should be used; if, however, the pulp-cavity approaches a cylindrical form, the operation will be more speedily performed with a four-sided broach, or, what is still better, a spear-pointed or spiral drill, all of which are exhibited in Fig. 44. The natural opening in the root should be enlarged to the depth of from one and a half to two or more lines, according to the length of the root; and the orifice should be made large enough to admit a pivot of sufficient size to secure the crown firmly in position. The direction of the drill in cutting should follow closely that of the natural canal in the root, since but a slight deviation in this respect may endanger the integrity ot the latter by too great a thinning, or actual perforation, of its walls. In all cases, however, where the direction of the canal will admit of it, the shaft of the instrument should be held steadily on a line with the circle formed by the cutting edges of the adjoining teeth, and either equidistant between the latter or with such a lateral inclination as will give to the tooth of replacement a symmetrical arrangement in the arch. During the operation, the drill should be kept constantly wet, and loose particles of bone should be washed from the cavity by occasional injections of water.

Fitting the Crown.—The pivot crown selected for any given case should correspond, as nearly as possible, in size and general configuration with its fellow of the opposite side, or, where several are inserted, with the form and size of the natural organs which they represent. The tooth or teeth of replacement should also harmonize in color with those immediately adjoining. The cervical portion of the crown applied to the root should correspond, as nearly as possible, in dimensions with the filed surface of the root, and the adaptation of the two surfaces should be sufficiently accurate at all points to afford a firm basis for the crown, and, at the same time, to exclude perfectly all particles of alimentary or other solid substances, the decomposition of which would tend to the decay or disease of the root, or become offensive in the mouth. To secure such a coaptation of the articulating surfaces, more or less dressing of the root and grinding from the base of the crown will be required, so that while uniform contact of the surfaces is secured, the artificial crown will be made to occupy its proper relative position in the arch.

The articulation of the crown and root may be very accuthe rod, and thus indicate with certainty the depth of the canal. The pivot being cut off at a point distant from the crown equal to the length of the uncovered end of the wire, is then dressed to the size of the orifice in the root. The pivot should be accurately fitted to the canal in the root, but not so tightly as to require any greater force in adjusting the crown to the root than may be readily applied with the fingers. A pivot thus easily applied will, when enlarged by the absorption of fluids, be so firmly retained as to render its removal difficult; and even when moisture is excluded, adequate stability will be imparted to the attachment, provided sufficient depth is given to the cavity in the root.

It may be observed, however, that any method of pivoting which does not effectually exclude the secretions of the mouth is objectionable. The too frequent method of fixing artificial crowns with pivots of wood, without providing for the exclusion of the oral secretions and pulpy portions of food, not only hastens the destruction of the root, but, in addition to being positively harmful, cannot fail to bring a desirable method of replacement into general and merited disrepute by reason of the offensive odors accompanying the animal decomposition inseparably associated with such a mode of procedure.

To provide against the intrusion of the secretions or portions of alimentary substances, either of the following expedients may be adopted:

If the coaptation of the prepared surfaces of crown and root in contact is accurate and uniform, one or two thicknesses of No. 4 or 6 gold foil, or corresponding thickness of tin foil, interposed when the crown is forced to its place, will exclude the secretions with tolerable certainty.

Such plastic substances, however, as are impervious and insoluble will more certainly accomplish the object in view, and among these, Hill's stopping is generally esteemed the best.

Amalgam may also be used for the same purpose, in which case the central portion of the articulating surface of the root should be somewhat countersunk.

It not unfrequently happens that a cone or funnel-shaped enlargement exists at the orifice of the root-canal as the result of decay. In such cases it will be difficult and often impracticable to adjust a pivot crown securely without preliminary treatment of the root.

Firmness of attachment, in these cases, may be secured in either of the following ways: 1. Having removed all softened or decayed material from around the orifice of the canal and enlarged the latter to the required depth for a pivot of ordinary length, the canal so prepared, together with the carious excavation, may be filled compactly with gold flush with the margins of the dressed end of the root. Through this a central passage is made with suitable drills for the admission of a pivot. 2. A highly polished and uniformly cylindrical steel wire, somewhat smaller than the prepared opening in the root, may be introduced into the latter and gold packed around it and into the excavation, flush, as in the former case, with the margins of the root, after which the steel wire is carefully withdrawn. In either of the above cases the gold should be securely fixed in place in the first instance by forming small pits or circular grooves in the walls of the enlarged canal, and by retaining-points in the sides of the excavation.

Pivots of Metal and Wood.—Pivots are sometimes formed of gold wire encased in wood. These impart additional strength to the attachment, and, at the same time, enable the operator to change the direction of the crown by bending the pivot whenever the root stands irregularly in the arch. A hole, somewhat smaller than that in the root, is drilled into a block of pivot wood, and into this is forced a gold wire—that formed of gold and platinum being the best, as it possesses greater stiffness and elasticity. The wood is then dressed down to a size a little larger than the canal in the root, and then compressed. One end being fitted to the hole in the crown, the projecting portion of the pivot, cut to the proper length, is trimmed to fit the opening in the root, and applied in the manner before described.

Another method is to close the hole in the crown with a cylinder of pivot wood, trim it even with the base of the crown, rately obtained in the following manner: Attach to the crown a temporary pivot of wood that may be easily applied and removed; coat the surface of the root uniformly with some pigment, as carmine, rouge, or rose pink, and apply the crown, with pivot attached, to the root; the points of contact will be indicated upon the base of the crown by the adherent coloring matter; the colored portions are then ground down somewhat on an emery wheel, and this process is repeated until the entire surface of the base of the crown exposed to the pigment becomes uniformly coated. Whenever it is thought important to preserve the form of the porcelain crown unchanged, the operation may be reversed by coloring the base of the latter and filing from the extremity of the root until a perfect adjustment of the parts is secured.

Another method, sometimes employed, may be adopted, and will secure an equally accurate bearing of the crown without subjecting the patient to the annoyance of repeated trials of the pivot tooth in the mouth. After having prepared the root in the manner already described, an impression of the root and contiguous teeth is taken, and from this a plaster model is obtained. The drilled cavity in the root will be indicated on the model by a corresponding depression; this may be extended into the body of the latter with an instrument fitting the orifice and held in the exact position as when enlarging the canal in the fang. The model is then varnished, and a pivot being temporarily attached to the crown, the base of the latter may be ground, with or without the use of coloring matter applied to the model, until the articulating surfaces close uniformly, and the crown occupies the required position indicated by the adjoining teeth represented on the model. If the impression is correct, and the manipulations are accurately conducted, a pivot tooth prepared in this manner will be found to fit the root and occupy a proper position in the circle with but little, if any, additional filing or grinding.

Attaching the Crown by Means of Wood Pivots.—The older and less expensive method of fixing artificial crowns to the roots of teeth is by means of pivots of wood. Thoroughly seasoned white hickory of small growth, fine-grained, and straight, compact fibres, is esteemed the best for the purpose. This substance is often used in its natural condition, but it will be much improved, both in respect to strength and durability, if previously well condensed by forcing it through the holes of an ordinary draw-plate, or, what is better, through apertures of various sizes formed with smooth bevelled edges in a piece of ivory, steel, or porcelain of sufficient thickness. Cylinders of wood, of uniform thickness throughout, are most conveniently formed by splitting the timber into rods five or six inches in length, and from one-eighth to a quarter of an inch in diameter, trimming them with suitable instruments to a size one-third larger than required when condensed, and then passing them through the holes of a draw-plate, on the side where they form a cutting edge, commencing with the larger and passing to those of diminished calibre, until a cylinder of the

FIG. 45.

size mentioned is obtained. These are then compressed in the manner before mentioned. When the draw-plate is used to compress the pivot, the latter should be passed through from the side opposite to the one used in forming the pivot.

One end of the pivot, dressed to the proper size, is made to fit accurately the hole in the crown, care being taken not to fracture the latter when forcing the pivot into place. The depth of the enlarged opening in the root will determine the length to be given to the end of the pivot projecting from the crown, and the former may be readily determined by means of a gauge (Fig. 45), consisting of a rod of wire of a size to enter freely the canal in the root, with a movable slide, to the end of which is attached a circular collar or flange. The end of the wire being pressed to the bottom of the canal, the flange, resting against the end of the root, will force the slide back upon the rod, and thus indicate with certainty the depth of the canal. The pivot being cut off at a point distant from the crown equal to the length of the uncovered end of the wire, is then dressed to the size of the orifice in the root. The pivot should be accurately fitted to the canal in the root, but not so tightly as to require any greater force in adjusting the crown to the root than may be readily applied with the fingers. A pivot thus easily applied will, when enlarged by the absorption of fluids, be so firmly retained as to render its removal difficult; and even when moisture is excluded, adequate stability will be imparted to the attachment, provided sufficient depth is given to the cavity in the root.

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Firmness of attachment, in these cases, may be secured in either of the following ways: 1. Having removed all softened or decayed material from around the orifice of the canal and enlarged the latter to the required depth for a pivot of ordinary length, the canal so prepared, together with the carious excavation, may be filled compactly with gold flush with the margins of the dressed end of the root. Through this a central passage is made with suitable drills for the admission of a pivot. 2. A highly polished and uniformly cylindrical steel wire, somewhat smaller than the prepared opening in the root, may be introduced into the latter and gold packed around it and into the excavation, flush, as in the former case, with the margins of the root, after which the steel wire is carefully withdrawn. In either of the above cases the gold should be securely fixed in place in the first instance by forming small pits or circular grooves in the walls of the enlarged canal, and by retaining-points in the sides of the excavation.

Pivots of Metal and Wood.—Pivots are sometimes formed of gold wire encased in wood. These impart additional strength to the attachment, and, at the same time, enable the operator to change the direction of the crown by bending the pivot whenever the root stands irregularly in the arch. A hole, somewhat smaller than that in the root, is drilled into a block of pivot wood, and into this is forced a gold wire—that formed of gold and platinum being the best, as it possesses greater stiffness and elasticity. The wood is then dressed down to a size a little larger than the canal in the root, and then compressed. One end being fitted to the hole in the crown, the projecting portion of the pivot, cut to the proper length, is trimmed to fit the opening in the root, and applied in the manner before described.

Another method is to close the hole in the crown with a cylinder of pivot wood, trim it even with the base of the crown, perforate its centre with a drill, and introduce into this one end of the wire, the surface of which is cut up into small barbs, or otherwise roughened to prevent it from drawing. A similar piece of wood is fitted to the orifice in the fang, and trimmed and drilled in like manner for the reception of the wire pivot —the latter being barbed and filed square to render it stationary when forced into place.

The author, in a number of cases, has adopted the following methods of inserting pivot teeth, in connection with the use of rubber, with gratifying results.

Having prepared the root in the ordinary manner, select and fit the pivot crown to the vacuity, leaving something of a space posteriorly between the base of the crown and the root. Fit a temporary wood pivot to the enlarged opening in the root, accurately, but in such manner that it may be easily withdrawn; the end projecting from the root should be trimmed down to say half the diameter of the hole in the crown, so that when the latter is applied in the manner to be mentioned directly, some latitude of movement will be provided, admitting of a proper adjustment of the crown when applied to the space. With the wood pivot in the root, fill the hole in the crown with stiffened wax, warm the pivot crown sufficiently to soften the wax, and apply it to the root in the desired position with respect to the other teeth. When the wax has hardened somewhat, withdraw the crown carefully on a line with the pivot, bringing the latter with it; then add sufficient softened wax to the base of the crown to fill in the gap or space between the crown and root; replace the tooth with the pivot attached, and press up until the crown again takes its proper position in the vacuity. By this means we get an *impression* of the filed extremity of the root, and, at the same time, secure an accurate relation of all the parts. The crown and pivot are then carefully removed. Now take plaster and pour a small quantity on a piece of paper or card and sink the pivot into it until the surface of the wax at the base of the crown rests upon the plaster, and then build the latter up upon the front part of the crown to the cutting edge, thus forming a shallow bed for its anterior face. When the plaster has hardened, warm the model to soften the wax, and then remove the crown and wax; the pivot will be found remaining in the model, but which, if previously oiled, can be readily drawn. We have now in the model an accurate representation of the end of the root, the size and direction of the root-canal, and, when the crown is replaced in its shallow bed, also the space between the crown and root to be filled in with rubber. The hole in the model, corresponding with that in the root, should be enlarged somewhat, and this may be done with the same drill used in enlarging the orifice of the root. After varnishing the hole in the model, pack in softened rubber until full, and insert into this the gold wire previously heated, the crown end of the wire projecting a line or so. Next fill the hole in the crown with rubber, heat the crown, and press it down upon the model and over the gold wire until the crown goes accurately into the depression made for it in the model. Then pack softened rubber into the space between the base of the crown and the model until it is filled in compactly. The whole is then encased in plaster, confined in a flask, and vulcanized. If the foregoing manipulations are carefully conducted, the crown will go to its place in the mouth with unerring accuracy, and, by placing one or two thicknesses of gold foil between the rubber and root, or some plastic material, as Hill's stopping, the joint will be rendered impervious. There is still an additional advantage in this method. All are aware of the liability of a wood pivot drawing from the crown where the latter is short and the hole in it shallow. The wired rubber pivot, vulcanized in the crown, cannot be drawn from the most shallow cavity without fracturing the crown. In very many cases this circumstance is of great value.

In substituting a porcelain plate tooth for the pivot crown in connection with the use of rubber the following method may be pursued: Fit a metallic pivot, composed of gold and platinum, accurately to the enlarged opening in the root, but not so tightly but that it may be readily withdrawn. Select and fit a suitable plate tooth, and solder to this a moderately thin gold backing. If, on reapplying the crown, with the pivot in place, the former is crowded forward out of proper position by the pivot, cut a slot in the latter, and, if necessary, groove the gold backing and crown at the base of the latter until the crown will take its required place, and the projecting portion of the pivot lies in close contact with the gold backing for a distance sufficient to insure adequate strength of attachment when the two are united by solder. When the crown is thus adjusted to the pivot, secure them in this relation with wax or plaster and remove them carefully; imbed in plaster and unite them securely with solder, and then proceed to take an accurate impression of the end of the root in connection with the united crown and pivot. This may be done by first filling in over the dressed end of the root with a sufficient quantity of softened wax, forcing the crown and pivot into place, and then moulding the wax with the finger to the end of the root and over the backing. Trim away superfluous portions of wax, remove carefully, imbed in plaster in the same manner as described in connection with pivot crown, form matrix in plaster, pack with rubber, vulcanize, dress down to the form of adjoining crowns, and polish.

To secure more perfectly the attachment of the rubber, the porcelain crown may be sufficiently undercut with a corundum disk along the sides of the gold backing, to bind the rubber, and this should be done either before or immediately after soldering the pivot to the crown.

When employing either of the foregoing methods, the wire pivot should be well barbed, and the joint between the crown and root sealed either by interposing folds of soft foil, or by some durable and impervious plastic material when the crown is finally and permanently adjusted.

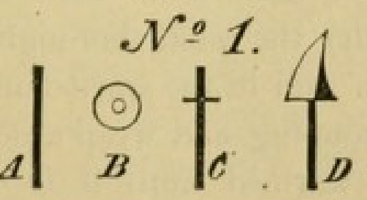
Pivot Plate.—The following methods of pivoting an artificial crown are applicable to all cases admitting of this mode of substitution, but will be found of especial utility under certain circumstances or conditions which exclude the use of the simple pivot crown, or which at least render their employment difficult and unsatisfactory.

It frequently occurs that the root to be used occupies a position in the arch inconsistent with a harmonious arrangement of the tooth of replacement by the usual method of attaching an ordinary pivot-crown. Thus it may lie closely against one or other of the adjoining teeth, distant from the centre of the space; or it may have too great an anterior or posterior obliquity, or too great a lateral inclination; or, again, it may range with the other teeth with respect to its direction, but may occupy a position entirely within the circle; in either case it will be difficult or impracticable to give a proper relative position to the crown in the usual way. It is true that any slight deviation from a just position or inclination of the root may be compensated for by a corresponding inflection of the pivot, or by forming an abrupt angle to it where the crown and root unite, or by placing the pivot on one side of the hole in the crown; but when the irregularities spoken of exist to any considerable extent, it will become necessary to adjust a pivot-plate to the root, and attach to the base an ordinary plate tooth, to which any desired position may be assigned.

One of the simplest and most practicable methods of performing this operation is thus described by Professor Edwin T. Darby:

"After this (the proper preparation of the root) has been thoroughly done, select a piece of gold or platinum wire (*a*), Fig. 46, of the diameter of the opening in root, and fit nicely

FIG. 46.



to the opening, letting it project one-eighth inch beyond the end of the root, that it may be readily removed and inserted in the root during the operation. Next select a thin piece of platinum, of which make a cap with hole to fit around the wire pivot snugly, and over the whole end of the root (*b*).

is here given (Fig. 47, *a*). When this is done and the wire and plate taken from the root and put in place in the impression, a correct model of the teeth and parts adjoining can be made with the gold in the same relative position as when in the mouth. After the model is made, the gold removed from it, the end of the wire which extended outside the root to aid in marking the position of the wire and plate in the impression cut off and filed down to the surface of the plate, a thick, narrow gold backing should be fitted and riveted to a suitable crown (plain 'plate tooth' with 'straight pins') and a groove be cut along each side, and, in some cases, near the cutting edge of the porcelain, as illustrated in Figs. 47 *b*, and 48. This is done that the parts may then be built out and the porcelain more perfectly secured, and the contour of the palatal

FIG. 47.

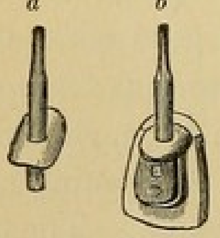
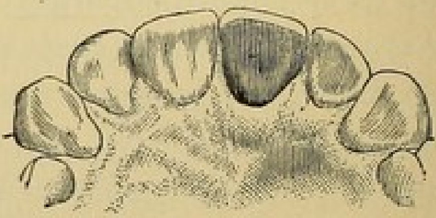


FIG. 48.



portion restored with pure gold, as shown in the cut with crown in place (Fig. 48). After the backing is placed upon the porcelain, it should be attached to the plate with wax and the whole carefully removed from the model, encased in plaster and sand, gradually heated, and soldered. The parts, prepared as described and illustrated, may be held by screwing the wire in a hand-vice while the gold foil is being built in place. This can be nicely done with the electro-magnetic mallet, and the crown made ready for insertion by the time of the next appointment with the patient.

" A very good and less difficult method of preparing crowns is to back the whole of the porcelain and restore the contour of the palatal portion with fine gold plate (18 to 22 k.), united with correspondingly fine solder.

" The apical foramen should be closed with gold. If gutta-percha or oxychloride of zinc be used for this purpose, some of the material may be pressed through the foramen, but with gold the operation can be made more certain and satisfactory. To avoid any exposure of gold should recession of the gum take place, the edge of the plate ought to be so cut away that the porcelain may be accurately fitted upon the labial portion of the root.

"When all is in readiness for placing the crown upon the root, fine barbs should be made with a knife or lancet along the entire surface of the gold wire, a thin layer of white gutta-percha (such as requires little heat) placed around the wires and against the plate; the metallic parts should be heated sufficiently to just soften the gutta-percha, and, with the root dried, the whole must be immediately pressed and carefully malleted to place. The surplus stopping should be trimmed off with a lancet a few hours or the day after the crown is placed upon the root, or when the gutta-percha shall be thoroughly cooled; the gum will then have been so pressed away that the boundary-line between the crown and root can be seen and the edge of the gutta-percha smoothly finished with pellets of Japanese bibulous paper, lint, or cotton saturated with chloroform.

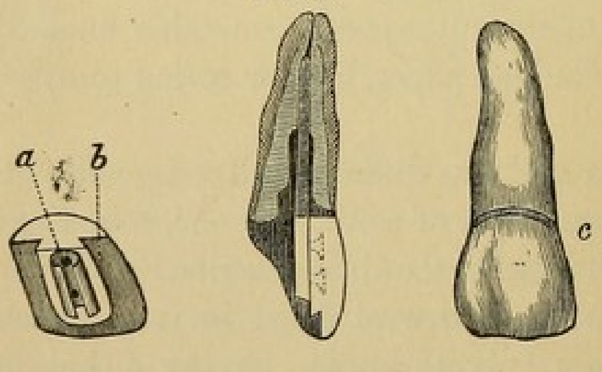
"There is a still less difficult and yet good method of placing crowns upon roots of teeth, and one, too, that does not require so much time as that just described; but the root should be prepared and a gold wire fitted in it in the same manner. A suitable plain 'pivot' crown, having a hole in it a little larger than the gold wire, should be selected and fitted to the surface of the root as perfectly as possible, and the opening in the porcelain filled with fine, well-seasoned hickory wood, which must then be cut off even with the base of the crown, and a hole drilled in the centre and entirely through it large enough to insert one end of the wire. The surface of the wire should be roughened or finely barbed along its whole length, one end placed (not malleted) tightly in the opening made for it in the wood in the crown, and the whole then placed upon the root and finished as above described.

"An artificial crown, by whatever method mounted, can be more successfully placed upon a root, and all operations better performed, when the rubber dam is applied than where it is not used, and it should, therefore, be secured, if the operator can apply it, to the adjoining teeth, and then to the root, before the final fitting and mounting of the crown."

Gold Crown Faced with Porcelain.—The subjoined method of attaching an artificial crown to a root was originally introduced to the notice of the profession, in 1872, by Dr. Marshall H. Webb. The following is a description of his more recent and perfected method of operating, which, while it necessitates great care, dexterity, and delicacy of manipulation, unquestionably possesses, in an exceptional degree, the important advantages not only of security of attachment, but of indestructibility, the union with the prepared surface of the root being effected by direct contact of impacted gold.

"Building crowns of gold upon roots of teeth and facing them with porcelain makes the most secure and satisfactory

FIG. 49.



though difficult operation. After preparing the root, closing the foramen with gold, and cutting away the irregular or projecting edges to within about a half line of the margin of the gum (leaving this much to aid in applying the rubber dam), a gold wire, No. 13 or 14, with a fine, sharp thread cut upon it, should be accurately fitted in the pulp-chamber to near the apical foramen. To the platinum pins of the porcelain selected for the case a cylinder or tube made of gold plate should be fitted, and, after it is opened (Fig. 49), riveted and then closed, placed in plaster and fine sand, and carefully heated and soldered. A thread must then be cut in the cylinder corresponding to that upon the wire to which it is to be attached. This is done that the crown may be more securely placed upon the root than by the method described by the writer in the *Dental Cosmos*, June, 1873. The end of the gold tube next the cutting edge of the crown may be bevelled and a slot made in the wire at that part, so that the cylinder will be prevented from turning, while still greater strength is added by impacting gold into the open part, thus spreading the end of the wire. A groove should be cut with a corundum disk in each side (*b*), and sometimes along the cutting edge of the porcelain, into which gold foil is to be placed, to secure greater strength and permanency.

"When all is in readiness for the operation, the rubber dam should be applied to two teeth each side of the root and to the root itself. The ligature of waxed floss silk should be placed twice around the root, tightened, and pressed well to place with a burnisher, the ends of the silk wrapped twice, as in tying a surgeon's knot, and the ligature then attached to the ring at the end of an elastic rubber dam holder and held just below the edge of the slightly upraised lip, so that, when the holder is fixed to a tie put around the patient's neck, there shall be constant tension upon the ligature. After this has been done the root should be trimmed down with corundum wheels or cones to the ligature, although not close enough to displace it. The porcelain should then be so fitted as to leave a half line of space to be filled with gold (as at *c*) between it and the root, after the wire has been placed in the cylinder and screwed into the root. In placing the parts in position a little oxychloride of zinc, nearly the consistency of cream, should be placed in the root next the gold that closes the foramen, and the gold wire at once put in this and screwed securely to place. After the oxychloride of zinc has crystallized, sufficient of it and of the dentine should be cut away with small burs to secure good anchorage for the gold now to be placed as perfectly and solidly as possible around the wire, to and over the margin of the root, along the gold tube, into the grooves made in the porcelain, and between it and the labial margin of the root (*c*). This narrow line of gold need not be made visible when the operation is completed. The gum should cover it. While the gold is being placed around the wire in the root the porcelain can be turned a little to one side upon the gold wire till the cylinder is reached and restoration of the contour of the parts commenced. All the gold should be cohesive and impacted by the aid of the electro-magnetic mallet, with which the surplus foil can easily be trimmed away from the margin of the root as placed upon it, and the form of the crown so nicely carried forward that but little dressing is afterwards necessary. The gold should be filed even with the margin of the root, and finished with narrow strips of fine emery cloth at and near that point, while the rubber dam is yet in place; after this is removed the gold should be so cut away as to allow proper occlusion of the teeth, and a little space should afterwards be gained by very careful wedging for the trimming and finishing of the gold along each proximate surface separately."

The form and relations of the several parts entering into the construction of a crown by Dr. Webb's method are shown in Fig. 49.

A process of attaching porcelain crowns to the roots of teeth by the use of steel screws, originally introduced to the notice of the profession by Dr. George T. Moffat, of Boston, Mass., but more recently and particularly described by Dr. E. W. Foster of the same city, is worthy of a place among the best operations of this kind by reason of its simplicity, security of attachment, comparative inexpensiveness, and its practicable application to other than the single-rooted teeth. Dr. F. thus describes the method:

"Among the principal features of this method is the steel screw in place of the steel pin, as first applied, and which unites the crown to the root in the most perfect and absolute manner. The inner head of the screw (Fig. 50 *a*) is a concave or half globular, and completes the principle of a ball-and-socket joint between itself and the circular cavity in the posterior part of the crown, seen at *b*, in a vertical section of the same. This, it will be observed, permits of an automatic adjustment to the root, but more so in lateral directions, a fact of great importance and convenience where the root is out of its normal position, as is frequently the case, especially as regards the anterior teeth. Where the root is sound and the joint close, a few layers of soft gold foil are placed between the crown and the root. After a careful and final setting of the screw, an impervious joint is thereby obtained—one perfectly odorless and highly antiseptic to the root for an indefinite period of time.

"The prejudice against the old and odorous varieties of crowns is well sustained by all persons of intelligence and refinement.

"The front view of an incisor crown thus set is shown at *a* (Fig. 51). The posterior cavity in the crown, over the screw-

FIG. 50.

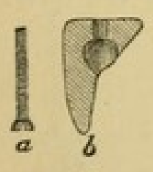
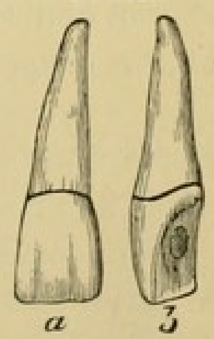


FIG. 51.



head at *b*, is filled with gold, or other material, and finished flush and smooth with the surface. Where gold is used, which is generally preferable, the retention of the first pellets is greatly facilitated by the previous arrangement of a few layers of adhesive gold foil under the head of the screw, whose overlapping edges serve admirably the purpose intended.

"Oxychloride of zinc or gutta-percha would be indicated in cases where the root was hypersensitive. In the place of the layer or layers of foil in the joint, a drop of gum sandarac varnish—quite thick—will often be all that is required to accomplish the same results. Where the end of the root is extensively decayed, the jagged interval in adjustment may be filled with gold or gutta-percha according to the judgment of the operator. The screws should be made of the best watchsteel wire, and in the main shaft do not require to be larger in diameter than a small knitting or common-sized darning-needle. The screws may be also slightly washed in a nickel bath to suit a whim or fancy, but practically they have no advantage whatever over plain screws, for the obvious reasons of their seclusion and dryness when in position. Most of the anterior roots will, for a sufficient distance, permit the use of a drill which is three or four, or even five times the diameter of the screw. A plug of hickory in such cases is firmly set in the hole thus drilled in the root, and the end of the wood neatly finished with the outer surface. The tooth crown, now firmly held in the desired position on the end of the prepared root, will act as a guide in drilling for the screw, the drill passing up through the posterior cavity of the crown. Presuming, of course, that the nerve cavity is filled to the screw with gold, a vertical half section of the root and crown with the inserted wood for the attachment of the screw would appear as in Fig. 52. At *a*

FIG. 52.

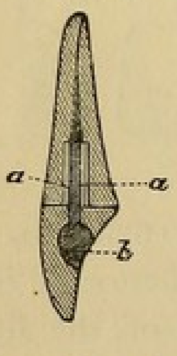
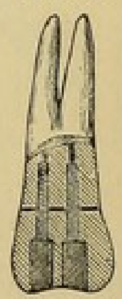


FIG. 53.



appears the wood, and at *b* the external gold plug. The final attachment is facilitated by having previously run the screw once through the wood before the crown is put on. A tap for the screw is easily made from a broken excavator or other instrument of like dimensions by drawing the temper and cutting the same thread as the screw for a suitable distance upon the end. After the end is slightly rounded, three grooves, equidistant from each other, should be filed rather deeply, lengthwise of the tap, then the whole tempered and drawn back to straw color. The screws themselves will run better by being grooved likewise, but should not be tempered. However, if a tap is necessary, and a regular one is not at hand, from accident or otherwise, the screw, already grooved, needs simply to be tempered to act admirably in a double capacity.

"We have spoken principally of the anterior teeth. We will now refer to this method as applied to those teeth, in either arch, that are posterior to the canines.

"It will be evident from the principles involved, that bicuspid and molar crowns can be applied with the same facility, especially whenever their situation in the arch will permit the use of the drill. Bicuspids are treated in the same manner as the anterior teeth, save that in the strong, broad, and frequently bifid roots of second bicuspids, two screws may attach the crown, especially where extra strength will be required from their situation in mastication.

"Fig. 53 will illustrate a second upper bicuspid, in part section with two screws. Upper and lower molars will require two, three, or more screws as the operator may determine. Many more layers of foil will be required for molar crowns than for others, in order to secure an equal perfection of their joints. Where many crowns may be called for in a case, the carver is indispensable. In cities, and in offices, even, where good carvers may be had, nearly, if not every tooth may be carved by him to suit each place precisely, and little or no fitting will be required. More diversified and desirable results are thus obtained. In the country, and places too remote for such advantages, the anterior and bicuspid crowns may be furnished in various colors and shapes after the ordinary patterns. Excellent crowns of the above description have been furnished us by the enterprise and accommodation of S. S. White from moulds made expressly for such.

"In the matter of screws we will merely remark that, as no town furnishes a dentist without at the same time furnishing him with a neighbor equally constant, omnipresent, and indefatigable,—the jeweller,—the facility of obtaining screws made to a desirable pattern will be abundant and satisfactory. Where it is decided to give the carver an opportunity to display his skill, whether it be upon one crown or a dozen, an impression in plaster will be necessary. Preceding this, all the crown-bearing roots should be prepared, dressed, and drilled the same as for setting, but not tapped. Bits of wire of any kind, the diameter of the drill, are now set in each place intended for a screw, and rising to the height of the future crown. These pins should sit in their places easily enough to come away readily with the impression when it is withdrawn. The removal of the impression from about the other teeth may be facilitated by the use of a slight portion of glycerin applied with a small camel's-hair brush about their necks and crowns. Glycerin, though agreeable of itself to most people, may be rendered quite so by perfuming it with some generally acceptable odor. The impression being now removed is carefully varnished and oiled, the pin or pins remaining *in sitû*. From this the true cast is made, the pins now being transferred to this one in turn. By careful manipulation and cutting the pins will part with the old cast or impression with little or no difficulty. The purpose of these pins is to serve the carver for attachment of the 'body' in its first moulding, and give, at the same time, the direction and diameter of the screws in the crown, the heads of which should finally occupy the position of about a sixteenth of an inch from the joint. A plaster bite of the antagonizing teeth should also accompany the final cast. If shrinkage in baking of the crown will not permit the passage of the screw freely, a small, soft steel mandril in the lathe, with the use of oil and the flour of emery, will be efficient.

"Fig. 54 represents a case where eight crowns have been set by this method. The black dots represent the gold fillings over the screws—two in the second bicuspid and three in each of the two molars.

"In conclusion, with regard to the above method of crowning roots, and its application, we may be permitted to offer for consideration a summary of its characteristics:

"1st. Its simplicity, neatness, and permanency.

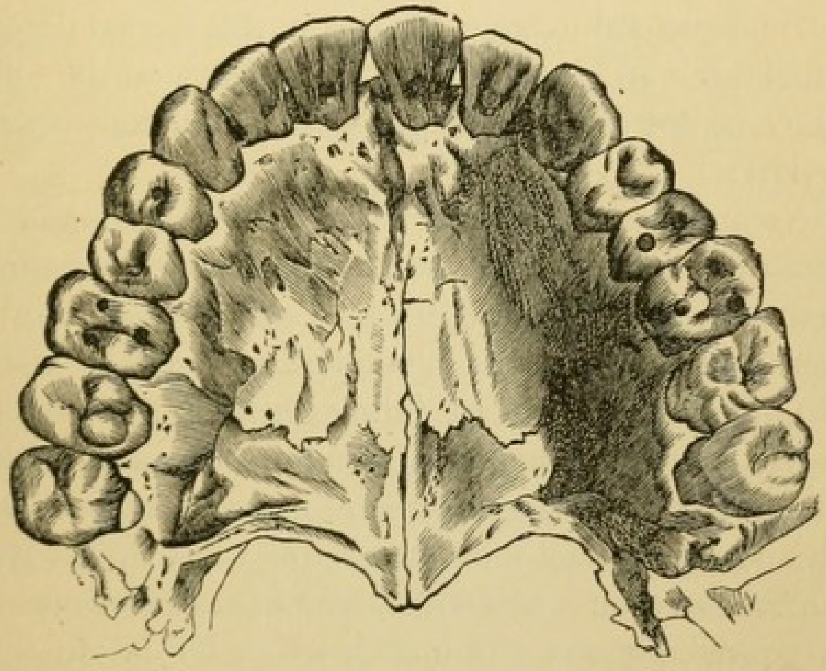
"2d. The impervious and antiseptic character of the union of crown and root.

"3d. The practical application of these crowns to bicuspids and molars, as well as to the anterior teeth, which have been chiefly concerned in this matter hitherto.

"4th. The use of the screw, which is one of the most powerful adjuncts in mechanics; and this screw of steel, uniting the minimum of size with the maximum of strength.

"5th. The application of an entire crown of porcelain, ivory, or gold and porcelain, as set forth.

Fig. 54.



"6th. The ball-and-socket principle of the screw-head and its cavity of reception in the crown, permitting of automatic adjustment to the root, whether in its normal position or otherwise.

"7th. The facility with which the carver may adapt one or many crowns in either dental arch.

"8th. The final filling and finish of gold or other material in the posterior cavity over the screw, sealing the whole imperviously, and at the same time permitting of the speedy and safe removal of the crown, when necessary from its fracture, or from other causes.

"9th. The many objections it refutes with regard to the popular notion of 'pivoting' teeth in general. Among the most prominent of which are not only the offensive odor and other imperfections of the older forms, but the costliness and tediousness of some of the later ones."

The author is indebted to the obliging courtesy of Dr. W. G. A. Bonwill, of Philadelphia, Pennsylvania, for advance proof-sheets of an article descriptive of a "New Method of Substituting an All-porcelain Crown upon any Root in Either Denture," prepared for August number (1880) of the *Dental Cosmos*. Dr. Bonwill's long-continued, intelligent, and successful experimentation in this special department of practice is well known to the profession, and the following may be accepted as embodying his best and latest experiences. He writes:

"No argument is needed to convince the advanced practitioner that some method is demanded whereby the thousands of good roots now sacrificed can be made permanently useful. Notwithstanding the great revolution wrought by machinery and improved appliances for filling teeth, so few are the successes that, unless some plan is brought to our aid to save the remaining roots from the ravages of decay and from a want of skill and judgment by three-fourths of the dentists, we shall have little else than plates with which to meet the issue. Teeth can be saved without filling as well as by filling by some operators, but by a few only. Most of the dilemmas which all of us encounter every day are the results of bad dentistry. The plan to meet the difficulty must be one which is founded on such mechanical and physical laws that it can be safely relied upon for resisting both time and the various surrounding circumstances; one which any ordinary operator can follow, and which will be so cheap as to bring it within the reach of all; one which, if by accident the porcelain crown has been fractured, will allow of easy substitution in a few minutes without interfering again with the operation performed on the root. A crown is needed which can be obtained by every operator as easily as porcelain teeth for plate work, and kept in stock by him ready for any emergency, and costing but a trifle to replace;

a method by which we can take any case of great irregularity, of any age and standing, and, without disturbing the root, cut off the crown and place the porcelain one in the proper curve in the arch; a result which is absolutely clean, and which will make the patient feel safer from accident than any other process of restoration.

"Has any such plan been generally practiced? A few have been successful by certain elaborate methods which only the exceptionally skilful could perform, and even then, when a 'break-down' came, there was no alternative but to do it all over again, either at the cost of patient or operator.

"Since 1871 I have been experimenting in this direction. The grand object in view was to give to the dentist at large such a made-up all-porcelain tooth as would meet almost any requirement.

"My first plan (see *Dental Cosmos*, September, 1877) of a bolt and nut planted in the root by gold foil did not succeed, as the safety of the whole depended on the perfect rigidity of the bolt. Gold could not be so packed, save in a few cases. Amalgam overcame this difficulty, a platinum bolt being used instead of a gold one; but this operation was practicable only to skilled mechanicians; the average dentist was unable to perform it.

"To meet this issue, the all-porcelain crown, without nut, was devised. In looking at the incisor crowns, superior and inferior, one might suppose that with so much cut away from their base, and with the pin-hole running entirely through the crown, the strength would be impaired. So I feared when the idea was first suggested to my mind. But upon trial the strength was found entirely sufficient. The experiments were made by drilling out old-style pivot teeth with a diamond. They are now made by the Trustees of S. S. White in special moulds. With these still greater strength is attained. The incisors are so shaped as to form a dovetail, which allows the strain outward to come high up near the cutting edge, and not to depend upon the palatal base for support. The bicuspids and molars are cut out at the base, leaving a little more than a shell, with undercuts for the amalgam to act as dovetails.

"This method leaves no joint on the natural root, and none in the crown, the operation being really an amalgam filling capped with porcelain. The hollow crown enables the operator to fit it in a very brief time, there being but little material to grind off.

"If a fracture occurs, a new crown can be placed with but little fitting on to the old amalgam base, first burring off any excess. When a case is presented where the pulp is not exposed, the hollow-base crown permits of so shaping the root as not to endanger the pulp, and to place the pins on either side of the same into solid dentine. At this time I cannot conceive of a single case occurring that cannot be met by one or the other of the plans herein described and shown clearly in the cuts,—equally adaptable where a number of roots are in continuous circle, or at intervals, or even for a full denture, as the teeth one by one give way; or in making the root of a lateral bear the crown of a central, or *vice versa;* or one or two adjoining crowns where no roots are left. Where more than one crown is needed, the nut and bolt are called for, as in case of accident, or the necessity for readjustment, they can be unscrewed, the fixture removed, repaired in the laboratory, and again screwed in place.

"Let me say just here that this plan of nut and bolt is applicable where no roots are present, for fastening one or more plate-teeth on a plate instead of by the method of Dr. Bing, in which, if the teeth are broken, they cannot again be readjusted. Such bolts with threads cut upon them can be inserted in any part of a perfect crown or a filled one by the use of amalgam, or gold, if one will use it in such cases.

"Next in importance to a crown that will meet all cases are, the bolt which is intended to attach it to the root or roots, and the cement for securing it.

"In such cases as are outlined in Figs. 59 and 60, see that the platinum pin is secure, and so placed where occasion demands that the lower part of the root need not be filled with cement, but that space be left for gases to escape through the tap-hole, which should be made obliquely from near the margin of the gum down below the cement, guarding against the liability of decay again occurring at the cervical margin by bevelling well the mouth of the cavity in the root. This once done correctly, there will be no need of again disturbing it. (Before setting the pin in any case the root should be temporarily filled at the apex to insure against abscess.) Cases will present, however, where gases will form and escape. Here perfect security can be obtained by the tap-hole, as before described. This left open a useful root is retained, and without any apparent unpleasant odor. Do not condemn an abscessed root. Such can be made equally successful where the periosteum can be restored to health. Save every old root that has any length, and in which the pin can be well anchored high up, even if the walls are fractured for an eighth of an inch below the gum, or even where the root is split. In such cases dovetailed holes can be made in each fractured part, and the amalgam will hold them together. Even without this if the pin have a good quarter-inch anchorage at the very apex it will be hard to dislodge.

"To make doubly sure, when a tap-hole has to be made, that it is open from the apex, pass a fine thread of silk or cotton down alongside of the pin, build up the amalgam around it, withdrawing it after the crown is on and before the amalgam has set, holding the crown firmly while doing it. Or the thread can be introduced through the tap-hole and then passed up to the apex, withdrawing it when the crown is in place. This practice is perfectly justifiable rather than to lose a serviceable root. To a conscientious operator it needs no argument. In a very important root I go so far as to allow or even to force an abscess to form, and then treat it through the pulp-canal and fistula. I save seventy-five per cent. of such cases rather than abandon them.

"Do not cut away the root very much, as a trifling space around the three-cornered pointed pin will permit enough cement for strength. Roughen the inner walls of the pulp-canal, and they may be left conical without danger of the pin being withdrawn. One very great satisfaction to the patient, as well as to the operator, is that the rubber-dam need never be used. The base of the root can be so prepared with a sharp bur that but little injury is done to the gum, and if it bleeds creasote or chloride of zinc will stop it; or, pressure of the thumb and index-finger against the buccal and palatal walls will stop it or any serous discharge while the root is being filled with cement. After that there is nothing to hinder the placing on of the crown. Be sure before forcing in the amalgam or cement that the apical foramen is closed. For this purpose I use fine zephyr saturated with creasote, except in cases were a tap-hole has to be made.

"Only in cases of fracture of the shaft of a root would I use a band, and that should be placed on separately from the crown, not with it. Not a half dozen times in nine years have I had occasion to use such a band. The use of the platinum pin in the pulp-canal and passed high up obviates any necessity for such band, which is at best unsightly, and, for many other reasons, objectionable. Such a plan admits of no readjustment, and has been used by others only to assist the cement in setting. Cases occur where each root of a molar or bicuspid stand separated. One small pin in each well pressed up gives equally good results.

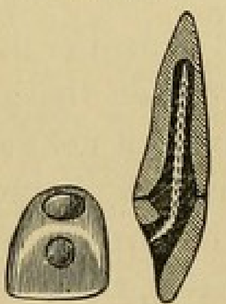
"Never depend upon cutting a female thread in the dentine and placing a screw therein. This can be done, but it is so easy to be deceived that the plan as shown in Fig. 58 is much more desirable because more reliable. It is preferable in such cases to place in the pins and wait until the next visit of the patient, and, before placing on the crown, to try the pins to see if they are well anchored. When more than one crown is to be placed on in a continuous circle or line, cut off all the natural crowns at one sitting instead of finishing one at a time as I once advised. As many as four incisors can be inserted at one sitting, though two is as much as one generally cares to adjust at one time. Where the crowns have been well fitted to a plaster model there will be little difficulty in getting a good arch in the mouth, though a model is not necessary except for the superior or inferior incisors. If you have a large stock of bicuspid and molar crowns on hand the fitting can be done at once. For special cases of very short teeth it would be well to have a plaster model. The only objection ever urged against using amalgam in the roots to secure the pins is that the gums soon look purple or blue. This can only occur where the joint is not high enough above the margin of the gum and where poor amalgam is used. Oxyphosphate or oxychloride of zinc can be used, but I prefer a special quick-setting amalgam such as I am using. Gutta-percha for such an operation is no better than putty. Some cases have succeeded with its use, but it does not at all meet the requirements.

"As to the objection against amalgam that it is too plastic and too long in hardening, let me say that in fact such is not the case, unless the ordinary amalgam is used. I have never had to replace in a single case from such cause, where the amalgam I have adopted is used in the crown. For the roots, any first-class amalgam will do that does not take too long to set. The safety is in having it not too soft in the crown when it is pushed home. When the platinum pin is pressed up into the root with forceps, with the pin resting against the palatal wall of the tooth in incisors, there is no displacement. The pressure made on the crown 'squeezes' out all surplus mercury and impacts the amalgam well around the pin, and with a lump of it well pressed or pounded with small points around the pin in the crown from the outside orifice, it holds securely.

"When amalgam is used, the shade of the crown should be rather lighter than if a white cement were to be used, as the opacity of the amalgam adds a blue tinge to it, just as in plate teeth the shade is made darker by the stay-plate, after soldering.

"Fig. 55 shows the crown of a superior central from the palatal surface, the base cut out high, and with another countersunk hole near the cutting edge, and undercut on the mesial and distal walls, to allow the amalgam to grasp the body of the tooth well up, so that it shall not depend for support at the base only. The base may be cut away after the amalgam has hardened and the crown would not fall off. The base is countersunk to admit of easy and free adjustment of the pin, and to allow of a large body of amalgam around it, making one continuous amalgam filling from the root through the crown, with no joint for retention of food, the material being stronger than the porcelain. The opening on the palatal surface is convenient as a safety outlet for the amalgam, and permitting the crown to go up to its place without obstruction. When the crown is well pressed up, the amalgam can be packed in around the pins, and the amalgam will act as a metallic base or backing for the palatal surface, thereby strengthening it. The thumb or index finger on this orifice prevents the too free escape of amalgam when pressing up the crown.

FIG. 55.



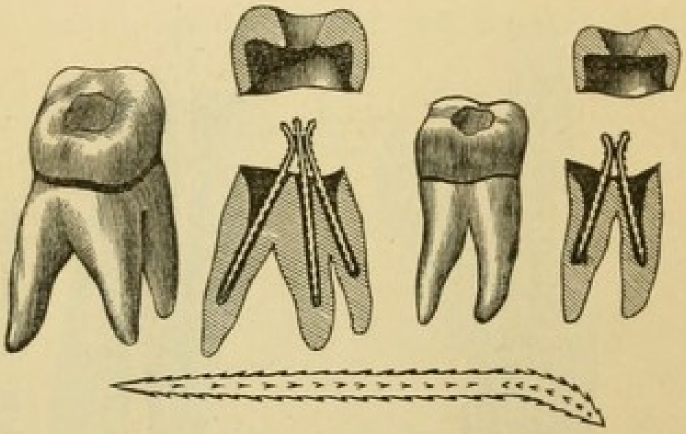
These crowns have no platinum lining or tubes as the English teeth have. They are stronger without them. A sectional view of a central is also shown in Fig. 55, with barbed pin bent at the proper angle, the dark part showing the amalgam.

"Fig. 56 shows a bicuspid with double pulp-canal, the cross-section of a crown with countersunk base, and the opening on the grinding surface for the escape of surplus amalgam.

"Fig. 57 embraces sectional views of a superior and inferior molar, showing arrangement of pins, with a magnified view of the platinum pin, pointed at each end, made triangular and well barbed, the barbs looking towards the angle of the pin where bent. The perfected crown on the root shows the line of amalgam. When two or more pins are used they need not be placed so far up in the roots or be so large in diameter as when a single pin is used. In cases where the root has to be tapped, then the pins can be placed in the mouth of each pulp-canal and the tap-hole made below, which should always be done before the pins are inserted, similar to Fig. 58, where there is a living pulp. Indeed, were it not for the fear of displacement before the hardening is complete, pins could be dispensed with in molars, as the body of amalgam is so great

FIG. 56.

FIG. 57.



that when set it will hold sufficiently. The pins when set like a tripod at the base offer greater security than one alone.

"Fig. 58 shows an all-porcelain crown, sectional view, where the pulp is still living. A hole is made on the buccal and lingual sides of the root as far away from the pulp-canal as possible, and of size very little larger than the three-cornered pin, with an enlargement near the opening made with a barrel-shaped bur. The side of the under-cut next to the crown should be as square as possible, not rounded, as in Fig. 58. In such a case the amalgam should be used quite dry, as the pins do not have to be pushed far, and can be well tamped in with narrow steel blunt points, so as to make sure that the amalgam is solid. The crown can be placed on at once, or you can wait until the next day to see that the pins are all secure.

"Fig. 59 is a sectional view of a case that requires tapping. The pin shows its thin flattened edge, with space on either side for gas to escape from the foramen. It is pressed up about three-fourths of the length of the canal.

"Fig. 60 illustrates the same case as Fig. 59, giving a view of the flat side of the pin and showing its bearing on either side of the canal, by which it is prevented from lateral movement, the same as if the amalgam encased it all the way. The gas escapes at the opening at A. (This opening should extend obliquely up to near the free margin of gum, and not as shown

FIG. 58.

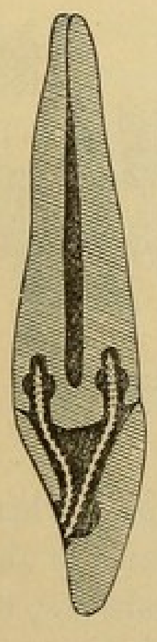


FIG. 59.

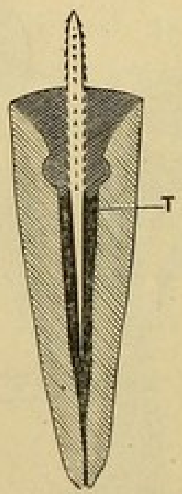
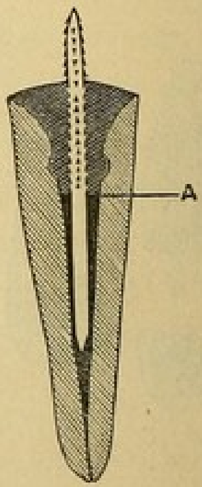


FIG. 60.



in the cut.) The amalgam extends no further into the root than A. This plan holds good in any tooth of one or more roots.

"Fig. 61 shows views of a superior central incisor crown as made from a plate tooth (pins crosswise), backed up with heavy gold plate entirely to the cutting edge and down to the base where it rests on the root. The .shape is given to the palatal surface by an extra plate, struck up concave with a round tool on lead and nicely fitted up to the backing on the buccal side, extending as high up as the angle or about up to the cross-pins, and filled in with scraps of gold plate and then soldered. The drilling of the hole through the base and the countersinking on the palatal side are done with the engine.

The base of the plate tooth should be cut off from the pins down to the cervix to leave more room for the nut. The nut ordinarily goes much closer to the backing than is shown in the sectional view of Fig. 61. The pin is barbed on its three sides and thread-cut on the end passing through the crown. This is done with the ordinary screw-plate before inserting. For central incisors the pin of platinum wire should be No. 16, and for small lateral No. 18. The nut is made of half-round or oval gold wire, about three thirty-seconds of an inch in thickness. The hole should be drilled before cutting it off from the main piece, and a female thread cut in it by a tap

FIG. 61.

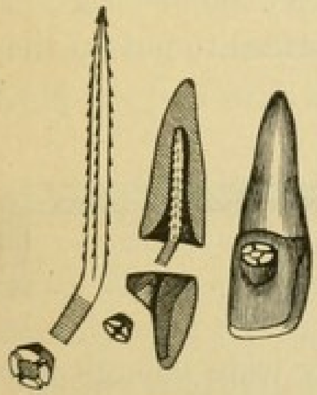
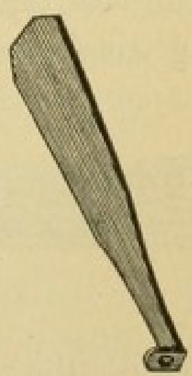


FIG. 62.

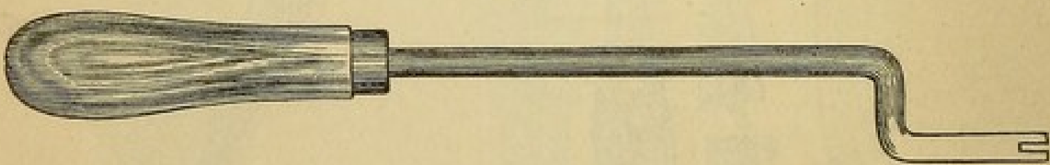


made of an old excavator filed down and run through the hole in a screw-plate of the size of the wire to be used in the root. The slots in the head of the nut should be crucial, to admit of the screw-driver (Fig. 63) being used at each quarter of a circle. The nut should be tried upon the threaded part of the pin before being finally inserted, to see that no mistake has been made in the size of either the nut or pin. Such mistakes will sometimes occur. The pin is bent slightly, to allow it to pass through the hole in the crown and stand in the countersink equidistant from all sides, so that when the nut is placed on it it will bear on all sides of the countersink alike, and the crown will not be tipped to one side. The pin, after the amalgam has hardened, can be bent with forceps to suit the countersink, taking care not to bruise the thread. The nut cannot be placed on at the same sitting, as the amalgam will not be hard enough to justify it.

"If so unfortunate as to injure the thread, repair it with a little screw-plate, as shown in Fig. 62. This may be made from a piece of steel dividing-file, cut down to about the size shown in cut, and bent at right angles after heating it to a cherry red, and afterwards drilling a smaller-sized hole than the pin, through the short angle, and tapping it with the same tap used in making the gold nut, then tempering it to a dark straw color. This screw plate can be run up on the pin in the root, and recut it its full length to the base. This obviates the removal of the pin after the amalgam has set. Taps and plates of various sizes should be kept on hand in duplicates.

"Fig. 63 is a forked screw-driver, bent at right angles to admit of getting into the palatal surface to put on the nut. It

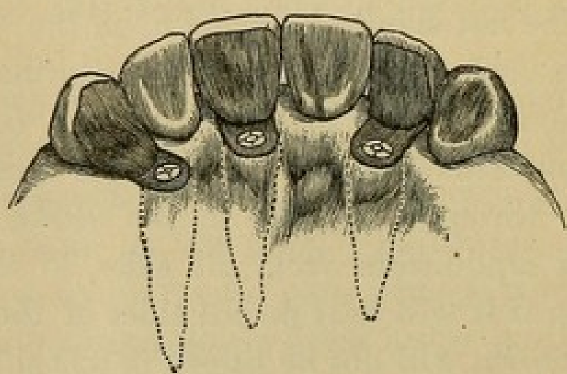
FIG. 63.



should straddle the pin and be only wide enough to cover the diameter of the nut.

"Fig. 64 shows a case of irregularity which was beyond correction, on account of the poor character of teeth, their very

FIG. 64.



ugly shape, their position in the palatal arch, and the age of the patient. In such cases I do not hesitate to cut off the crown, destroy the pulp, and place one of the plate-tooth crowns with a nut. To do so, the crown must be connected to the root by a strip of heavy gold plate, extending for a quarter of an inch or more, to bring the artificial crown into the circle. For such cases the all-porcelain crown will not do. The teeth can be separate or connected. I prefer the former.

"The nut and bolt is best where a crown has to be very long and there is a close and deep underbite, with little room for the crown, without being too full in front. The gold backing gives greater security, and should cover the whole palatal surface of the tooth. There are other special cases in which this plan is to be preferred, but only for superior incisors or cuspidati.

"This plan, as before suggested, I should use in attaching one or more teeth on a small plate, where the roots have been lost, securing the bolt with amalgam to either decayed or sound crowns.

"In this plan (Fig. 61) the pin is placed in the same as for all-porcelain crowns, and adjusted before it is set to suit the hole in the base of the crown, placing gutta-percha over the pin in the countersink until the next visit of the patient, when it is removed and the gold nut placed on. All excess of amalgam around the margin of the gum should be removed, and before placing on the crown finally it should be warmed and a piece of gutta-percha stuck on to the base and pressed up, making a water-tight joint when the nut is screwed up.

"The illustrations are so accurate that it seems almost unnecessary to enter into any detailed direction as to the manner of procedure; but as it may help to perfect operations, I will do so in few words.

"The root or roots having been prepared, and in readiness for the crowns, the canals enlarged, and the foramina closed, the platinum pin is cut off rather shorter than the length of the root, as it cannot be pressed up quite its full length through the amalgam. It is made three-cornered, and pointed at either end—more so at the root end—and well barbed with a sharp knife, as shown in cut, to and from the line between the crown and root, and bending the pin so that it shall impinge upon the palatal wall if for an incisor, which will hold the crown firm while the amalgam is setting.

"The crown having been adjusted to its place on the root, and all being in readiness, the canals dry, place soft amalgam entirely up to the end of the canal, and when full, take a pointed, three-cornered excavator and run it up through the amalgam, to force a way for the platinum pin. This latter is placed by grasping the pin with a pair of forceps, and gradually pressing it up as far as it will go. A thin, flat-pointed tool can now be used to condense the amalgam about the pin. Before this is done the crown should be placed on to see whether the pin will permit it to assume its proper place. If not, the crown can be forced either way, and the pin will follow. The tamping around the pin can now be completed, and an excess of amalgam placed around it. The crown is now filled with amalgam and grasped between the thumb and index-finger, and pressed hard home. The opening on the palatal side of the crown can be filled with hard amalgam and well driven up about the pin, leaving a surplus for dressing when it is fully hardened. The excess of mercury is pressed out by the force used in driving it into place. When more than one pin is used, they can be filled in between on the grinding surface, and wedged apart against the wall of the porcelain tooth, which will very much assist in retaining them.

"This can be done all at one operation, although the pin can be placed in at one visit and the crown at the next. Where a crown has to be replaced from fracture, cut off the surplus amalgam around the pin with the engine and cutting-pliers until the new crown fits nicely. Fresh amalgam having been laid over the old amalgam, and the crown pressed up as before, the repair is complete. The crowns are not made to allow of their being pressed up over the end of the root, as in the Richmond plan of a gold band, as there is no necessity for the band, save in the few instances named in a former part of this article.

"As to many little details, the practitioner can improvise to suit every case. I am of opinion that platinum wire is the best for the pins, although steel well softened will do if entirely covered with amalgam. The cost of platinum is but a trifle more than the steel, and with it there is no danger of oxidation or of injury from the mercury.

"I give this plan to the profession with the assurance that there is no other operation in dentistry which will so delight patients. Instead of crowns patched up with gold, amalgam, gutta-percha, etc., you have in this plan 'art concealing art,' recommending itself to the common sense of the patron and enabling the operator to get well paid for his labor, and suiting itself to the purse of every class of society,—a plan which will enable us to blot from our practice in a great measure the necessity for dental plates."

What is known as Richmond's method of attaching artificial crowns to the roots of teeth is applicable to bicuspids and molars as well as to single-rooted teeth. The latter, or incisors and cuspidati, however, are porcelain-faced, and are constructed and fixed in the following manner:

Prepare the root in all respects as in the case of an ordinary pivot tooth. Bevel the sides of the dressed end of the root with chisels or other suitable instruments one-half or three-fourths of a line in depth, forming parallel walls for the reception of a narrow gold band, which is subsequently to be forced over the end of the root. Take then a narrow strip of gold plate (that made from the gold pieces coined since 1860 being the best adapted to the purpose) about 24 gauge, and three lines or more in width. With round-nosed pliers, bend this strip so as to encircle the end of the root; mark the point of junction and cut off. From this again cut off from one-sixteenth to one-eighth of an inch according to the size of the root, and unite the ends with solder composed of gold coin same as band five parts, and one part of fine brass wire. With files or corundum disks fashion this band so that, while it is of equal width, it will conform to the marginal contour of the dressed end of the root, the edge of the band underlying the gum, presenting, when finished, an antero-posterior convexity and lateral concavity corresponding with the marginal inequalities of the alveolar processes.

Bevel the outer and upper edge of this band, and force it over the end of the root. Fit a gold or platinum wire pivot to the enlarged opening in the root accurately, but not so tightly as to prevent its ready withdrawal on gentle traction, and long enough to project a line or more from the orifice. With the metal pivot in place, take an accurate impression of the parts, including the adjoining teeth, and remove carefully, when the metal pivot will be found imbedded in the wax impression, or if not, it may be afterwards removed from the root and adjusted in its proper place in the impression. The gold band should also be forced from the root and placed in the impression. The latter should then be filled in with plaster to secure a model of the parts, with the pivot and band secured in their proper relations. Then cut and fit a cap of thin platinum plate, perforated to pass over the pivot and down upon the end of the root, or within a little distance of it, leaving some space underneath for plastic material on final adjustment. This platinum cap should fit into the gold band accurately. Next, select and adjust a suitable plain plate tooth to the space to be supplied; remove and back it with a thin plate of platinum, and rivet or bend the pins to secure it in place. Then readjust it in its proper place on the model, and secure it by adding fresh portions of plaster and sand, building it up over the front face of the tooth and around the model.

The several parts are thus secured in their proper relations to each other. When the investient is sufficiently hard, heat up the piece slowly, and with the blowpipe flow in upon the parts exposed to view successive portions of gold solder, compounded as before mentioned, until sufficient has been added to form the desired posterior contour of crown.

The piece, when properly dressed and polished, is now ready for final and permanent adjustment to the root, previous to which, however, the walls of the root-canal should be roughened or grooved somewhat, and the wire pivot or tube barbed or serrated.

Before forcing the band, with tooth now attached, over the root, introduce into the enlarged canal of the root, and around the base of the crown, sufficient os-artificial, phosphate of zinc, German cement, or other allied plastic material, to fill completely all vacuities that may exist around the wire pivot and underneath the platinum base plate, securing by this means increased attachment and stability to the substitute. To permit the escape of surplus material a small opening may be made with a drill through the posterior face of the crown near the band, and which may afterwards be closed with gold foil. When in place and firmly fixed, the lower edges of the goldband underneath the gum should be forced in closely upon the root with burnishers.

In attaching artificial crowns to the roots of bicuspids and molars by this method, the operation is simplified somewhat by constructing the crown, superficially, exclusively of gold plate. A band, of the quality of gold before mentioned in connection with the front teeth, equal in width to the required length of crown, is employed, and is prepared in the same manner as the narrow band. The end of this gold tube or band antagonizing with the teeth of the opposite jaw is then closed with a platinum cap fitting into it, and solder flowed over this until sufficient thickness is provided for purposes of mastication, while cusps are raised by adding and flowing additional pieces of solder at appropriate points. A small opening having been previously made for the escape of surplus, the hollow crown is filled with some one of the plastic materials heretofore mentioned, and the crown forced over the root and into proper position. Increased stability and firmness of attachment may be secured by fixing serrated gold wires in the roots before placing the crown.

The following method of substitution, contributed at the solicitation of the author, by Professor M. H. Chappell, of the Indiana Dental College, though similar in some respects to that practiced by Dr. Richmond, is sufficiently original and distinctive in its main features to warrant its introduction in this connection.

Having formed and fitted a gold band to the root in the manner heretofore described, the writer continues: "Fit the crown to the root, and to the ferule or band; bevel the tooth at the gum edge; dress the inside of the band to a sharp edge, so as to form a lap joint with the tooth; or, if preferred, use diamond disk and cut shoulder in crown to receive the untrimmed edge of band.

"The pulp or pivot canal must be drilled in a line with the palatine surface, so that the plate will not have to be forged back under the tooth. The canal is made the usual size and depth for pivot teeth.

"A backing, of the same quality of gold as the band, soldered to a thin plate of platinum, is the best. Punch or drill holes to attach the tooth pins; countersink and rivet solid. Have sufficient plate of backing to form the pivot. With a fine saw or separating file cut in each side at base of tooth one-third way off, and bend in the edges forming a tube for pivot. Solder the rivets and upper part of tube to make firm.

"The tooth and ferule are now ready to be attached. Dry the mouth and root, using napkins and saliva ejector. Force the band over the root, firm and perfect, to the exclusion of moisture. Line the inside of band and end of root with gutta-percha, extending it down the canal. Etch the tube or pivot so that the beards of etching touch the walls of pivot canal. Fill the tube of plate with gutta-percha, and line the etched surface and end of crown. Heat the artificial crown and gutta-percha on water-bath pan, and with warm pliers place the tooth in position, forcing the pivot to its place. When cool burnish the band or ferule to root and crown.

"Have retaining-points in root and tube; build up with gold from root and ferule, to give the proper contour of the palatine surface of the natural teeth. After polishing the ferule or band and palatine filling, the case is complete."

Though differing very materially from the ordinary methods of pivoting an artificial crown, the following novel manner of supplying the loss of a natural tooth, in the absence of the root, and without the intervention of a plate or clasps, may properly be classed under the same general head. The original conception and practical application of the process is ascribed to Dr. B. J. Bing, of Paris, France. Space will only permit the introduction of descriptions which relate to the more recent modifications of the method.

Dr. Marshall H. Webb thus describes his method of operating in these cases:

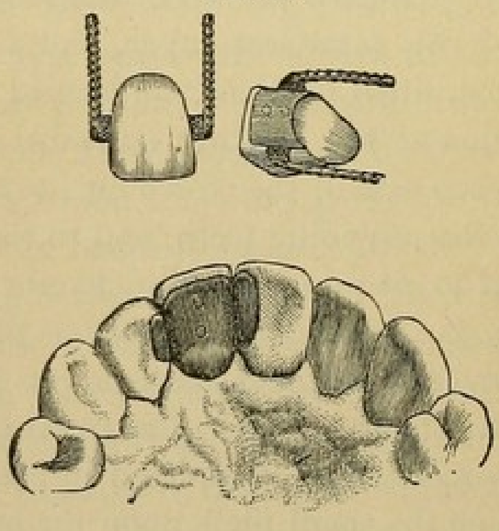
"The insertion of a crown without plate or clasps where no root remains is a difficult operation, but when well performed, and the crown attached to teeth that are firm in their sockets, it is both satisfactory and permanent.

"The first such operation performed by the writer was completed February 12th, 1873, and the crown now remains as firm as when inserted. The operation was performed in the following manner: After suitably forming the cavities in the proximate wall of each tooth next the space left by the loss of the one that had been extracted (unnecessarily) some years before, an impression of the parts was taken, and a plain porcelain crown was selected, fitted to place and backed with gold plate (18-k.). A portion of the backing extended about one and a half lines from each side of the crown for insertion in the cavities prepared in the adjoining teeth, and to these parts a gold wire was soldered to fit into the pulp-chamber of the central and lateral incisors. A small gold plate was then formed to fit upon the gum, covering as much space as was taken up by the neck of the natural tooth. When the backing was riveted to the pins in the porcelain and this placed in position, and while the whole rested on the small plate upon the gum, the backing and plate were so secured by wax that they could be removed intact, and, after being placed in a matrix, soldered. Each extended side of the backing and the surface of the wire was barbed with an engraver's lossing tool, so that the gold foil would the better secure the crown when filled into every part.

"The porcelain, with the gold attachments, being ready for insertion, a piece of light medium rubber-dam was put in place on two teeth each side of the space to be filled, and over the gum upon which the crown was to rest. (The rubber takes up but little space, and this is more than compensated for when the ligature—waxed floss-silk—is pressed to or near the neck of each adjoining tooth.) Oxychloride of zinc was then placed in the pulp-chamber of the central and lateral incisors and the crown at once pressed to place. When the cement had hardened sufficiently to safely admit of further progress in the work, a portion of it was cut away from around the wire so as to make proper anchorage for the gold. Small pieces of light cohesive gold foil were then impacted around part of the wire and that portion of the plate extending into the cavities, and the crown was thus secured. The porcelain and gold attachments as prepared for insertion and the crown in position are illustrated in Fig. 65.

"The cavity in the central incisor was extended to the cutting edge of the tooth, that access might be had to the wire and

Fig. 65.



both sides of the plate; foil could not otherwise have been put in place, unless a portion of the labial margin of enamel were cut away, and this would have been objectionable because of the exposure of gold. A small part of the labial instead of the cutting edge of the enamel of the lateral was removed, for the reason that there is not such a body of tissue as to safely allow it to be cut away to the same extent as in a central incisor. The margin of enamel was so formed, and the foil so inserted and finished, however, that, though the gold can be seen, it is not conspicuous.

"While the operation just described has thus far proved successful, yet there is a possibility of the porcelain being broken from the platinum pins which hold it to the gold plate. To avoid such an accident a groove should be cut on each side, and along the cutting edge of the porcelain (Fig. 49, *b*), that gold foil may be impacted into it, after a heavy backing of gold plate and the wire have been fixed in place and soldered. After the groove has been cut in the porcelain with a fine-edged corundum disk, one with an edge of the diameter of the gold wire selected for the case should be used to make a groove across the porcelain between the pins (Fig. 66, *a*), into which the wire to connect the artificial crown with the natural teeth is to be placed (Fig. 66, *b*), either beneath the plate or so that

FIG. 66.

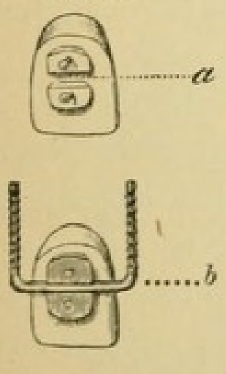
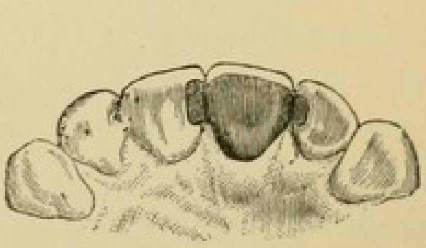


FIG. 67.



the edges of the latter may be joined to it, as the necessities of the case may require.

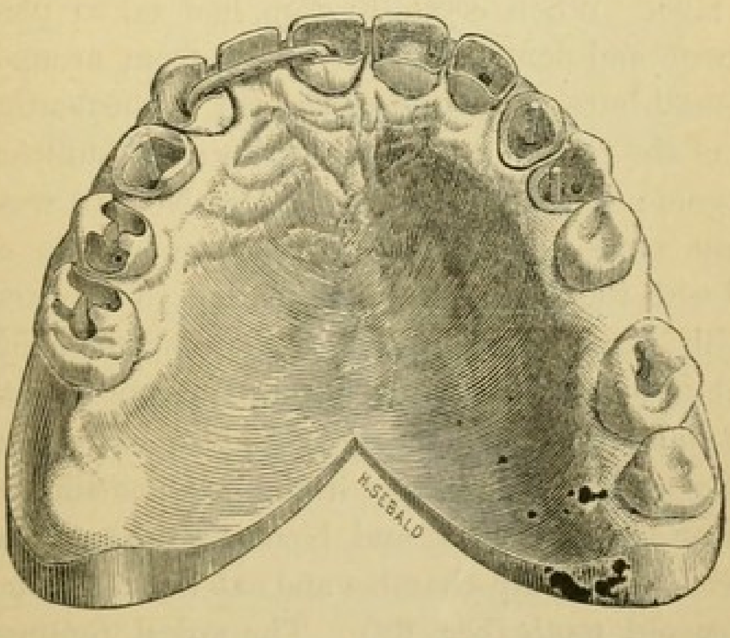
"A starting-point should be made either between the gold backing and porcelain, or between this and the wire, and the latter firmly fixed in a hand-vise while the gold foil is being impacted with the electro-magnetic mallet. When the gold is properly and solidly placed in the groove and over the backing and wire, it not only aids in securing the porcelain, but the contour of the crown can be nicely filled out, and the operation made durable and beautiful (Fig. 67).

"The surface of the gold placed along the base of the crown to the edge of the porcelain, and which is to rest against the gum, together with the palatal portion, ought to be properly formed and finished before the crown is put in place, and this should be done in the manner before described. There should be a little space between the wire and cervical wall in each tooth to which the crown is to be attached, and narrow pieces of light gold foil carefully placed in this part, between the wire and enamel, with small curved instruments, and with the aid of the mallet; the surface of the gold at this part at least should be smoothly finished with very narrow ($\frac{1}{16}$ in.) strips of fine emery-cloth before the rubber-dam is removed.

"In cases where the pulp is living in one or both of the teeth to which an artificial crown is to be attached, the heavy gold plate or the wire must be so arranged as to fit as accurately and to be made as secure as possible in the cavities prepared for them. In some cases, and where the form of the cavity admits of it, it is better to adjust and solder a small gold plate to the end of and at right angles with the wire attached to the crown. This plate should be so formed and bevelled that gold foil can be solidly placed over the surface of it next to the artificial crown, and into the groove made around the cavity in the dentine along the boundary-line between this tissue and the enamel. When all is in readiness for the operation, oxychloride of zinc should be placed in each cavity and the crown immediately put in place, and very carefully held there till the cement has so crystallized as to secure the ends of the wire and plate; about an hour is necessary to such perfect crystallization as to safely admit of the preparation for and the packing of the gold foil. The oxychloride of zinc should be left between the little plate or end of the wire and bottom of the cavity, and all parts where gold cannot well be placed; this preparation also protects the dentinal fibres from thermal changes.

"One of the most satisfactory operations the writer ever performed was the insertion of a crown where a cuspid root had been extracted (unnecessarily), and the lady subjected to the wearing of a gold plate for some time. This crown was prepared and the contour filled out with foil as described (and as illustrated, Fig. 67), but gold wire, No. 13, was attached to and built in with the porcelain, and placed into the pulp-chamber of the adjoining lateral incisor (which had been filled), and this same wire extended from the anterior to near the posterior proximate surface of the first bicuspid tooth, the pulp of which remained in normal condition. The crown was placed in position with oxychloride of zinc, and cohesive gold foil was then impacted with the electro-magnetic mallet around a portion of the wire in the root and into the cavity in the crown of the incisor, and also into the cavity in each proximate wall of the bicuspid tooth, as well as around and over the wire, joining the two fillings through the enlarged fissure.

FIG 68.



"The most extensive operation of attaching a crown to adjoining teeth was performed by the writer before the Pennsylvania State Dental Society, at Delaware Water Gap, in July, 1879. In this case disintegration had taken place in many of the teeth, and cavities of decay had been prepared and filled from time to time. The teeth were abraded and the dentine was exposed along the entire cutting edge of each tooth that occluded with another. The right upper lateral incisor had been lost twelve years before. The crown of the left cuspid tooth was missing, and but a small portion of the enamel and dentine of the first bicuspid upon either side remained. These last were, of course, pulpless, as also were the right cuspid and central and left lateral incisor teeth, and the pulp-chamber of each of these had been filled. All the operations made necessary by the abrasion and fracture of enamel from time to time, and because of imperfection in the fillings before introduced, were performed previous to the insertion of the crown in the space left by the loss of the lateral incisor, and as this crown and each cavity and pulp-chamber was prepared for the gold, all appeared as here illustrated (Fig. 68).*

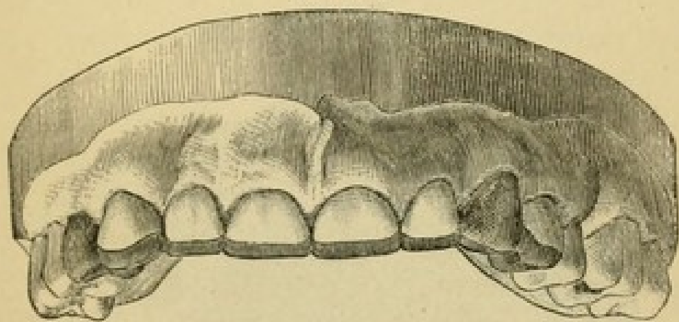
"Gold wire (No. 13), with a sharp thread cut upon it, was screwed into the dentine, and, at the same time, all the interstices between the tissue and the gold were filled with oxychloride of zinc. When crystallization had taken place some of the cement and dentine was removed from around the wire with a small burr, and a groove was cut in the dentine near the margin of the root so as to secure proper and sufficient anchorage for gold; cohesive foil (principally No. 30) was impacted into these parts, and the entire contour of the crown was restored with the electro-magnetic mallet. This crown was not faced with porcelain, because the teeth of the gentleman for whom these operations were performed are but slightly exposed to view; and then, too, the gold had to be placed over the enamel to support and protect it along the cutting edges of all the incisor and the cuspid and bicuspid teeth. A gold screw was placed in the pulp-chamber and extended into the crown of each bicuspid tooth (Fig. 68). The apical foramen of each pulpless tooth was closed, and the whole of each pulp-chamber into which a wire was not placed was filled with gold. With a properly adjusted electro-magnetic mallet, carefully guided, and operated with a full current of electricity from a freshly charged four-cell Bunsen battery, the contour of each crown was restored with gold, made solid and perfect throughout; the foil was placed in the same manner over the finely prepared

* The cut (Fig. 68) illustrates the case well, though there are parts and grooves in which to anchor the gold that are not distinctly shown.—M. W. H.

margins of enamel, and these were not marred in the least (Fig. 69).

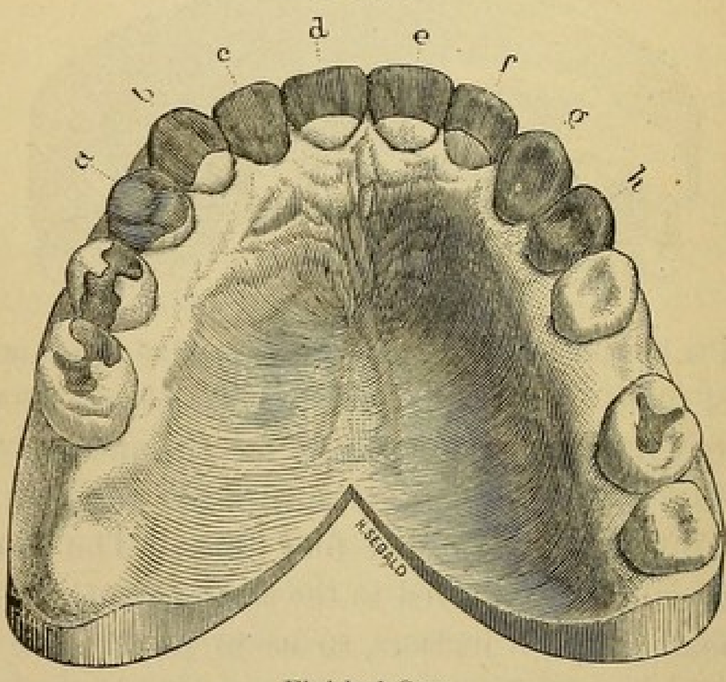
"The lower incisor teeth had so changed after the loss of the upper lateral that they almost closed upon the gum. This was partly owing to the abrasion of the remaining teeth, and in part due to the lower incisors gradually rising in the alveolar process. Because of such occlusion of the teeth a porcelain crown (plain 'plate tooth') with 'cross pins' was used, and

Fig. 69.



fitted and soldered to the gold wire, there being no space for a backing of plate. When the wire was prepared, the porcelain grooved and fitted to it, and ready for the placing on of the gold foil, the whole appeared as illustrated (Fig. 68); the wire extending into each root about four lines. The cutting edge of the porcelain was removed to the same extent as that of the abraded and prepared incisors, so as to present the same appearance and have the gold support and protect the remaining part. The wire of the crown was held in a hand vise, while cohesive gold foil was placed solidly in the grooves, around the wire, over the cutting edge of the porcelain, and the entire contour restored with the electro-magnetic mallet. During the final fitting of the crown, it was made to so rest against the gum that the blood was pressed from the capillaries of the part. When ready for insertion, a light medium rubber dam was applied to two teeth each side of and across the space which was to receive the crown; small barbs were made all around the wire with a sharp knife, and oxychloride of zinc was then placed in the pulp-chamber of the central incisor and cuspid, and the crown at once pressed to place. After it had been in position an hour to allow of complete crystallization of the cement, portions of this and of the dentine were removed with a small burr so as to better secure the crown and obtain anchorage for the gold foil then to be put in place around the wire, into each cavity, and over the prepared margins of enamel. Principally No. 30 gold (one-quarter ounce cohesive foil) was used in this case, and all was impacted with the electro-magnetic mallet, except a few pieces of light foil placed in the space between the wire and cervical wall, and even these pieces were

FIG. 70.



Finished Case.

a, b, d, f, g, and *h,* pulpless teeth; *g,* whole crown restored with gold; *a, f,* and *h,* almost entire gold crowns; the teeth, *b* and *d,* support the gold crown faced with porcelain, *c,* and fully one-fourth of the crown of each of these is restored with gold, as is also that of *e,* the pulp of which is living.

gone over with this very valuable instrument after they were in place. With this and all the operations completed, the case appears as here illustrated (Fig. 70).

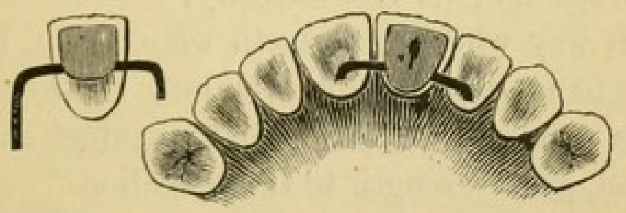
"All those who have the ability and who will work earnestly and conscientiously to properly perform the various operations described, and do their very best in every case, can so manage their practice as not to make it necessary for any of the patients they have charge of to wear artificial crowns mounted upon plates."

Professor Darby, in commenting on this method, says:

"Dr. B. J. Bing was the first to call my attention to a method of building one tooth into the adjoining teeth by means of gold wires running from the artificial into the natural teeth. I have never seen any of Dr. Bing's operations, but Dr. Marshall H. Webb has called my attention to one or more in the mouths of his patients, which have done good service for years. I also have in my own practice one or more which have proved most satisfactory.

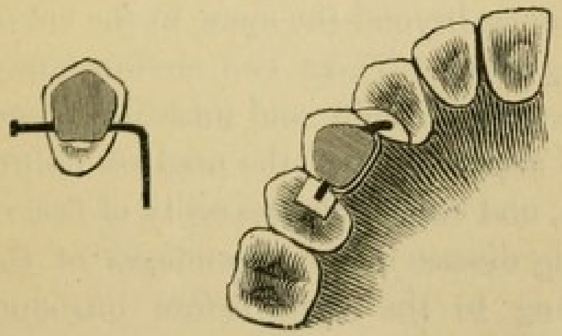
"The cuts, Figs. 71 and 72, represent two cases where artificial crowns have received their support from the adjoining

FIG. 71.



teeth. It is desirable to have a pulpless tooth for a neighbor, though I question if one would be justified in devitalizing a pulp to secure this end. In the cases presented, a piece of gold wire was soldered to the backing of the porcelain tooth,

FIG. 72.



and allowed to extend well up the pulp-canal of one of the adjoining teeth. After it had been nicely fitted to its place, the rubber dam was applied and drawn tightly over the gum between the two natural teeth; the canal of the devitalized tooth was then filled with oxychloride of zinc, and the tooth with its gold support pressed into position. When the cement had hardened, the bulk of it was cut out and the space filled thoroughly with gold. The other end of the bar was packed around with gold foil, and the cavity of decay or cavity of convenience was filled in the ordinary way.

"It is always better to take an impression of the space and adjoining teeth at the outset, and then do the major part of the work in the laboratory. The gold wire which enters the root can be bent or shaped with the pliers when the patient presents for final insertion.

"I would not be understood as saying that these operations can only be performed successfully where there is a devitalized tooth for a neighbor; on the contrary, I have seen teeth inserted in this way where both teeth were living, but the support which is to be derived from the long right angle of gold in the root is certainly a great security against accident, adding, as it must, great strength to the operation."

If, after the operation of ingrafting an artificial crown, inflammation of the peridental membrane and surrounding structures ensues, active measures should be immediately instituted for its reduction. In a majority of cases, active suppurative inflammation is induced either by shutting up an habitual discharge from secreting surfaces at the apex of the root, or by a forcible injection of the air contained in the nerve canal into the sensitive tissues beyond the apex in the act of pressing up a tightly fitting pivot. These two circumstances, in conjunction, sometimes, with rough and unskilful manipulation, afford a rational explanation of the needless failures so common to this method, and enforce the necessity of first radically treating any existing disease in the appendages of the root, and of afterward filling to the apex before introducing a pivot. Where inflammation results from the injudicious application of the pivot as just stated, it will ordinarily be sufficient to remove the latter if timely application is made by the patient for relief; and it is important in all cases to instruct the latter in reference to the necessity of early attention to any disturbance that may accrue from the operation. Unavoidable inflammation may generally be aborted by the timely application of some active counter-irritant to the gum directly over the affected root, or by local bloodletting, until resolution is effected. The topical remedies will sometimes be rendered more effective, especially when the local trouble is associated with an inflammatory diathesis or febrile condition of the system, by such constitutional treatment as will tend to diminish or equalize the force of the circulation.

CHAPTER VI.

Partial Dentures retained in the Mouth by Means of Clasps attached to the Natural Teeth.

Remarks on the Use of Clasps.—Clasps, or metallic bands, have been long and very generally employed as a means of retaining parts of sets of teeth in the mouth, and are still used for that purpose by many practitioners. When these appliances are skilfully adjusted, and all the conditions pertaining to the mouth and remaining natural teeth are favorable to their application, they afford a certain, permanent, and satisfactory means of supporting partial dentures, and may be employed, under such circumstances, with comparative safety to the natural organs. When it is remembered, however, that in a lamentably large proportion of cases, clasps are carelessly or unskilfully formed and fitted to the teeth; that the organs of support are often indiscriminately selected, and are neither adapted in form, situation, or structure for such uses; and that they are frequently diseased and insecurely attached to the jaw, or are mutilated for the reception of clasps, we can readily understand to what unlimited extent this method is subject to abuses. In fact, no other special process in mechanical practice has been so fruitful of evil as that under consideration, and the opprobrium which but too justly attaches to it in professional as well as popular estimation, is chargeable more properly to bad faith and unskilfulness on the part of the operator, and to want of attention in respect to the cleanliness of the substitute and the organs of the mouth on the part of the patient, than to any inherent unsuitableness of the method itself. Nevertheless, it must be admitted that, under the most favorable circumstances, the teeth clasped are not wholly exempt from liability to injury, and this circumstance in itself renders it the more imperative that the process should be surrounded by all the safeguards that skill and ingenuity can devise.

The opinion, at one time current, that the injury inflicted upon the teeth by clasps was mainly the result of mechanical action, has given place to the more defensible view that the causes concerned in its production are chiefly of chemical origin. Thus, the secretions of the mouth with particles of alimentary and other substances being retained between the clasp and tooth for a sufficient period of time, and exposed to the favoring conditions of warmth and immobility, suffer a process of putrefactive decomposition by which acids are eliminated, and which, in their nascent state, act with perceptible energy upon the bone constituents of the tooth, producing decay. The rapidity and extent of this action will depend much upon the nature and quantity of the acids liberated; the structural characteristics and vital resistance of the teeth; the mechanical execution, adaptation, and composition of the plate; and the personal habits of the patient with respect to cleanliness.

The most usual seat of decay in these cases is at the neck of the tooth where the enamel is thinnest, and is sometimes limited to a circumscribed spot, but oftener extends on a line with the gum involving nearly or quite all of that part of the neck of the tooth embraced by the clasp. At first the enamel becomes bleached and softened as though macerated, and is ordinarily very sensitive to both chemical and mechanical irritants. With a continuance of the cause, the superficial portions of the affected parts become more and more thoroughly disintegrated, and sooner or later assume the open form and characteristics of ordinary decay. If, as was formerly supposed, decay or solution of tooth-bone in these cases resulted from mechanical attrition, or wearing away of the enamel, the injury would be inflicted at points distant from the neck of the tooth, where the clasp lies in more direct and immediate contact with the protuberant portions of the crown; but we find that decay, from this cause, is not only of infrequent occurrence at such points, but, on the contrary, the enamel here is frequently found condensed and polished by the mechanical action of the clasp. Certain conditions of the plate and clasp undoubtedly favor mechanical action and accelerate the destruction of the tooth; as where the clasp bears unequally with sharp and unfinished edges upon the tooth, or where the base is faulty in its adaptation to the mouth, admitting, by its mobility, of irregular traction or pressure upon the organs of support. Whenever the artificial appliance is thus unskilfully constructed and applied, and free interspaces are furnished for the lodgment and retention of particles of food, and the teeth clasped are defective in structure, and we have conjoined with these an utter disregard of cleanliness in respect to the substitute and remaining natural teeth, the destruction of the latter is certain, rapid, and generally irretrievable.

The Teeth to which it is most proper to attach Clasps.—The utility, comfort, and appearance of a partial set of artificial teeth in the mouth, will depend much upon the fitness of the natural organs selected for the purpose of support. "A clasp," says Professor Harris, "should never be applied to a loose tooth, or to one situated in a diseased socket, or which is so much affected by caries as to render its perfect restoration and permanent preservation impracticable, and when none but such can be had, the proper course to pursue is to extract every tooth in the jaw, and replace the loss of the whole with an entire upper set. The application of clasps to diseased or loose teeth, always aggravates the morbid condition of the parts, and causes the substitute which they sustain, to become a source of annoyance to the patient. Besides, such teeth can be retained in the mouth only for a short time, and when they give way, the artificial appliance becomes useless, and even while it is worn, it is not held firmly in place, but is moved up and down by the action of the lips and tongue, so that its presence can hardly escape observation from the most careless observer."*

Teeth, also, that are too short to admit of sufficient breadth

* Principles and Practice of Dental Surgery, p. 717.

to the clasp to impart stability to the substitute, and those that stand very irregularly in the arch, rendering it difficult for the patient to apply and remove the appliance, are unsuitable as organs of support.

In respect to the individual classes of teeth, it may be observed that the incisors, both as regards form and situation, are inadmissible for clasping, and are, therefore, never used for this purpose. The cuspidati, likewise, being placed conspicuously in the front part of the mouth, cannot be securely embraced without manifest exposure of the clasp; besides, the conical form of these teeth makes the use of a very slender clasp indispensable; hence, these teeth are rarely employed, and may only be used when, in the judgment of the operator, the necessities of the patient for the time being seem to require it.

Either the anterior or the posterior molars, when sound and firm, offer, in respect to their general conformation and position in the arch, the most desirable and efficient support for parts of sets of teeth. The crowns of these teeth generally afford ample breadth to the clasp; have nearly parallel walls; and furnish, by the strength and immobility of their attachments to the jaw, the greatest security to the artificial appliance. The anterior molars are preferable where these are remaining in good condition, or are susceptible of being properly restored and preserved if diseased or carious.

Of the bicuspids, the posterior are to be selected, if practicable, as these better favor the concealment of the clasps; to effect which more perfectly, in the use of either the first or second bicuspids, it will be sufficient in many cases to embrace only the posterior half of the crown.

The dentes sapientiæ, or wisdom teeth, will seldom admit of the application of clasps, as the crowns of these teeth are usually very short and cone-shaped, the walls converging abruptly from the gum; besides, the retractive forces applied to the anterior teeth of the substitute, would, on account of the increased leverage consequent upon the extension of the plate back to these teeth, tend either to disengage the clasps or produce displacement of the teeth to which they are applied.

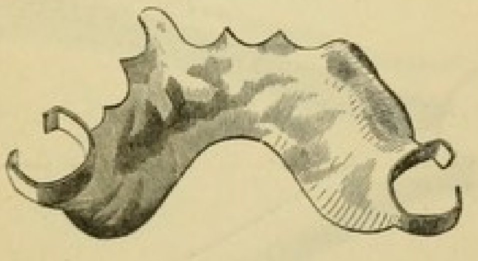
In supplying the loss of one or more of the inferior incisors, the appliance should, as a general thing, be attached either to the anterior or posterior bicuspids, as these teeth stand more nearly vertical in the arch. In fixing partial lower dentures, it will be sufficient to simply provide against mobility of the base, as they are favored rather than opposed, as above, by gravitation. The replacement of the inferior teeth posterior to one or both bicuspids, however, are more frequently demanded; in which case it is customary to attach the clasps to the teeth immediately in front of and adjoining the vacuities on each side. It will not, however, be necessary to attach clasps in these cases whenever the edentated portions of the jaw present a distinctly scooped form, or marked concavity of outline, forming a kind of bed for the plate. If, on the other hand, the ridge falls back with a tolerably uniform inclination from the teeth in front, with no sufficient elevation at the base of the coronoid process, it may become necessary to provide against backward displacement of the substitute by attaching clasps, as before stated, to the teeth immediately in front. In any case, if the dentes sapientiæ remain, partial or stay clasps may be attached to each heel of the plate, and so adjusted as to rest against the anterior face of these teeth, obviating entirely the necessity of clasps in front.

Separation of the Teeth, by Filing, for the reception of Clasps.—The practice of separating the teeth with the file to provide for the application of clasps should always be avoided if practicable, since the liability of the teeth thus denuded of enamel to decay is greatly increased under circumstances so favorable to their disintegration. In the case of young subjects, especially, where the teeth are but imperfectly consolidated, and in adults whose teeth are defectively organized, presenting but a feeble resistance to the disorganizing agents usually present in the mouth, the use of the file, for the purpose indicated, is eminently pernicious, and should never be resorted to until every other means of supporting the artificial appliance have been fairly and patiently tried.

Whenever a plain necessity for this operation exists, a careful examination of all the teeth to which it is proper to apply clasps should be made, and if decay is found upon their proximate surfaces, the separation should be made between the teeth so affected; and this circumstance should, in most cases, determine the selection, though the affected tooth or the one adjoining may not be esteemed, in other respects, the best for the purposes of support. If decay exists on the proximate surface of only one of the teeth to be separated, a safe-sided file should be employed, and the filing confined entirely to the carious tooth, leaving the enamel of the one adjoining unbroken. The cavity of decay should be well filled, and the filed surface thoroughly condensed and polished with a burnisher.

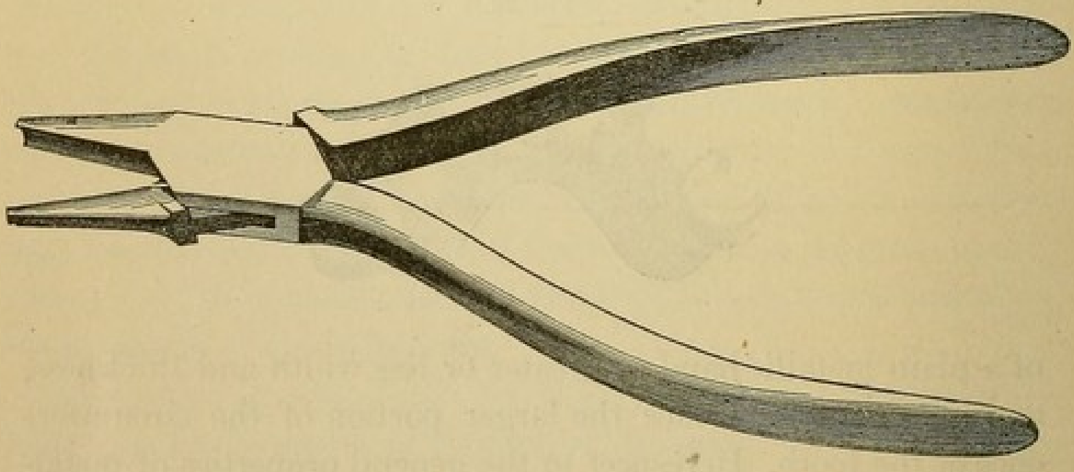
Modifications in the Form of Clasps.—1. *Plain Band.* The most usual form of clasp is that shown in Fig. 73. It consists

Fig. 73.



of a plain metallic band of greater or less width and thickness, and is made to embrace the larger portion of the circumference of the tooth. In respect to the general properties of metallic clasps, it may be said that they should be, as nearly as practicable, of the same quality or fineness as the plate or base to which they are united; they should be heavy enough to impart adequate security to the attachment, say twice the thickness of the base, and exceeding this in some cases; and sufficiently elastic to embrace accurately the more contracted parts of the teeth after having been temporarily forced apart in passing over the enlarged portions of the crowns. In constructing a plain band or clasp, a strip of sheet lead or other pliable substance may first be fitted accurately to the plaster tooth, making it of the required width, and shaping the edge next the gum in conformity with the irregularities in the latter around the neck of the tooth; the exact counterpart of the pattern thus obtained is then cut from the plate to be used in the formation of the clasp. The strip thus obtained is then bent with round-nosed or grooved pliers (Fig. 74), until conformed as perfectly as possible to every portion of the surface of the tooth embraced by it. This coaptation should be sufficiently accurate to exclude perfectly all solid substances from between the clasp and the tooth. A more accurate adaptation of the clasp may be secured in the following manner: First secure a pattern, as before described, and by this cut from a thin strip of platinum, say No. 30 or 32 of the gauge-plate, a band of the required size and form, and press or burnish it accurately to the form of the plaster tooth. The soft and pliant condi-

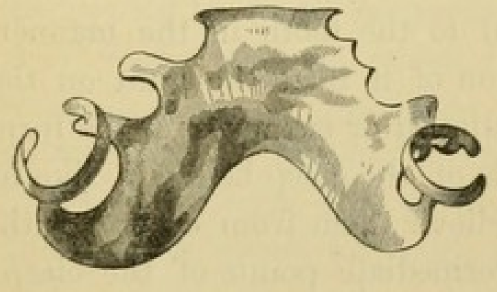
FIG. 74.



tion of this metal will admit of its being easily adapted to any irregularities upon the lateral walls of the tooth. The band thus moulded to the tooth is then carefully removed from the model, or the mouth, if fitted to the tooth in the latter, and its central portion filled with a mixture of plaster and sand with a small metallic wire or bar passing through the centre to support it while soldering. The outer or exposed surface is then smeared with a mixture of borax, and small scraps or fragments of gold plate of equal fineness with the main plate, are placed at intervals and fused with the blowpipe until diffused uniformly over the surface. Small pieces may be added from time to time, until the required thickness of the clasp is obtained. The piece should be heated uniformly throughout to induce an even flow of the gold over the exterior surface of the platinum ring. By this method a faultless adaptation of the clasp to the tooth may be secured, provided the form of the latter is correctly represented on the model. In all cases where the plain band is used, it should be made as broad as the tooth will admit of, as a clasp so formed gives greater stability to the plate, and does not endanger the tooth clasped in any greater degree than a narrow one.

2. *Standard Clasp.*—To guard more perfectly against the retention of vitiated secretions and particles of food around the neck of the tooth, a method of constructing clasps has been devised and introduced to the notice of the profession by Dr.

Fig. 75.



C. W. Spalding, which, by leaving the cervical portion of the tooth in a great degree uncovered, permits the action of the tongue and the natural circulation of the fluids of the mouth to wash or cleanse that portion of the tooth most liable to be injuriously affected. In commenting on this method, Dr. S. remarks: "The writer has for many years been in the habit of employing *narrow* clasps for the purposes of support, making them of sufficient thickness to give the required strength, and attaching them to the plate by means of standards, so arranged as to induce the removal of accumulations between the clasp and tooth, by the circulation of the saliva (Fig. 75). The use of one or more standards as a means of attachment, also provides, by a variation of their length, for the grasping of the tooth at any desired point. If the tooth is long, and particularly if it is at the same time bellcrowned, the point selected should be toward the grinding surface, as far from the gum as is found practicable. If the tooth is short and of such form that it can be successfully clasped at no other point than that near the gum, the plate should be cut away at least one or one and a half lines from the tooth, and standards introduced for the purpuse of promoting circulation, by affording a free passage for the ingress and egress of fluids. These standards should also be *narrow*, no wider than the clasp itself, and should constitute the only point of union between the clasp and plate. Haf-round wire will be found to be a very convenient article for making clasps. The particular *form* of the clasp is, however, immaterial, if it is both narrow and strong."*

3. *Scalloped Clasp.*—Somewhat analogous in form to the clasp just described, and constructed with a similar design, is the one recommended by Dr. B. T. Whitney. A plain band of gold is fitted to the tooth in the manner first described, when that portion of it next the gum on the lingual side of the tooth is scalloped or cut away in the form of a semicircle or arch, the ends of the clasp being in like manner narrowed sufficiently to relieve them from contact with the neck of the tooth. The intermediate points of the clasp which serve to unite the latter to the base may be two or more in number, and should be wide enough to impart adequate strength to the attachment. A clasp so formed and applied to the base will present very nearly the appearance of the standard clasp as represented in Fig. 75. Dr. W. recommends soldering but a single point at first, and then having tried the plate in the mouth and adjusted the clasp properly to the tooth, remove and solder the remaining point or points.

4. *Partial or Stay Clasp.*—This form of clasp, instead of embracing the tooth, is designed to steady or fix the substitute in place by simply resting against one side of the tooth to which it is applied. (Fig. 76.) They should be so connected to the plate that when pressed over the enlarged portions of the

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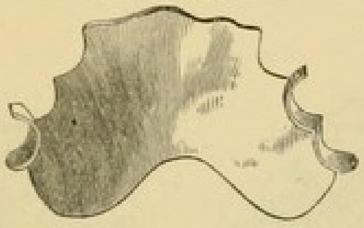
* American Dental Review, vol. i, p. 12.

crowns of the teeth, they will spring readily into place and adapt themselves closely to the more contracted parts near the gum. In cases where there is no adequate opposing force to that exerted by the clasp, care should be taken that no more pressure is produced than is necessary to keep the substitute in

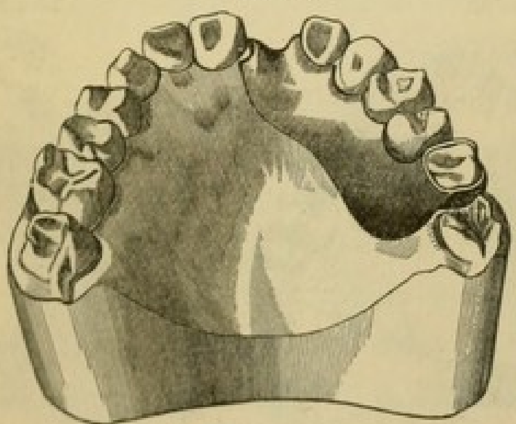
FIG. 76.



place, as, without this precaution, outward displacement of the teeth is liable to occur, and the appliance, losing its bearing upon the teeth, soon becomes loosened and insecure in the mouth. The result alluded to should be particularly guarded against in the case of young subjects, whose teeth are easily moved by the application of very slight forces.

Modification in the Form of Plates for Partial Dentures supported in the Mouth by Clasps.—The particular form and dimensions of a plate, when clasps are used, will be mainly

FIG. 77.



determined by the number and position of the teeth to be replaced, and by the location of the natural organs to which the clasps are attached. It will be sufficient in this place to indicate the leading forms as they relate to the substitution of the several classes of teeth. In supplying the loss of a superior central or lateral incisior, it will be sufficient in many cases to attach the plate to either a bicuspid or molar on the same side, as in Fig. 77. If two or more of the front teeth, however, are to be replaced, it is better to extend the plate on each side of the palatal arch, and attach to a bicuspid or molar

Fig. 78.

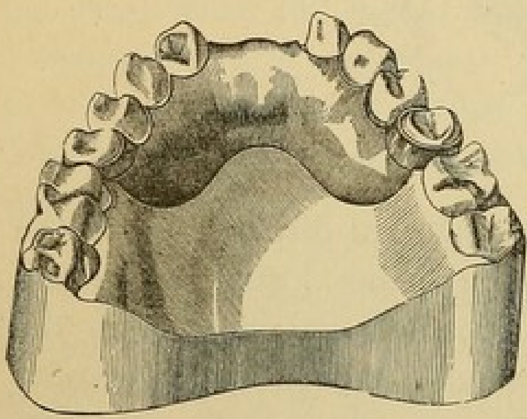
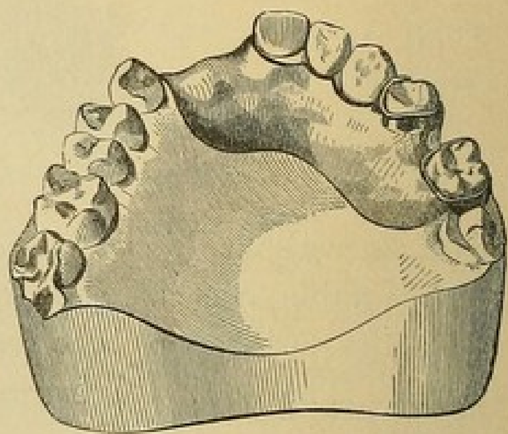


Fig. 79.



(Fig. 78); or to a bicuspid on one side, and a molar on the other; unless two firm and well-formed teeth on the same or the opposite side can be commanded (Fig. 79), while those upon the other could not be employed without a separation. In all

Fig. 80.

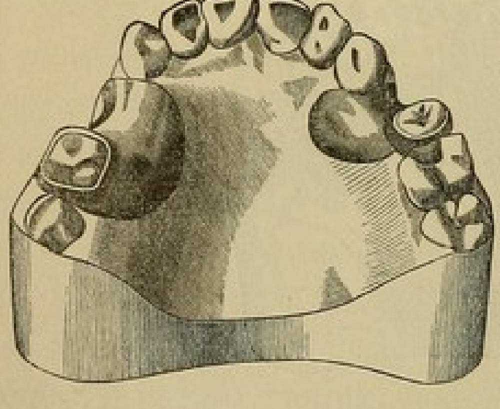
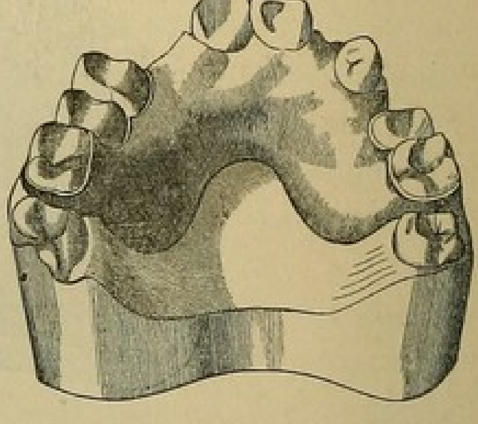


Fig. 81.



cases where it is necessary to extend a narrow plate from the extreme front part of the mouth to a single tooth situated posteriorly in the arch, the former should be strengthened by soldering a narrow rim of plate or half-round wire along the border next the teeth, and the clasp should, whenever practicable, pass in front of, and embrace, the anterior face of the tooth to which it is applied.

If an anterior bicuspid is to be replaced, the plate may be attached to the adjoining bicuspid (Fig. 80, right side), or if both are absent, then to the first molar (Fig. 80, left side), or the clasp may embrace both of the latter if remaining and no separation between them exists. Fig. 81 represents the form of a plate supplying the loss of teeth at intervals; the clasp on one side embracing the posterior bicuspid in front and extending round the back part of the adjoining molar.

Fig. 82 represents the form of plate supplying the loss of the two bicuspids on one side, and the anterior bicuspid and

FIG. 82.

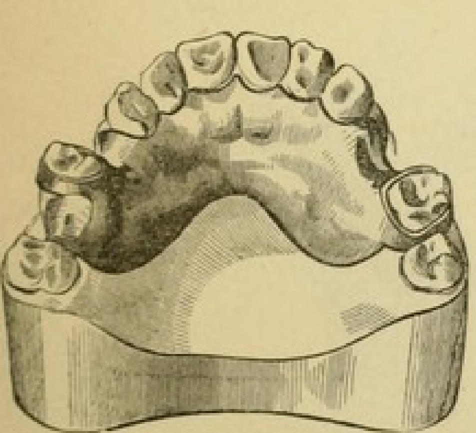
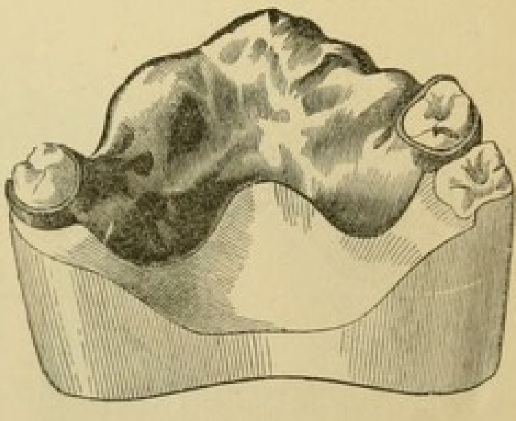


FIG. 83.



molar on the opposite, the plate being attached to an anterior molar and second bicuspid. The antero-posterior extension of the plate, as exhibited in connection with the bicuspid tooth, greatly favors the stability of the substitute, and, provided the plate and clasp are accurately fitted to the parts, the support afforded by a bicuspid tooth under such circumstances is equivalent to that furnished by a firm and well-formed molar clasped as shown on the opposite side. A base so supported may be made to sustain any number of teeth with the greatest security.

Either the anterior or posterior molars, if firm and securely attached to the jaw, will afford adequate support to a plate replacing all of the teeth anterior to them. (Fig. 83.) Even a single molar situated on either side of the arch, if similarly circumstanced, may be made to sustain, with tolerable firmness, a base supplying the loss of all the remaining teeth,—though, ordinarily, it is better to extract such a tooth and substitute an entire upper denture. In all cases, where any considerable number of teeth anterior to those clasped are to be replaced, and a vacuity on the ridge exists posterior to the latter, the plate should be extended back and overlap the ridge (Fig. 84), the latter affording a counter-point of resistance when traction is made upon the anterior teeth, thus directing the forces applied more on a line with the long axes of the teeth that sustain the appliance.

In supplying the loss of the inferior molars and bicuspids, or any number of these teeth, the form of plate represented in

Fig. 84.

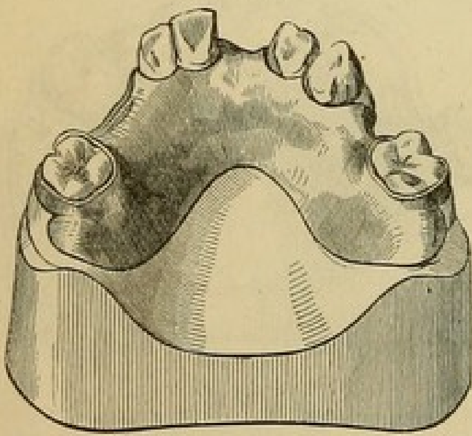


Fig. 85.

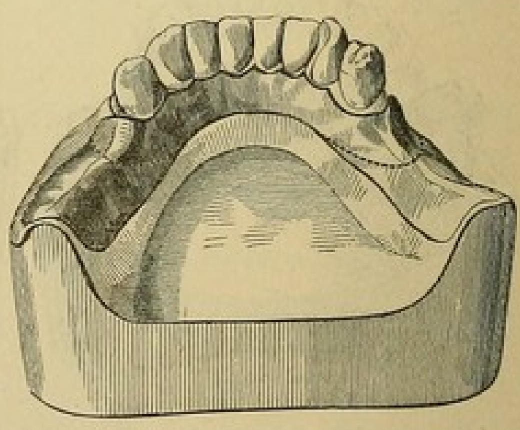
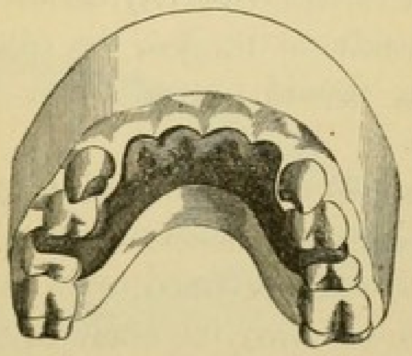


Fig. 85 is generally employed. The parts of the plate overlapping and resting upon the ridge behind, are connected with each other by a narrow strip of plate extending round the ridge in front on the lingual side of the anterior teeth. This latter portion of the plate should be accurately swaged to the form of the gum on which it rests, and should be made narrow enough to avoid encroaching upon the reflected portion of mucous membrane, the glands beneath the tongue or the frænum linguæ. To avoid wounding these parts, and to allow them unobstructed play, it will be necessary to make this portion of the plate quite narrow; and as a single thickness of plate would not impart adequate strength, it is customary to double this connecting band—the duplicate band extending back to the lateral wings of the plate, and crossing them obliquely, as indicated by the dotted lines in Fig. 85. Additional strength will be given by doubling the entire plate, but this is not generally required. The outer border of those portions of the plate overlapping the ridge may be turned up to the depth of from half a line to a line to form a groove or socket for the reception of the ends of gum teeth, or blocks, if such are used; while the inner margins should terminate in a rounded edge, extending from heel to heel of the plate, this form being given to it either by turning the edge over and filling in the groove with solder, or by soldering a narrow

Fig. 86.



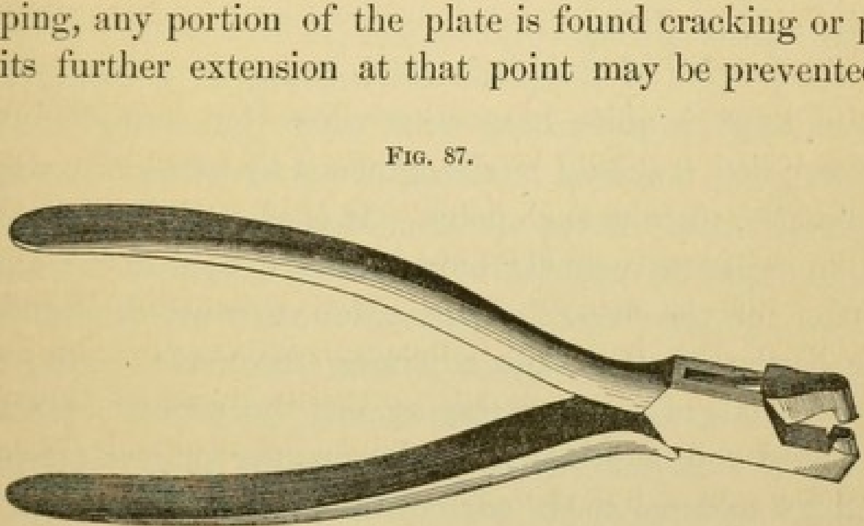
strip of plate or half-round wire along the border. The circumstances or conditions which make the use of clasps necessary in these cases, as well as those, also, which contraindicate their employment, have already been noticed. The practice of extending a narrow band or wire from the sides of the plate round the outer border of the ridge in front of the anterior teeth, to prevent a backward displacement of the base, is liable to produce irritation and tenderness of the mucous membrane immediately over the roots of the anterior teeth, and should, therefore, never be resorted to, unless there are no teeth remaining to which clasps may be applied.

If the appliance is designed to restore the loss of teeth recently extracted, and where but little or no change has occurred from absorption of the parts, the portions of the plate which pass in between the adjoining teeth should terminate a line or more within the outer circle of the remaining teeth; and where the space, if it happens in the front part of the mouth, admits of two or more teeth, the edges of the extended portion of plate should be scalloped in correspondence with the festoons of the gum, as seen in Fig. 86. In such cases, plain or plate teeth, by which is meant those which represent only the crowns of the natural organs, should be employed; these, resting on the edge of the plate, will overlap somewhat, with their anterior edges resting directly upon the gum in front, taking the place occupied by the crowns of the extracted teeth. On the other hand, if sufficient time has elapsed after the extraction of the teeth to permit the changes in the form of the ridge to occur incident to partial or complete absorption of the parts, and a greater or less concavity exists between and above the teeth on the outside of the jaw, the plate, where it passes into the interspace, should extend some distance over the border of the ridge.

Swaging or Stamping the Plate.—Having determined upon the proper form and dimensions of the plate for any given case, its outlines may first be traced upon the model; from this an exact pattern in lead may be obtained, or the pattern may be sufficiently ample to partially overlap the cut extremities of the teeth when the latter are not represented upon the die, having been previously cut from the model. The outlines of the pattern are then traced upon the plate of gold or other metal to be used for the base. The redundant portions of plate are then cut away with plate shears and forceps, and the edges trimmed smooth with a file. A very convenient and almost indispensable instrument for cutting away the plate where it describes the palatal curvature of the teeth, is a plate forceps, as exhibited in Fig. 87.

The plate cut to the proper form is now placed upon the die and brought as nearly as possible into adaptation with a wooden or horn mallet; it is then placed between the die and counter, the latter resting on an anvil or other equally resisting surface, when the two metallic pieces are brought forcibly together with a few steady and well-directed blows of a heavy hammer. Tilting of the die, resulting sometimes unavoidably from a one-sided blow, may be obviated by placing a cone-shaped piece of cast iron, brass, or zinc over the die, the base of the cone resting on the back of the die; by this expedient the force of the blow is equalized and concentrated more directly over the die. The metallic swages should at first be brought cautiously together, and should be separated after the first blow or two to enable the manipulator to detect and remedy any malposition of the plate before it becomes intractable from continued swaging. If, in the process of stamping, any portion of the plate is found cracking or parting, its further extension at that point may be prevented by

FIG. 87.



flowing a little solder at the termination of the fissure. During the progress of swaging, the plate should be frequently annealed, which is done by bringing it to a full red heat under the blowpipe, or by placing it in the furnace; the plate is thus rendered more pliant and can be more readily and perfectly forced into adaptation to the irregularities on the face of the die.

If, after somewhat protracted swaging, the plate is not conformed perfectly to the face of the die, another and unused counter should be substituted for that in use; and, indeed, it is better in all cases to have duplicate copies both of the die and counter in reserve with which to complete the swaging, inasmuch as more or less deformity of both swages unavoidably occurs before the plate is brought into very accurate coaptation with the die. The stamping conducted thus far, the plate may be applied to the plaster model, and if found too full at any points, it should be trimmed with a file to the exact dimensions required. The margins of the plate adjoining the necks of the teeth should be permitted either to lie closely to them, or should be cut away, leaving a space equal to a line or more between the plate and the teeth; for if but a very narrow line of uncovered gum remains at these points, injury to the parts immediately surrounding the necks of the teeth is more liable to occur from strangulation of the interposed gum than if the plate were further removed from the teeth or rested directly against them.

If the portion of the plate which passes in between the remaining teeth is quite narrow, as where but a single tooth is to be supplied, it should be strengthened by wiring the edges or doubling the plate at such point. It is also advisable in many cases, in order to provide more perfectly against fracture or distortion of the base in mastication, to wire or double the entire border of the plate adjoining the necks of the teeth. Narrow bands of gold resting against the necks of the teeth, constructed and adjusted after the manner of stay clasps, are sometimes soldered to the edge of the plate next the teeth; but unless the substitute is frequently removed from the mouth and cleansed, as well, also, as the teeth to which they are applied, serious injury is likely to be inflicted upon the teeth implicated.

The edges of those parts of the plate occupying the vacuities on the ridge should be filed thin to admit of a more accurate adaptation of the artificial with the natural gum, and should not, as before observed, ordinarily extend beyond the outer circle of the contiguous teeth, allowing the gum extremity of the artificial tooth to overlap and rest directly on the natural gum above. If, however, the concavity between and above the teeth on the external border of the ridge is considerable, the interdentinal portions of plate should overlap the border completely and underlie the porcelain gum.

Uniting the Plate and Clasps.—Having proceeded thus far in the operation, the plate and clasps should next be united to each other, and the utility and comfort of the appliance in the mouth, as well as the safety of the natural organs used for the purpose of support, will depend, in a great measure, upon the accurateness of the relation of the several parts of the appliance to the organs of the mouth ; it being a matter of primary importance that the various parts of the substitute should be so adjusted to the remaining teeth,—especially those to which the clasps are applied,—and the ridge and palate, that it shall not, in any material degree, act as a retractor upon the organs of support, or furnish interspaces for the lodgment of food, while at the same time it should be so fitted as to be easily removed and applied by the patient.

The clasps having been fitted to the plaster teeth and the base swaged to the form of the palatal arch and ridge, the plate is placed in its proper position in the mouth and an impression in wax taken of the latter with the plate in place. The impression with the plate adhering, is then removed from the mouth, its surface oiled and a model obtained in the manner heretofore described. If, in separating the model and impression, the plate adheres to the latter, it should be detached and adjusted to the model and the clasps arranged upon the plaster teeth. The plate and clasps may now be bound to the model with annealed wire, and united to each other with solder; but the better way is to attach them to each other temporarily, with adhesive wax, in the relation they occupy on the model, and then remove them carefully and imbed the clasps and palatal face of the plate in a mixture of nearly equal parts of plaster, sand, and asbestos. Before uniting the two pieces on the model with wax, however, the ends of the clasps should be straightened out or spread apart, in order that they may part readily from the plaster teeth, without, in any degree, changing their exact relation to the plate; in doing which, it should be observed that all parts of the clasps which are to be united to the plate should remain in close contact with the plaster teeth. After the plaster mixture, in which the plate and clasps are imbedded, has become sufficiently hard, the portions of wax which temporarily united the latter should be removed, and the surfaces of the clasps and plate, where they unite with each other, smeared with borax ground in water to the consistence of cream; small pieces of solder are then placed along the lines of contact, the investient heated in the furnace until the plate acquires a full red heat, when it is removed, placed upon a suitable holder, and the solder fused with the blowpipe.

Whenever the form and inclination of the teeth to be clasped are not fairly represented on the model, owing to dragging or displacement of the wax in withdrawing the impression, the difficulties of securing a proper relative adjustment of the several parts of the appliance will be increased; but either of the following methods, if carefully and accurately manipulated, will secure accurate results.

1. Gutta-percha may be substituted for wax when taking an impression with the plate in the mouth. With the proper use of this material, the exact form and inclination of the teeth will be preserved; and when employed, it should be filled in with plaster for the model immediately after removing it from the mouth. The subsequent steps in the operation are precisely similar to those described when wax is used.

2. Another method is to adjust the clasps and plate to the parts in the mouth, attach them temporarily in their proper relation, and remove, invest, and solder in the usual way. This may be accomplished in the following manner: First, spread apart the ends of the clasp somewhat to permit it to be easily removed from the tooth; place this upon the tooth in the mouth to be clasped; then adjust the plate in the mouth, and attach the two to each other by pressing a piece of stiff, adhesive wax in against the clasp and plate where they unite; harden the wax by placing against it, for a few minutes, the end of a napkin moist with cold water; then remove the plate and clasp carefully from the mouth, and invest and solder as before. The plate, with one clasp permanently attached, is now placed back in the mouth, and the second clasp adjusted to the tooth on the opposite side in the manner before alluded

to; this is then temporarily fastened to the plate and otherwise treated in like manner as the one first described. If the teeth to be clasped are favorably formed and regularly arranged in the arch, both clasps may, at the same time, be temporarily attached to the plate in the first instance; if not, it will be impracticable to remove them from the teeth without disturbing the wax and changing their relation to the base and the teeth clasped. The additional labor and consumption of time incident to a separate attachment of the clasps, will, in proportion as they secure better results, amply reward the operator for his painstaking.

Plaster is sometimes substituted for wax in this process; in which case it is introduced into the mouth on a small piece of wax or sheet lead and pressed gently against the uniting portions of the plate and clasp, and allowed to remain until sufficiently hard. Any superfluous portions around the tooth that may hinder the easy removal of the clasp should now be cut away, when the pieces so attached to each other are removed from the mouth. A separation of the plaster from the clasp or plate, or both, may occur when removing the latter; in this case the several parts may be readily and accurately adjusted to each other again in their exact relation when out of the mouth; as the latter will be plainly indicated by the impression made by the plate and clasp in the plaster. Being readjusted, they may be further secured by sticking them together with a little softened wax, when they are invested, the temporary fastenings of plaster removed, and the pieces united by soldering. The use of plaster in these cases is due to Dr. Lester Noble, and unquestionably possesses many advantages over wax for the purpose, as the latter is liable even with the most skilful manipulation, to become displaced in removing it from the mouth; and this change, when it occurs, not being indicated by inspection of the wax, is incapable of timely correction.

3. Still another method is that contrived by Dr. Fogle and described by Dr. Cushman in the tenth volume of the *American Journal of Dental Science.* It consists in securing the proper

relation of the clasps to the teeth in the mouth by the use, in the first instance, of what are termed "temporary fastenings." The plate and clasps are first applied to the model, and are then connected by a narrow strip of plate or piece of wire bent in the form of a bow, the concavity facing the model, one end of which is soldered to the palatal side of the clasp, and the other to a contiguous point upon the plate. The pieces thus temporarily united are removed from the model and adjusted to the parts in the mouth. If the position of the clasps is found in any respect faulty, they can be easily and accurately adapted to the walls of the teeth by bending or twisting the connecting strip in any desired direction with pliers or other instruments suitable for the purpose. This accomplished, the plate and clasps are removed, and the operation of permanently uniting the clasps to the plate performed in the usual manner.

CHAPTER VII.

Partial Dentures supported in the Mouth by means of Cylinders of Wood attached to Tubed Plates.

The following description of a method of supporting partial sets of teeth in the mouth by means of wood cylinders attached to the plate is copied from an article contributed by Dr. W. M. Hunter to the fourth volume of the *American Journal of Dental Science.* The same principle has long been made available in Europe in attaching artificial substitutes constructed of the hippopotamus ivory, but the credit of its application to metallic plates is alike due to Drs. Hunter and Charles Stokes of London.

"After swaging, the plate, as usual, is tried in the mouth, and an accurate impression of the teeth to be used is taken over the plate, as recommended by Dr. Arthur, in the *American Journal*, which will show the exact position of the tooth in its relation to the plate; after which the edge of the plate surrounding the teeth to be made use of, should be doubled or wired, when the tubes may be soldered at their proper points, taking care never to apply pressure to one side of a tooth without some means of counteracting the effect; the means being either a *sufficient number* of natural teeth contiguous to the tooth to be used, a counter tube, an arm of metal, or an artificial tooth, depending entirely upon the nature of the case.

"At times, it is well to tube but one side of the plate and clasp the other; in cases where the crown of the tooth is much larger than the neck, a beautiful application may be thus made.

"The tubes should be from one-eighth of an inch to one line in diameter, and should be filled with whiting before applying heat, to prevent them from filling with solder at the time of soldering to the plate. They should be placed upon the plate so carefully, that the mouth of the tube will come in contact with the natural tooth, as it is desirable to have the wood protrude but very slightly beyond the orifice.

"When it can be properly done, the tubes are soldered at the same time the teeth are, as it saves much trouble in fitting; it cannot, however, be very well done where it is designed to fit a tooth over a tube, but can very readily be done where the tooth is designed to fill the angle caused by the meeting of the stay and plate, in the incisors and canine teeth, and where a canine is used for a bicuspid, building over the tube with metal to form the inner cusp."

The accompanying cuts show clearly the form and application of the tubes referred to. In Fig. 88, showing on one side but a single tube, the counter-force is obtained by the

Fig. 88.

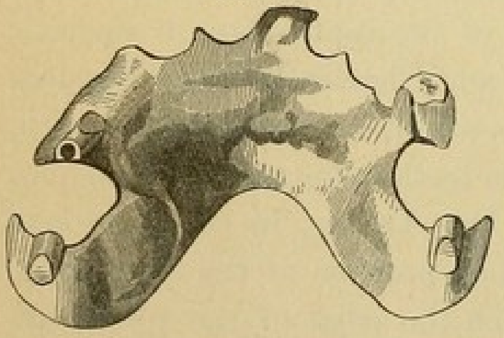
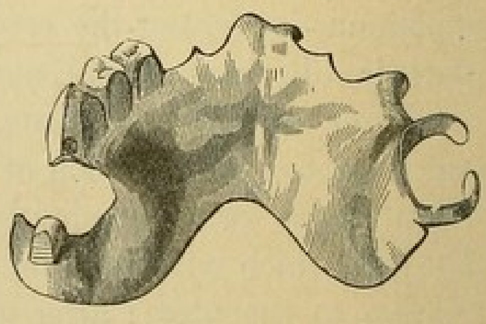


Fig. 89.



artificial tooth which rests against the anterior face of the one to which the wood cylinder is applied. Fig. 89 exhibits tubes arranged on one side, and a clasp on the other; and shows the substitution of a canine for a bicuspid, with an inner cusp built up over the tube, practically converting a cuspid into a bicuspid tooth.

In commenting on the application of this principle to partial sets of teeth, Dr. H. remarks: "The advantages in many cases must be apparent to the thinking dentist, but, perhaps, it might not be amiss to enumerate a few.

"The fixture is held in place with greater firmness than by means of clasps.

"In some instances where I have used clasps, I have also used the tube in combination, to give stability for masticating purposes.

"The injury to the natural teeth must be much less, owing to the smaller amount of surface in contact.

"If decay should take place, it would require but an ordinary filling to restore the tooth.

"It prevents that peculiarly disagreeable sensation experienced, particularly in fruit season, upon removing and replacing artificial teeth.

"After having tested it for more than a year, I am satisfied that it greatly lessens the chances of decay in those cases where it can be applied, and I have removed the clasps in some old cases with great satisfaction to my patients."

CHAPTER VIII.

PARTIAL DENTURES SUPPORTED IN THE MOUTH BY PIVOTING THE PLATE TO THE ROOTS OF THE NATURAL TEETH.

A LIMITED number of teeth may be mounted on a plate pivoted to the roots of two or more of the front teeth; and provided the latter are firm, well formed, and in a healthy condition at the time of the operation, an appliance so adjusted may be worn by the patient with comparative comfort and efficiency for from five to eight years.

Ordinarily, the roots of the cuspidati afford the most secure means of attachment, and will furnish adequate support to a

FIG. 90.

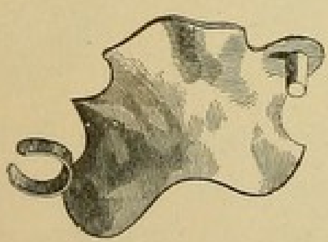
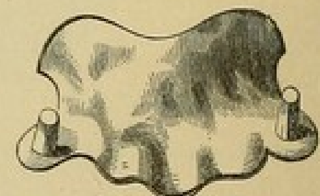


FIG. 91.



substitute supplying the loss of a part or all of the teeth anterior to the bicuspids (Fig. 90), and, in some cases, one or two of the latter on each side. The roots of the incisors, also, may be used, or one of the latter and a cuspidatus. In some cases the plate may be secured in the mouth by pivoting to a root on one side, or in front, and clasping to a tooth on the opposite side (Fig. 91), provided the crown of the latter and the pivot root stand nearly or quite parallel with each other, as any considerable deviation from this relation will render it difficult or impossible to apply and remove the substitute.

The roots of the teeth to be used as a means of support should be prepared in the manner described under the head of "Pivoting Artificial Crowns." In all cases, the enlarged canal of the root should be provided with a gold tube, as this method is the only one which will protect the root from the mechanical action of the pivot, or permit a ready or frequent removal of the appliance for the purpose of cleansing it and the parts associated with it in the mouth.

The roots being prepared in the manner indicated, an impression of the mouth is taken, and with a die and counter obtained from a plaster model of the parts, a plate of the required form is swaged covering the filed extremities of the roots to be pivoted, and extending anteriorly very nearly or quite to the free margins of the gum in front. The plate, at those points corresponding with the openings into the roots, is then perforated and enlarged sufficiently to admit of the passage of the metallic pivots; the form and position of the orifices in the roots being transferred to the metallic die, the corresponding depressions in the plate at these points, when the latter is swaged, will serve as a sufficient guide in perforating the plate for the pivots. The plate is now applied to the mouth, and the metallic pivot, one-half longer than that ultimately required and formed to fit the tube accurately but not tightly, is passed through the opening in the plate and pressed to the bottom of the tube, leaving the surplus portion of the pivot projecting on the lingual side of the plate. The plate and pivot are now secured in this precise relation by imbedding the projecting portion of the latter and the parts of the plate immediately surrounding it, in a batter of plaster. When the plaster has hardened, the plate and pivot, with the plaster attached, are removed in their undisturbed relation from the mouth. To preserve the several pieces *in situ* more perfectly, the projecting end of the pivot may be flexed, or a head formed on it with the file before applying the plaster; the pivot thus secured will bring all parts together if traction is made on the plate in the act of withdrawing the pivot.

The plate being removed from the mouth, its palatal portion is imbedded in the plaster mixture, and when the latter is hard, the plaster is removed from around the pivot on the opposite side of the plate, and the pivot permanently united by flowing solder at its point of contact with the plate. The redundant portion of the pivot on the lingual side of the base is then cut and filed away even with the surface of the latter. If the manipulations have been accurately conducted, the plate and pivot, on being reapplied to the parts in the mouth, will be found to adapt themselves perfectly to the palatal arch and roots.

It is better, unless the roots to be pivoted stand nearly or quite parallel, to adjust and solder but a single pivot at a time, as but a very slight variation in the direction of the roots would render the withdrawal of both pivots at the same time difficult or impracticable without more or less change of relation. The same may be remarked of those cases where a clasp is used in conjunction with the pivot.

The most efficient method of rendering the appliance stationary when applied to the roots, and at the same time of enabling the patient to readily apply and remove it at will, is that recommended by Dr. Dwinelle, and which consists in splitting the pivot with a fine saw, and spreading the sections apart somewhat, thus giving them an increased lateral bearing.

Gold used for pivots in these cases should be alloyed with platinum, as that ordinarily employed for plate is too inelastic for the purpose.

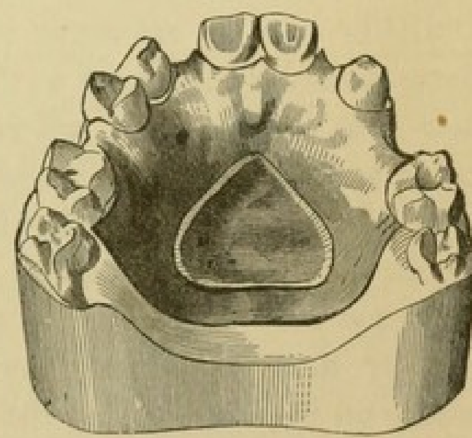
CHAPTER IX.

Partial Dentures Supported in the Mouth by Atmospheric Pressure.

The method of attaching partial sets of teeth to the superior jaw by means of atmospheric pressure, is much more generally practiced now than formerly, and whenever the condition of the soft parts of the mouth, the general configuration of the palatal arch, and the antagonism or occlusion of the artificial with the natural teeth favor its adoption, there are good and sufficient reasons why it should be preferred, in all practicable cases, to either of the other methods heretofore described.

Modifications in the Form of the Base.—If vacuities exist at various points on the ridge, the plate on which the teeth of replacement are mounted, should be ample in its dimensions, covering nearly or quite all of the hard palate. The general form of the base wher- several teeth scattered throughout the arch are required, is shown in Fig. 92. In most cases, whether but one or a greater number of teeth are to be replaced, increased adherence and stability of the substitute will be better secured by permitting the plate to cover the larger portion of the roof of the mouth; though, in cases that present the best form of the vault, a diminished surface may be given to the base with equally satisfactory results. In the substitution of a single incisor, for example, it will frequently be sufficient to employ a very small plate, covering only a part of the anterior sloping

Fig. 92.



wall of the palate. (Fig. 93.) In the latter case, the plate used may be very thin, say No. 30 of the gauge; it will thus impede the movements of the tongue less, and may be swaged more accurately to the parts. If constructed with an air-chamber, the latter should be quite shallow.

A somewhat anomalous form of atmospheric pressure plate employed in the substitution of one or two bicuspid teeth on each side is described by Professor Taft,* the design of which

Fig. 93.

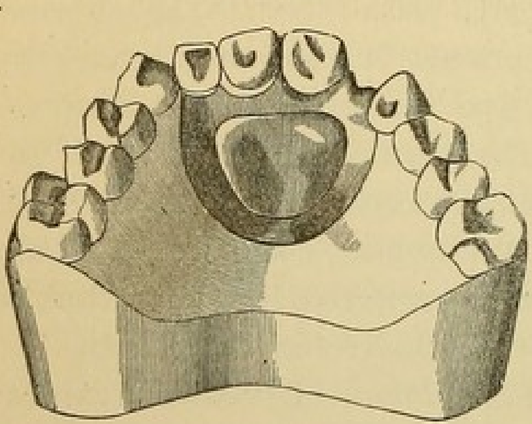
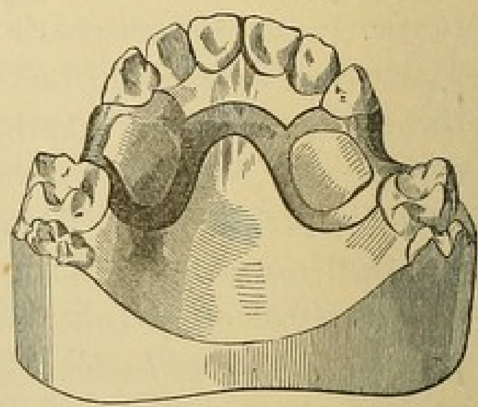


Fig. 94.



is to secure, in such cases, increased stability of the substitute, while much of the palatal arch is left uncovered. It consists, as will be seen by reference to Fig. 94, of two lateral cavity plates accurately adjusted to the sloping walls of the palate on each side, immediately adjoining and partly occupying the spaces to be supplied. These lateral plates may be made as large as a dime, or somewhat larger, and of an elliptical shape, if both bicuspids on the same side are to be replaced, and are connected with each other by a narrow band of gold plate, two lines or more in width, having an anterior curvature, and resting on the front wall of the palate, two or three lines behind the anterior teeth. The entire appliance may be constructed from a single piece of gold plate swaged accurately to the parts; or the lateral plates and connecting band may be separately swaged and secured in their proper relation to each other in the mouth with wax or plaster, when they are care-

* Dental Register of the West, vol. xiii, p. 112.

fully removed, invested, and soldered together; it should then be re-swaged to correct any change of relation that may have happened during the concluding manipulations. The liability of the plate to ride upon the central and raised portion of the palate, when pressure is made upon one side, throwing the plate off from the ridge on the other, as in the case of a base extending across the arch, is in a great degree obviated by the method just described.

Manner of Forming an Air-chamber.—Atmospheric pressure plates for partial cases are usually constructed with a central air-chamber; in which case, the part of the model representing the chamber may be formed in either of the ways mentioned in the chapter on "Plaster Models." The model prepared, the form of the plate to be used is first indicated thereon, and from this a pattern in sheet lead is obtained, which is placed on the plate of gold or other metal, and its outlines traced with a pointed instrument; the redundant portions are then cut away with plate-shears and forceps. The plate is now placed on the die, and brought as nearly as possible into adaptation to the latter with the mallet and pliers; it is then interposed between the die and counter, and swaged until it conforms perfectly to the face of the former; annealing the plate frequently to render it more pliant and manageable under the hammer. Unless the plate used is purer and thinner than is generally employed, or than is consistent with the required strength, it will fail to be forced perfectly into the groove around the chamber by the process of swaging alone; a more definite border, however, may be formed by forcing the plate in at this place with a small, smooth-faced stamp, shaped to the angle of the groove, passing round the chamber and carefully forcing the plate in with the stamp and a small hammer or mallet until a somewhat sharp and abrupt angle is obtained to the palatal edge of the chamber. After the chamber is as perfectly formed as possible in this way, the plate should be well annealed and again swaged to correct any partial deformity occasioned by stamping the chamber.

A still more perfectly defined angle may be given to the borders of the chamber in the following manner: After swaging the plate sufficiently to indicate the exact position and form of the chamber, the portion forming the latter should be separated from the main plate by completely dividing it with a small, sharp, chisel-shaped instrument, cutting on a line with the groove around the chamber until the latter is entirely separated. The cut portion of the main plate is then trimmed evenly with a file, being careful not to enlarge the opening more than is required to remove the irregularities of the edge formed in cutting. The plate, with its central portion removed, is then placed upon the die, when a separate piece of gold cut to the general form of a chamber, but somewhat larger than the opening in the main plate, is adjusted over the chamber, and struck up with the plate until the overlapping portions of the central piece are forced down upon the plate around the margins of the chamber. It is not, however, always necessary to employ a separate piece of gold for the chamber, as the central portion cut from the plate in the first instance may be sufficiently enlarged for the purpose. This is accomplished by first flattening out the detached portion, annealing it, and then passing successive portions of its edges a sixteenth of an inch or more between the rollers, the latter being sufficiently approximated to produce a perceptible thinning of the margins. When the entire border of the chamber piece has been thus attenuated and extended, it will be found so much enlarged that when adjusted to the die and swaged in connection with the main plate, its borders will overlap and rest upon the margins of the opening in the base, as in the other case.

The portions of the plate and cut chamber lying in contact are now coated with borax and pieces of solder placed along the line of union on the lingual side of the plate, when the two pieces, being transferred to a bed of charcoal, are permanently united by flowing the solder with a blowpipe. Sufficient heat should be applied to induce an extension of the solder between the two portions of plate, filling up completely the gap between them to the edge of the orifice in the main plate, forming, at this point, a square and well-defined angle to the margins of the chamber.

CHAPTER X.

METHOD OF OBTAINING AN ANTAGONIZING MODEL FOR PARTIAL DENTURES; SELECTING, ARRANGING, AND ANTAGONIZING THE TEETH; INVESTING, ADJUSTING STAYS, SOLDERING, ETC.

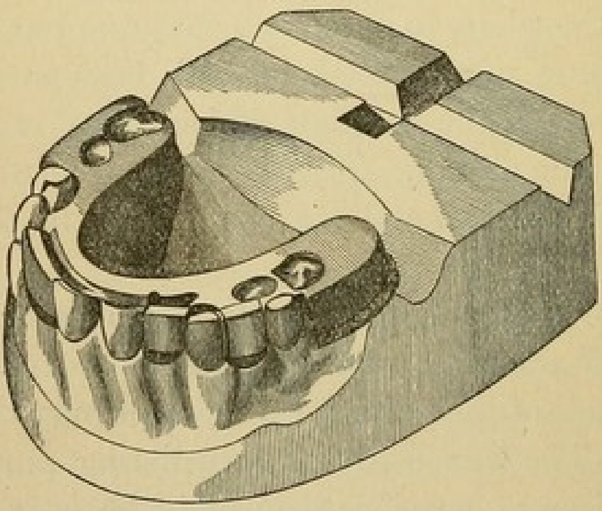
HAVING constructed the plate or base to be used as a support for partial sets of teeth in either of the ways described in the preceding chapter, it will be necessary, before arranging the teeth on the plate, to secure an accurate representation of all the remaining natural teeth of both jaws in plaster, preserving accurately the relation which these organs bear to each other in the mouth. This is effected by what is called an *antagonizing model*, and may be secured in the following manner:

A roll or strip of adhesive wax is first attached to the lingual border of the plate, and its adhesion secured by holding the opposite side of the plate for a moment over the flame of a spirit-lamp. The wax used for articulating purposes should be harder and more tenacious than plain beeswax, and may be compounded from the following formula:

Beeswax, ...	1 pound
Gum mastich, ...	2 ounces
Spanish whiting, ...	1 ounce

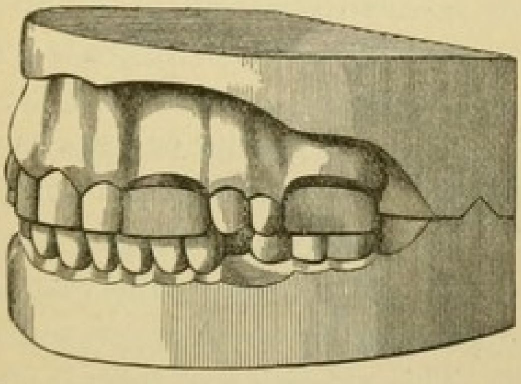
The wax is first melted in a shallow vessel, and the mastich, finely pulverized, gradually added, and then the whiting, stirring constantly until thoroughly incorporated. The rim of wax being arranged on the plate, all superfluous portions overhanging the margins occupied by the remaining teeth are cut away; the plate may then be placed on the model and the wax again trimmed, leaving it somewhat fuller than the outer circle of the teeth, and from one to three lines longer than those immediately adjoining the spaces. The plate, with the wax attached, is then placed in its proper position in the mouth, and the patient instructed to close the jaws naturally until the remaining teeth meet; one-third or more of the crowns of the opposing teeth opposite the spaces will thus be imbedded in the wax. A still fuller impression of the opposing teeth may be obtained, if desired, by pressing the edges of the wax down upon the crowns with the finger. If a series of anterior teeth are to be replaced, the mesial line of the mouth in front should be indicated upon the wax by drawing a line vertically across the latter to serve as a guide in the arrangement of the

Fig. 95.



central incisors and adjoining teeth. The plate and wax are then carefully removed from the mouth and again placed upon the plaster model, the latter having been previously obtained from an impression of the parts with the plate in the mouth. The model is then placed on a slip of paper with the plate and wax upward, and the heel of the model extended from one to two inches posteriorly to form an articulating surface for the remaining portion of the antagonizing model. The added portion of plaster may be confined by a narrow strip of wax or sheet-lead extending back upon each side of the model, into which a batter of plaster is poured to the depth of half or three-fourths of an inch. When hard, the edges and upper surface of the added plaster should be trimmed smooth, and a crucial groove, or two or three conical-shaped holes, cut in the surface of the latter to secure a fixed and definite relation of the two parts of the model. The articulating surface is then varnished and oiled to prevent the next portion of plaster from adhering; the imprints of the teeth in the wax are also oiled. This portion of the antagonizing model, with the plate and wax attached, is exhibited in Fig. 95. The open space looking into the palatal vault should be closed with a sheet of softened wax to prevent the next portion of plaster from flowing into the cavity underneath. A batter of plaster is now poured carefully upon the exposed surface of the wax, filling the imprints of the teeth perfectly, and extending back upon

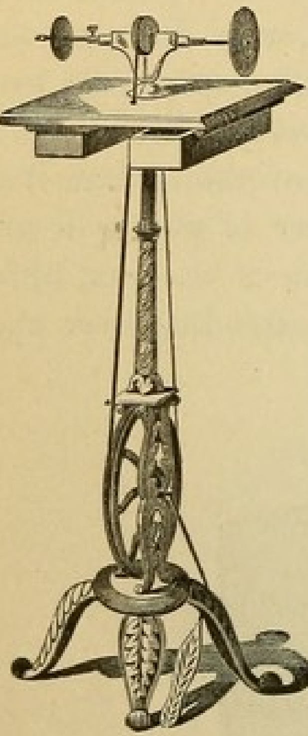
Fig. 96.



the heel of the model until it acquires a depth of half an inch or more. When sufficiently hard, the two sections of the model are separated, superfluous portions trimmed away, and the entire surface of both pieces glazed with varnish. The model complete, with the plate in place, and the wax (retained as a temporary support, whilst adjusting the artificial teeth) trimmed as required, are shown in Fig. 96, and if the manipulations have been accurate this simple contrivance will exhibit all the parts represented in plaster in precisely the same relative position which they occupy in the mouth when the teeth are closed upon each other. It will be seen, by reference to Fig. 95, that only those teeth of the opposing jaw which present to the spaces, are represented in plaster, as these are all that are required in arranging the teeth of replacement.

Selecting, Arranging, and Antagonizing the Teeth.—The teeth of replacement should harmonize, as nearly as possible, in size, configuration, and color, with those remaining in the mouth; and when selecting teeth for any given case, the operator should be provided with a sufficient number of sample teeth to meet every requirement, by comparison, in respect to the various tints or delicate shades of color characteristic of the natural teeth and gums. The required size and form of the artificial teeth may be determined with tolerable accuracy by a comparison with those on the plaster model, but the form or figure more certainly by a careful inspection of those in the mouth.

FIG. 97.



A greater or less change in the form of porcelain teeth will be required, in nearly all cases, in arranging and fitting them to the vacuities in the jaw; and this is more particularly so in those cases requiring the use of gum teeth. This alteration of form is effected by grinding away portions of the tooth upon an emery or corundum wheel, attached, as will be seen in Fig. 97, to a foot-lathe. If the edentated portions of the ridge have suffered but little change of form by absorption, as where the teeth have been recently extracted, and plate teeth (those representing only the crowns of the natural organs) are used, the posterior portions of the base of the latter resting upon the margins of the plate will only require to be conformed to the irregularities on the surface of the base, grinding sufficiently to give to them the proper length and relative position, while their anterior cervical portion is permitted to overlap the edge of the plate and rest directly upon the gum in front on a line with the adjoining teeth. When, however, a considerable concavity exists in the ridge and external border, and single gum teeth are employed to restore the customary fulness and contour of the parts, the gum portion of the tooth should be ground away on its posterior face sufficiently to restore the circle of the gum on the external border of the alveolus, and from the base of the tooth where it rests upon the plate, to admit of a proper relative position of the artificial crown; while those portions of the porcelain gum terminating at, and adjoining the remaining teeth, next the spaces, should be formed with a thin, retreating edge, where it laps upon the natural gum, giving to the parts, when the substitute is adjusted to the mouth, the appearance of an unbroken denture and a continuous gum. When the space to be supplied requires a series of two or more single gum teeth, the latter should be united to each other with the greatest care and exactness by grinding the proximate edges of the gum portions until the coaptation is such as to render the seams imperceptible in the mouth. In adjusting the porcelain teeth to the plate, the base of each tooth should be ground to rest as directly and uniformly on the plate as possible; for if thrown, in any degree, from the plate, the whole strain in mastication will come upon the platinum rivets, and, in a comparatively short time, the latter will either be entirely worn or cut off, or the artificial crown will be fractured on a line with the pins.

In antagonizing partial sets of teeth, the indications pointed out by the customary closure of the natural organs should be followed as nearly as the form and position of the opposing teeth will permit. A changed or abnormal relation of the teeth of both jaws, however, frequently renders it difficult to effect a satisfactory adjustment of the teeth of replacement. If, in the case of the bicuspids, for example, one or more teeth in the under jaw project into a vacuity above to the extent of one-third or more of its depth, a direct closure of the substituted organs upon these, in the ordinary manner, would be impracticable without a corresponding shortening of the porcelain teeth, enforcing, in such cases, an inharmonious arrangement, entirely inconsistent with the just requirements of the case. The difficulty cited, or any of the various modifications of it, may be overcome wholly or in part in one of two or three ways. If the teeth encroaching upon the opposite space are very loose, as is frequently the case with those that have become elongated from the long-continued want of an adequate opposing force, or are hopelessly carious or otherwise diseased, they should be at once removed. If they remain firm and sound, and stand slightly within the circle of the teeth of the opposite jaw, or if they have somewhat of an inward inclination in the arch, the vacuity opposite may be filled with non-masticating teeth, as a canine, on the lingual side of which an antagonizing cusp of gold may be constructed, allowing the point of the cuspid to lap over upon the labial face of the encroaching tooth or teeth; or a bicsupid, manufactured for the purpose, with the inner cusp near the base of the tooth, may be used instead. Additional room may be provided, in such cases, for the overlapping portion by filing away from a corresponding point on the opposing tooth. If, however, taking the most impracticable case, the intruding teeth are sound and firm, and stand vertically in the arch, closing between the opposing teeth on a line with, or somewhat outside of, the outer circle of the latter (the elongation of such teeth being rather relative than absolute, as where it results from a mechanical wearing away of the remaining antagonizing teeth and a corresponding approximation of the jaws), the practitioner will be compelled either to submit to a mal-arrangement of the teeth of replacement by grinding away sufficiently from their grinding surfaces to permit an unobstructed closure of the natural organs, or decline the operation altogether.

The undue projection of the teeth of one jaw into a vacuity occurring in the one opposite more frequently happens, however, in connection with the loss of the superior incisors. In such cases, the points of the lower incisors very frequently encroach upon the circle of the upper teeth, so that when the artificial teeth are arranged above in correspondence with the circle of the adjoining teeth, and the jaws are approximated, the points of the inferior teeth will strike prematurely either upon the cutting edges of those above or will close upon their inner surfaces,—impeding thereby, or entirely preventing, the occlusion of the teeth posterior to them. For such cases thin teeth should be selected, and whenever necessary the lower teeth may be filed away sufficiently, while those of replacement should, at the same time, be arranged as prominently as the circle will admit of. If these expedients fail, and a sufficient number of teeth posterior to the incisors require to be substituted in connection with the same appliance, it will be better, in cases not susceptible of satisfactory correction by the means already suggested, to change the bite by substituting an entirely new antagonism with the artificial teeth,—spreading the jaws sufficiently apart to relieve the artificial incisors in front.

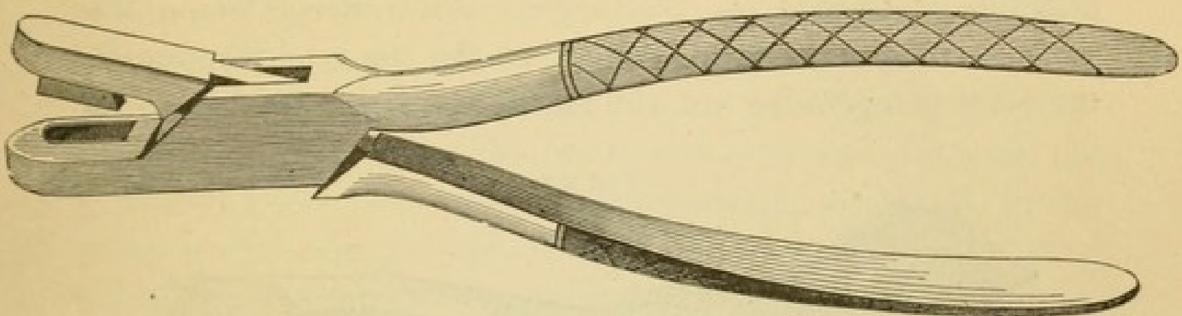
In no case, except that last described, should the artificial teeth come in contact with the opposing teeth before the occlusion of the remaining natural organs when the jaws are closed. The contact of all the teeth of one jaw, artificial and natural, with those of the opposite, should either be simultaneous, or the natural teeth should be permitted to strike first.

In view of the difficulties which so frequently present themselves in connection with the arrangement of artificial teeth in partial cases, it may not be amiss to observe that, however essential to the natural and agreeable expression of the individual an exact and harmonious arrangement of the teeth of replacement may be, this requirement should, in some degree, be disregarded whenever the necessities of the patient, in respect to the comfort and utility of the appliance or the safety of the natural organs, demand it;—to what extent appearances should be sacrificed to these considerations will depend upon the peculiar exigencies of the case, and cannot, therefore, be specifically stated. On the other hand, it may be observed that, if a sufficient number of the natural teeth are remaining in both jaws to enable the patient to perform, with tolerable efficiency, the act of mastication, the mere utility of the substitute in regard to the performance of this function may be partly or wholly disregarded whenever there is sufficient reason to apprehend that the substituted organs cannot be antagonized with a view to the comminution of food without endangering the permanency and usefulness of the appliance by necessitating the application of forces unfavorably directed.

Investing, Adjusting Stays, Soldering, and Finishing.—Having arranged and antagonized the teeth as accurately as possible on the plaster model, the piece should be placed in the mouth to detect and remedy any faultiness that may be found to exist either in the adaptation, position, or antagonism of the artificial teeth. It is then removed and imbedded in a mixture of plaster, sand, and asbestos, in the proportion of about two parts of the former and one part each of the latter. The body of the investient may be surrounded by a copper or sheet-iron band to prevent the plaster from breaking away whilst adjusting the stays or linings to the teeth. All parts of the plate and teeth, except the lingual side of the former and the backs of the latter, should be incased in plaster to the depth of half an inch or more, and when the latter is sufficiently hard all traces of wax from the inside should be carefully detached with suitable instruments.

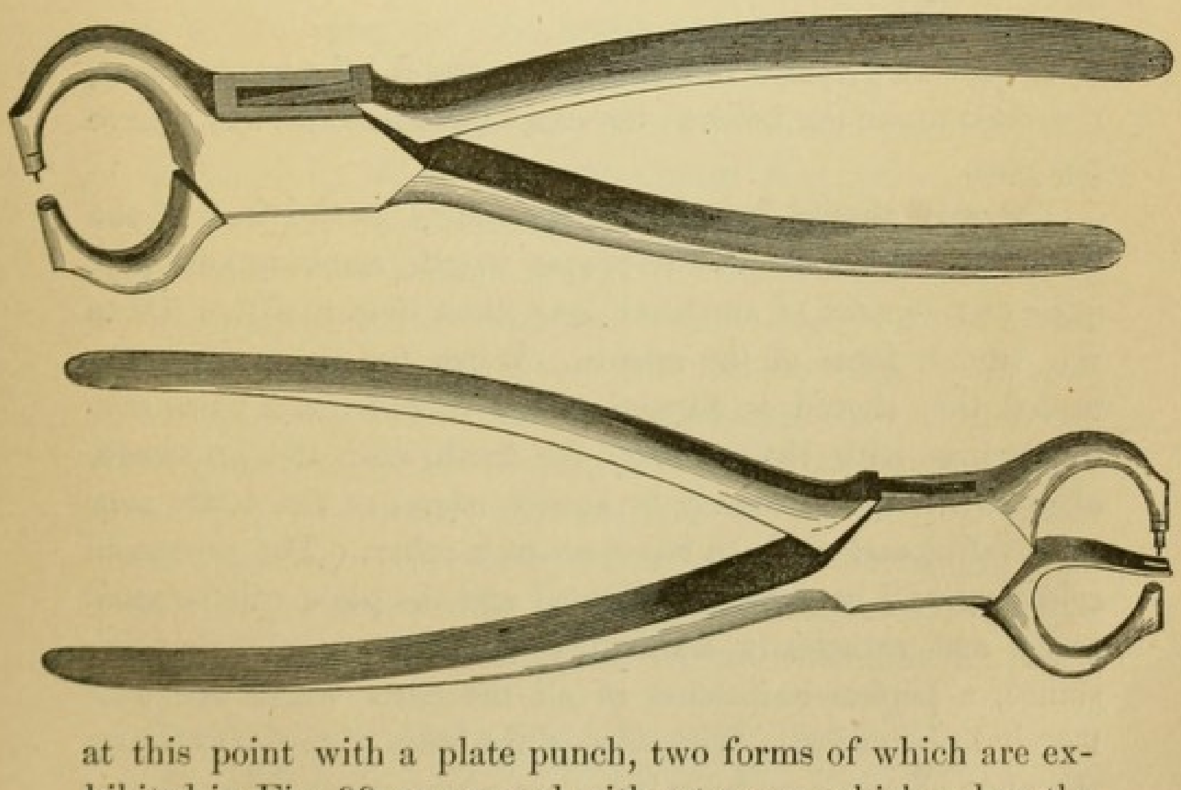
The piece is now ready for the adjustment of stays or backings, which, when permamently united by soldering to the base and teeth, are designed to sustain the latter in position. These supports are formed from plate somewhat thicker than that used for the base; a heavier and stronger stay being necessary when they are not united laterally, as when plate teeth are used. If, however, single gum or block teeth are employed, and the stays are joined, forming a continuous band, plate one-half thicker than that used for the base will, ordinarily, impart adequate security to the attachment. A plain strip, corresponding in width with the tooth to be lined, is cut, and the end resting on the main plate conformed accurately with the file to the irregularities on the surface of the latter, and in such a manner as to permit the strip to take the direction of the tooth. The general form of the stay may, in the first place, be obtained by cutting a strip from a piece of gold with a pair of plate forceps. (Fig. 98.) The points upon the stay to be pierced for the admission of the platinum pins may be ascertained by coating the surface of the former with wax

Fig 98.



softened in the flame of a spirit-lamp, and pressing it first against the lower pin, the point of which will be indicated by an indentation of the wax. The backing is then perforated

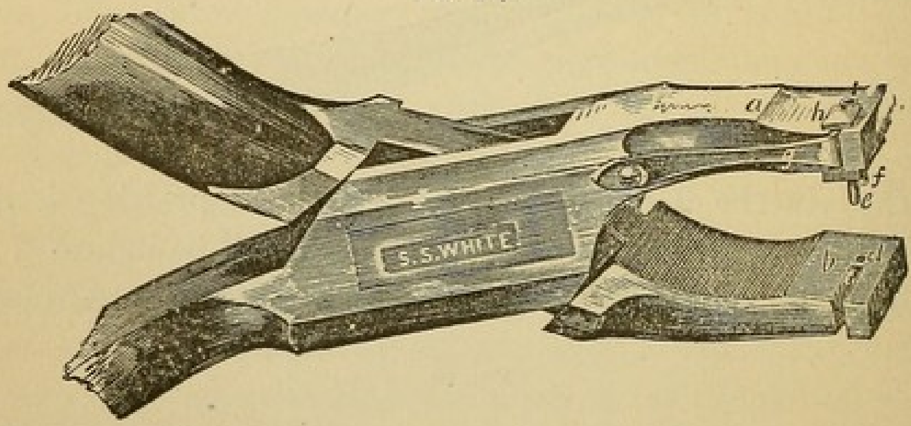
Fig. 99.



at this point with a plate punch, two forms of which are exhibited in Fig. 99, one armed with a tongue, which, when the plate is pierced, forces the latter from the punch. The strip is then reapplied to the upper pin, and the second hole obtained in like manner as the first. Instead of using wax, the ends of the rivets may be stained with some pigment, which will show the points to be pierced in the lining.

Fig. 100 represents an ingeniously contrived instrument, invented by Dr. Samuel Mallet, and designed to secure an accurate relation of the two holes. After straightening the pins, one is placed in the hole *i*, at the head of the punch, the other pin pressing out the movable punch *e* (which works

Fig. 100.



by the spring *g*), until it slips into the slot *h*; the two punches, *f*, *e*, then make the holes at the exact distances apart to receive the pins.

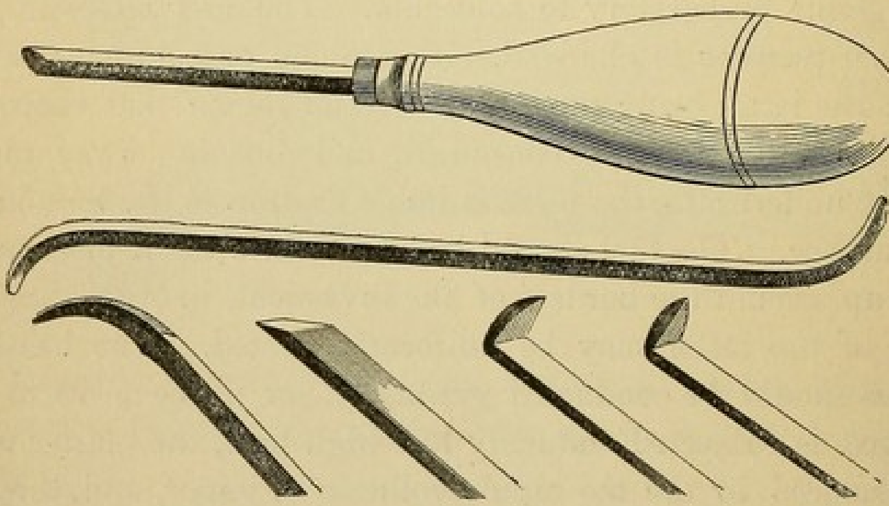
The stay should be adapted accurately to the face of the tooth; it is then cut to the proper length, reaching nearly or quite to the point of the tooth, and then shaped with a file to the general form of the crown. When the stays are to be united they should be formed with a shoulder at a point corresponding with the neck of the tooth, and the proximate edges below united closely by square edges, or the latter may be bevelled and made to lap upon each other. The process of soldering will be greatly facilitated and the piece will be more easily and artistically finished, by securing, in the first instance, a perfect coaptation of all the parts which are ultimately to be united. The sides of the holes in the stays facing the plate should now be enlarged or countersunk with a spear-shaped or conical burr drill, and when applied to the teeth the projecting ends of the platinum pins are cut off even with the backings and then split and spread apart with a small chisel-shaped instrument; a head will thus be formed to the rivets when solder is fused upon them, and which will prevent them from drawing from the linings. All the lines of union between the several pieces should next be well scraped, exposing a clean, bright, metallic surface to the solder; the seams are then smeared with borax, ground or rubbed in clean, soft water to about the consistence of cream;* after which small pieces of solder are placed along the joints and over the points of the platinum pins. The piece thus prepared is now placed in the furnace or ordinary fireplace, in order to heat the entire mass throughout preparatory to soldering. The fuel most proper for this purpose is charcoal, either alone or combined with coke; the latter being preferable for the reason that charcoal alone is more quickly consumed, and burning away more rapidly underneath, the piece is liable to drop to the bottom of the furnace. The fuel should be broken into small pieces and built up around the borders of the investient, in order that all parts of the latter may be uniformly heated. The heating process should be conducted gradually, for if the piece to be soldered is subjected suddenly to a high heat, the plaster will be displaced by the too rapid evolution of vapor, and the integrity of the porcelain teeth will be endangered. The piece may be allowed to remain in the fire until the plate acquires a visible red heat, when it should be removed, placed on a suitable holder, and the solder fused with the blowpipe. A broad, spreading flame should first be thrown over the entire surface of the plate and border of the plaster until the temperature of the entire mass is nearly that required to fuse the solder, and which is indicated by the latter settling and contracting upon itself; the flame may then be concentrated upon a particular point, as at the heel of the plate on one side, passing round

* Slate is often used for this purpose, but is unfit, as in rubbing the borax, loosened particles of the former become mixed with the latter and impede the flow of the solder, and becoming entangled render it unclean and porous. Ground glass or a porcelain slab is the best for the purpose.

from tooth to tooth until all parts are completely united and the solder is well and uniformly diffused.

Having united the teeth to the plate, the piece may be allowed to cool gradually, or it may be plunged after the lapse of a few minutes into boiling water without risk of injury to the teeth. When cool, the plaster is removed and the plate placed in a solution of equal parts of sulphuric acid and water, where it may be allowed to remain until the discoloration of the plate and the remains of the vitrified borax, incident to soldering, are removed; or it may be put into a small copper vessel, partly filled with the same solution and boiled for a few

Fig. 101.



minutes. After removing the plate from the acid, it should be boiled for five or ten minutes in a solution of chloride of soda or common salt and water to remove thoroughly all traces of the former. Superfluous portions of solder are now to be removed, and this at first may be more quickly accomplished by the use of burrs of various forms and sizes attached to a lathe. After the rougher and more redundant parts are thus cut away, any remaining irregularities upon the surface may be further reduced with properly formed files, scrapers, and cutting instruments. Flat and half-round curved files, and scrapers having a right and left curvature to their cutting edges, and chisel-shaped cutting instruments for paring or chipping away (Fig. 101), are the implements usually employed for this purpose, and with which a comparatively smooth surface may be obtained; after which, the filed portions should be well rubbed with Scotch stone until all traces of file-marks or other scratches are completely removed. With a rapidly revolving brush attached to a foot-lathe, the final polish or lustre may be imparted by the use, first, of Spanish whiting, or prepared chalk, and then rouge mixed with water or alcohol.

The following method of finishing plate-work communicated by Professor J. L. Suesserott,* embodies some practical suggestions in reference to this process: "The first step is to procure and attach to the lathe a three- or four-pronged fork, or a screw such as is used for withdrawing a load from a gun; upon this a good smooth cork is fixed, and, with a sharp knife, turned to any desired shape. The cork is saturated with water as well as it can be, and powdered pumice placed upon it. If we have been careful to remove all excess of solder from our work, which can easily be done by a burr attached to the lathe, we can, with the cork and pumice, make a very smooth surface, and this can be still more perfectly accomplished by substituting a very finely powdered spar for the pumice, after we have removed the largest scratches with the latter. By continuing the cork for a little while after the above-named powders have been used off, we avoid the use of the Scotch stone; and finally we dispense with the burnisher, by taking a new cork with a piece of chamois or buckskin stretched upon it, and going over the plate in the same manner as before, with the lathe revolving very rapidly.

"A higher color can be given to the plate by the use of the burnisher after the above proceeding, but we can certainly not produce a smoother surface.

"Some precaution is necessary by those who have never used the lathe in finishing the plate; in the first place the careless use of the burr, in removing the excess of solder, might result in the weakening of the piece by removing more than necessary, or, what would be still worse, holes might be cut

* Erroneously ascribed in the first edition to Professor T. L. Buckingham.

entirely through the plate. Again, in polishing, if a little care is not taken, the fork or screw, whichever is used, may pass through the cork, and before the operator is aware he will have inflicted an injury that will be difficult to repair. A small amount of experience—that which is essential in the proper performance of every nice operation—will enable almost any one, even those, to use a common expression, 'whose fingers are all thumbs,' to finish their work in about one-eighth of the time that the most expert workman would require for the accomplishment of the same by the old method."*

In the final adjustment of the finished piece to the mouth, and after any additional change in the form of the teeth necessary to secure the most perfect antagonism has been made, the patient should, in all cases of partial dentures, receive explicit directions in regard to the general care and management of the appliance and the remaining natural teeth. Ordinarily, there will be but little difficulty experienced by the patient in the immediate and successful use of a substitute supported in the mouth by clasps, or any equivalent means, but in the case of atmospheric pressure plates, the patient should be candidly advised of the probable want of stability incident to the first use of the appliance, and the consequent annoyance which in many cases follows its occasional displacement in mastication until such time as the adaptation of the several parts to each other are perfected, and the patient has acquired a habit of controlling and directing the forces applied to the substitute. The time necessary to accomplish these results will depend much upon the form and condition of the mouth, a favorable or unfavorable antagonism, the adaptation of the plate, and the aptitude and temper of the patient. It will be prudent and but just to the patient to state that the complete utility of an appliance sustained by atmospheric pressure will not, probably, be realized in less time than from four to six weeks; and this estimate of time, in a majority of cases, will be fully justified by experience in the cases under consideration.

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* Dental Cosmos, vol. i, p. 330.

The importance of thorough and absolute cleanliness of the substitute and natural teeth, and the reasons therefor, should be clearly stated; and the comfort, utility, and durability of the artificial fixture as well as the safety of all the remaining natural organs will depend, in a great measure, upon the fidelity of the patient with respect to the observance of these injunctions. In those cases especially where clasps are used, the substitute should invariably be removed after each meal and cleansed, while the teeth clasped should, at the same time, be freed from deposits of food or other foreign substances with a brush, or any of the means usually recommended for the purpose.

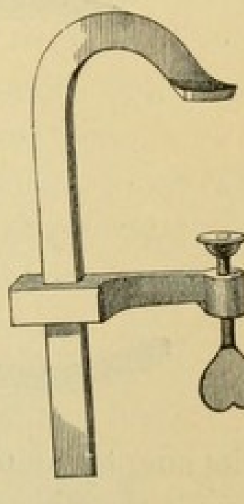
CHAPTER XI.

Entire Dentures.

Method of Constructing a Plate Base for an Entire Denture for the Upper Jaw.—The general form and dimensions of the required base to be used as a support for a complete denture for the upper jaw may first be indicated by drawn lines upon the plaster model, and a sheet-lead pattern obtained from this to serve as a guide in securing the form of the plate to be swaged. Whenever the substitute for the upper jaw is designed to be retained *in situ* by the external pressure of the atmosphere, and especially where a central air-chamber is employed, the plate should be made sufficiently ample in its dimensions to cover all the hard palate, the alveolar ridge, and all portions of the external borders of the latter not directly encroached upon by the muscles and reflected portions of the mucous membrane of the lips and cheeks.

Before swaging, the plate should be well annealed, and its central portion brought as nearly as possible to the form of the palatal face of the die with the mallet, forcing the heel of the plate down in advance of the portion covering the more anterior concavity of the arch, preventing thereby a doubling of the posterior edge of the plate upon itself. This central portion may also be forced more perfectly into adaptation with a partial counter before swaging in the ordinary manner, and this is advisable in all cases when the palatal arch is very deep; but as this is very liable to be drawn from the arch in the process of turning the borders of the plate over upon the ridge, a useful contrivance has been invented by Dr. Kurras, of New York, to prevent the displacement. Fig. 102 shows the form of this instrument. The die and plate are placed near the edge of the bench, and the upper part of the clamp adjusted over the central portion of the plate; the two pieces are then bound firmly to the bench by tightening the screw underneath. A protective piece of buckskin, cloth, or paper, should be placed between the plate and clamp, to prevent the former from being bruised or indented. The margins of the plate are now turned over upon the ridge, and if the external borders of the latter are undercut or stand even vertically, the edges of the former will tend to double upon themselves at such points, and hence it will be necessary, before swaging, to split the plate in front, and, in some cases, on each side, and wherever divided, a V-shaped piece may be cut out of sufficient width to allow the divided edges to overlap slightly when approximated in the process of swaging. The proximate edges of the divided sections should be filed to a thin edge before swaging, so that when brought together and soldered there will be but little additional thickness of the plate at such points. The cut portions should not be soldered until after a partial or complete swaging.

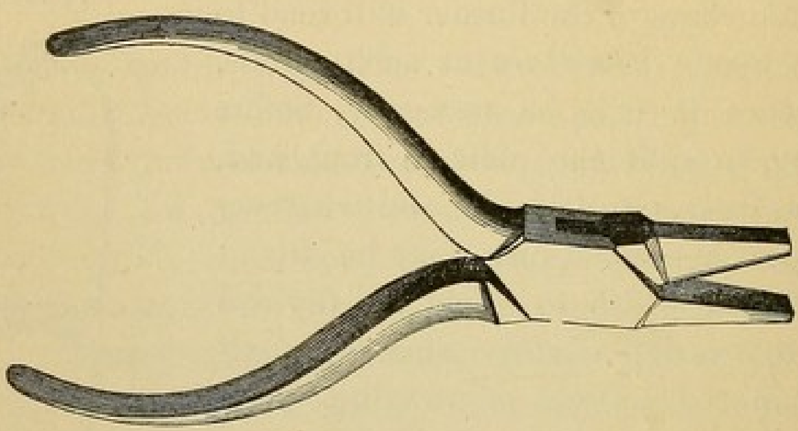
Fig. 102.



Having conformed the plate as nearly as practicable to the die with the mallet and pliers (Fig. 103), or with plate forceps constructed for the purpose (Fig. 104), it should be placed between the die and counter, and the latter forced together with a heavy hammer until a tolerably accurate coaptation of the plate is obtained, the latter being frequently annealed during the process of stamping to render it more pliable. At first considerable yielding and consequent deformity of the counter-die will occur; hence, after partial swaging, another should be substituted and the process continued until the greatest possible accuracy of adaptation is secured. If the face of the die is marked by prominent and sharply defined rugæ, or other irregularities, such points will, to some extent, be bruised or flattened; it will therefore be expedient in such cases, and better perhaps in all, to finish the swaging with a new and unused die and counter, in which case two or three moderate, steady, and well-directed blows of the hammer will be sufficient.

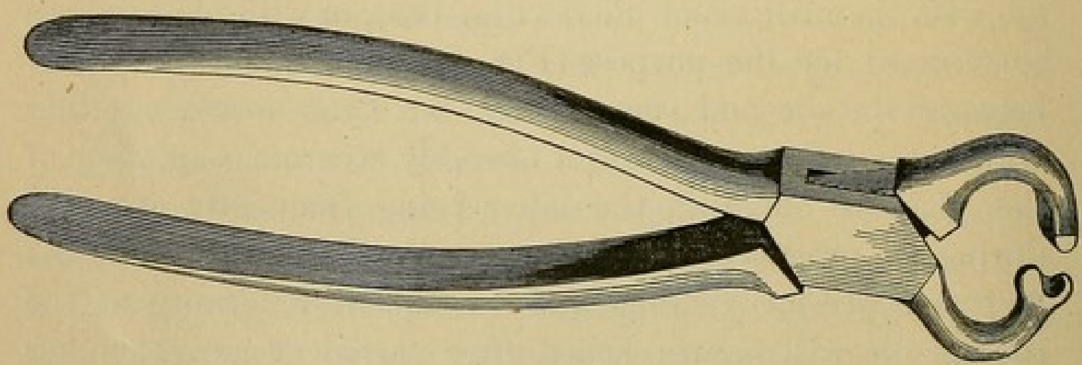
If the plate is brought into uniform contact with all parts of the face of the die, this conformity is the only reliable test

FIG. 103.



of its adaptation out of the mouth. In no case will the swaged plate fit the plaster model perfectly, inasmuch as the unavoidable contraction of the die, however slight, will, especially in deep-arched mouths, cause the plate to bind on the posterior

FIG. 104.



and external borders of the ridge, preventing it from touching the floor of the palate; while the bruising, though inconsiderable, of the more prominent points upon the die, and a corresponding flattening of the plate at such points, will prevent uniform contact of the latter with the unchanged surface of the plaster model.

After final swaging, the plate should be again annealed with a heat nearly or quite equal to that which will be ultimately required in soldering; after this any additional swaging should be avoided, unless the plate warps in the heat, and which may be determined by applying it to the die; if any change has occurred, it should be re-swaged and again annealed at a high heat, and the operation should be repeated, if necessary, until the plate retains its integrity of form after the last annealing. This process of final heating does not apply to silver if in the form of a swaged plate, as this metal invariably suffers some change of form when subjected to an annealing heat.

Modifications in the Form of Plates for Entire Upper Dentures.—Whenever a central air-chamber is employed, it may be constructed in either of the ways described when treating of

Fig. 105.

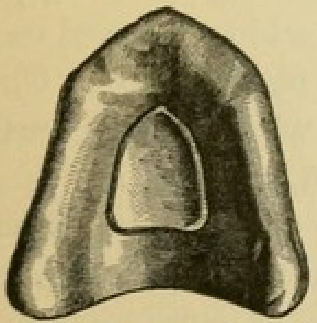
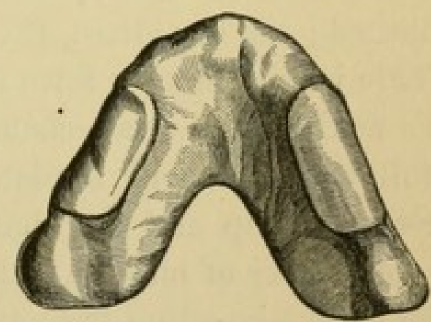


Fig. 106.

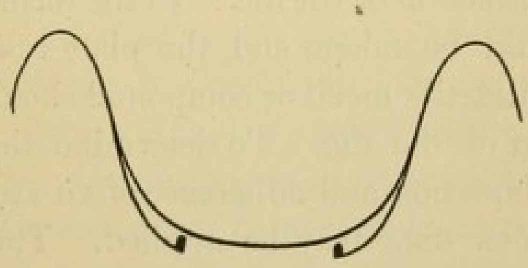


partial atmospheric pressure plates. The general form of a plate for an entire upper denture, with a central chamber, is exhibited in Fig. 105. Other modifications in the form of cavity plates for full upper sets are in limited use, as where chambers are arranged one on each side of the sloping walls of the palate, or directly over that portion of the ridge previously occupied by the anterior molar and the bicuspids on each side, as seen in Fig. 106, called "Lateral Cavity Plates." Dr. M. Levett, of New York, has recently introduced another modification of cavity plate, consisting of a number of small air-chambers arranged directly over the ridge and placed at short intervals throughout the entire border. It is claimed that plates constructed in either of the ways last mentioned cohere with equal firmness to the jaw, and are less liable to "rock" in the mouth, than when formed with a central chamber. Whatever their general utility may be, cases doubtless occur where they may be advantageously employed, as when any great inequality exists in the hardness of the ridge and palate, and a plate constructed in the ordinary manner is dislodged by "riding" upon the hard palate when forces are applied to the ridge on either side.

It has been recommended, after having constructed a base of the form represented in Fig. 105, to cut through the plate immediately in front of the central chamber, making an opening of a semilunar form. It is claimed that, by the more ready application of the tongue to this part, the air contained in the chamber, when the plate is applied to the mouth, may be more easily and thoroughly exhausted. There is great danger, however, of the soft tissues being drawn into the opening, in which case it can scarcely fail to produce injury to the parts implicated; the expedient, therefore, is seldom resorted to.

There is still another form of cavity plate known as Cleveland's modification of air-chamber, and which is constructed in the following manner: A plate like that exhibited in Fig. 105 is first struck up and the chamber cut out. A thin sheet of wax, or a layer of plaster, is then placed upon the lingual side of the plate, extending from two to three or four lines from the edges of the orifice in the main plate; a thin, retreating edge is given to the wax or plaster at the outer borders, making it continuous with the surface of the plate. The plate with the wax attached may now either be tacked to the model with softened wax along its outer borders, and shaped in such a way as to permit the model and plate to be withdrawn from the sand, and a mould of the parts taken in the ordinary way, and from this a die and counter; or an impression in wax or plaster may be taken of the lingual face of the plate and wax, and afterwards a model, die, and counter. With the latter, a second plate, covering nearly or quite all of the palatal concavity, is swaged, and when this is applied to the main plate over the cut chamber, and united by soldering, a space, equal to the thickness of the wax or plaster placed on the primary plate, will be found to exist between the two laminæ. Fig. 107 exhibits a transverse section of the two plates, disclosing the space between them, and also the opening through the gum plate into the cavity. Before soldering on the duplicate plate, a half-round wire should be soldered around the opening in the palatal plate on its lingual side, to protect the soft tissues of the mouth from injury when drawn in as the air is exhausted from the chamber; or, what is preferable, this form of cavity may be converted, practically, into what is known as "Gilbert's chamber" (which is the central swaged chamber before described), by filling in the space between the two plates with some impervious substance, as Hill's filling, or an amalgam of gold, the excess of mercury being driven off by heat. In the construction of continuous gum work, the interspace may be filled in with gum body. The advantages of these double plates are,

FIG. 107.



a greatly increased strength imparted to the base, a diminished liability of warping in the process of soldering, a smoother surface presented to the tongue, and a more decidedly angular form of the chamber.

In whatever way the plate is formed, a notch or fissure of sufficient depth to receive and permit an unobstructed play of the frænum of the lip should be formed in the front part of the plate, while the borders of the latter nearly opposite the anterior molars on each side should be narrowed to prevent undue contact of its edges with the folds of the mucous membrane stretching obliquely across from the cheeks to the jaw. Care should also be taken to trim away from the heel of the plate any portions that might otherwise encroach upon the soft palate.

It is only in the fewest number of cases that a rim can be swaged to form a groove or socket properly situated for the reception of the plate extremities of either single gum or block teeth, as it will usually be found impracticable to adjust the gum extremities to the socket thus formed without necessitating, in some degree, a departure from a just arrangement and antagonism of the teeth. Whenever it is thought best, therefore, to rim the plate, it will generally be necessary to adjust and solder a separate strip to the plate along the plate ends of the teeth after the arrangement of the latter on the base is completed.

After the plate has been worked as nearly as possible into the required form, it should be applied to the mouth of the patient to ascertain the correctness of its adaptation to the parts before proceeding further with the operation. If the adaptation is found imperfect, the fault lies either in the impression, or in undue contraction of the die. In the former case, another impression should be taken, and the plate re-swaged; in the latter, a less contractile metal or compound should be employed in the formation of the die. To determine the practical efficiency of the adaptation and adherence of an atmospheric pressure plate, various tests may be applied. The coaptation of its borders to the external walls of the ridge may be ascertained by inspection, and the patient's sense of contact or non-contact of its central portion with the floor of the palate may, in some degree, be relied on as evidence of the accuracy of its adjustment to parts not visible. The tenacity with which the plate adheres on the application of direct traction cannot always be relied upon, inasmuch as a well-fitting plate will sometimes be readily dislodged in this manner, while, on the contrary, one but illy adapted to the parts may require considerable force to separate it from the jaw when acted on in the same way. The most trustworthy test of actual or practical stability is firm pressure applied alternately over the ridge on each side and in front. If the plate maintains its position and remains fixed under repeated trials of pressure applied in the manner indicated, the adaptation may be safely relied on; if it slides upon the palate or is easily disengaged from the mouth, the instability of the plate may be referred in many cases, not to a want of coaptation, but to a want of uniformity in the condition of the parts on which the plate rests. Thus, for example, if the ridge along the mesial line of the palatal vault is more than usually prominent and incompressible, and the alveolar ridge relatively soft and yielding, the plate, meeting with a fixed point of resistance at the floor of the palate, will prevent the ridge from being sufficiently compressed when the atmosphere is exhausted from underneath the plate; and hence, when forcible pressure is made on one side over the ridge, the plate, riding upon the resistant surface of the arch, will be thrown off from the opposite side. Whenever, therefore, the conditions alluded to prevail to any considerable extent, a perfect coaptation of the plate to the parts, instead of favoring the retention of the former, will impair its stability for all practical purposes. The remedy is found in so constructing the plate that, when adjusted to the mouth, and before the air is exhausted, a greater or less space will exist between the central portion of the plate and palate, but which, when a vacuum is formed, will be carried up into contact with the roof of the mouth, and at the same time compress the ridge sufficiently to afford a firm and resisting basis for the plate in mastication. This peculiar adaptation of the plate may be obtained by adjusting a piece of sheet-lead or wax plate over the central ridge on the plaster model, by means of which the corresponding portion of the plate, when swaged with a die obtained from the model so prepared, will be thrown far enough from the roof of the mouth to answer the purpose before indicated. This will be more particularly necessary in shallow arches; while, if the arch is very deep, or even moderately so, the unavoidable contraction of the die may render the expedient unnecessary.

Method of Constructing a Plate Base for an Entire Denture for the Under Jaw.—Aside from the differences in the form of the plate, and the manipulations incident thereto, the process of constructing a plate for the under jaw does not differ essentially from that already described in connection with full upper dentures.

If the lower plate is constructed from a single lamina of gold or other metal, it should be somewhat thicker than that used in upper cases, and should also be of finer quality, as the additional thickness of the plate and the peculiar form of the inferior maxilla renders a greater degree of pliancy necessary in swaging it to the form of the ridge. The general form of a base for an entire lower denture is exhibited in Fig. 108. The internal border of the plate should usually be doubled,—either by turning the edge over in swaging, or by soldering on a narrow strip of plate or half-round wire.

A more perfect adaptation of the plate to the ridge may be obtained by the use of a double instead of a single plate, in

Fig. 108.

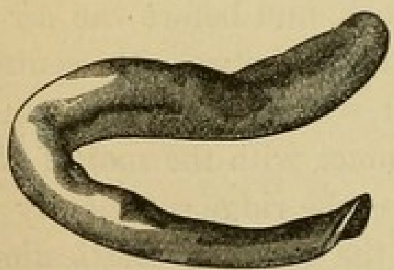
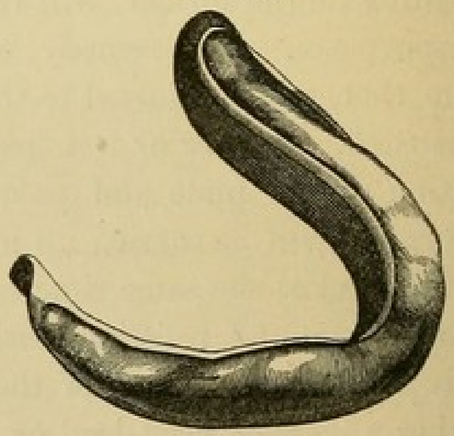


Fig. 109.



which case a thin basement plate, not exceeding No. 30 of the gauge, should be swaged to the form of the ridge in the first instance, and then a duplicate plate, swaging the two together and uniting them to each other with solder. A plate of the specified thickness may be very readily and accurately conformed to any irregularities in the ridge, and when the two are united the base will be heavier and stronger than a single lamina of the ordinary thickness. Instead, however, of doubling the entire plate, it will be sufficient, in most cases, to adapt the second plate only to the lingual surface of the first, extending it up from the lower edge to a point corresponding as nearly as possible with the posterior portions of the base of the teeth when the latter are adjusted to the plate (Fig. 109). A moderately thin plate may, in this manner, be used for the primary base, while the duplicate band will impart the requisite strength to the plate, and, at the same time, obviate the necessity of wiring its inner edges. In adopting either of the last-named methods, the plates after they are united to each other, should be again swaged to correct any change of form incident to the use of solder.

Antagonizing Model for an Entire Upper and Lower Denture.—Either of the following methods may be adopted in securing an antagonizing model for complete dentures:

1. Attach to the ridge of each plate a roll or strip of adhesive wax corresponding in width to the length of the teeth which will be required for each plate respectively; place the plates with the wax attached in the mouth, and trim away from the proximate edges of the wax until the two sections close upon each other uniformly throughout the circle; then cut away from the labial surfaces of the rims of wax, above and below, until the proper fulness and required contour of the parts associated with the lips and mouth are secured. The approximation of the two jaws, when the finished substitutes are ultimately adjusted to the mouth, will depend altogether upon the aggregate width given to the two sections of wax at this stage of the operation, and it is, therefore, important that the "bite" or closure of the jaws secured at this time should be such as will most perfectly fulfil the requirements of the case in respect to the utility and comfort of the appliance, and the proper restoration of the required facial proportions. If there is any considerable change produced in the relation of the jaws habitual to them prior to the loss of the natural teeth, the characteristic expression of the individual will, in some degree, be changed or marred; an unaccustomed and restrained action will be imposed upon the muscles concerned in the movements of the lower jaw, which will render the use of the appliances at least temporarily, if not permanently, uncomfortable and fatiguing, or even painful; while the utility of the fixtures may be impaired or wholly destroyed, by compelling a partic-

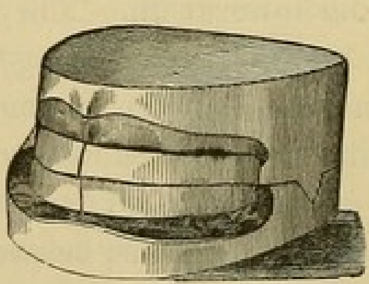
ular application of forces in mastication inconsistent with their stability in the mouth. No specific directions, of course, can be given that will apply to all cases, but it may be observed that, ordinarily, the two sections of wax should be cut away from their approxinating surfaces until the jaws close sufficiently to permit the edges of the lips to rest easily and naturally upon each other when in a relaxed condition, or the upper rim may extend somewhat below the margin of the upper lip, while the lower section of the wax is cut away on a level with the lower lip, or a little below it. Cases occur, however, where a less exposure of the upper portion of wax, even though quite narrow, will be required; as where the alveolar ridge is very deep, and the lip covering it either absolutely or relatively short, or where the latter is retracted, exposing, even when in a state of repose, a greater portion or all of the crowns of the teeth, and in extreme cases the margins of the gum. Between the latter extreme and an inordinate extension of the upper lip below the ridge all intermediate conditions occur, and the practitioner, aiming to produce an agreeable, harmonious, and truthful expression of all the parts, must rely wholly upon his judgment in reference to the necessary approximation of the jaws, the restoration of the natural fulness and contour of the mouth, and the relative length to be given to the upper and lower teeth.

Patients, when requested to close the mouth *naturally*, are very liable to *project* the under jaw; hence it is well to have them open and close the jaws frequently, observing, at the same time, if the separate portions of wax meet in precisely the same manner at each occlusion. If the bite varies at every approximation of the jaws, the patient should be directed to relax and abandon for the moment all control over the muscles of the lower jaw; the operator should then grasp the chin and press the jaw first directly backward and then upward until the opposing surfaces of the wax meet, in which position it should be steadily held by the patient until the two portions of wax are attached to each other in that particular relation. The latter may be done by drawing lines vertically across the rims of wax at various points which will serve to indicate their relation to each other when out of the mouth; or a heated knifeblade may be passed between the two sections, the melted wax temporarily uniting them. A very convenient and secure method is to attach them together by means of two strips of metal bent in the form of a staple; these may be warmed in a spirit-flame, and pressed into the wax, one on each side—one end penetrating the upper rim of wax, the other the lower. Before removing the plates, the mesial line of the mouth should be indicated upon the wax by drawing a line vertically across the latter in front to serve as a guide in the arrangement of the central incisors.

2. Another method is to attach to either the upper or lower plate a single rim of wax somewhat wider than will be required for both the upper and lower teeth. The plates are then placed in the mouth, and the jaws brought together, imbedding the opposite plate in the wax. When this method is adopted, the proper closure of the jaws is best determined by a gauge or guide consisting of a strip of plate or other substance encased in the wax and interposed edgewise between the borders of the two plates in front in such manner that, when the latter are approximated, they will close upon the guide, the desired relation of the jaws to each other having been previously ascertained by trial of the guide with the plates in the mouth before adjusting the wax. The exterior surface of the wax rim is then trimmed away, or additional portions added to it, until the proper fulness and contour are given to the lips; after which the medium line of the mouth should be traced upon the wax in front, as before described.

The plates, attached to each other in either of the ways mentioned, having been removed from the mouth, a batter of plaster may be poured upon a piece of paper or other substance, forming a layer a fourth or a half an inch thick and two or three inches long, when the under surface of the lower plate may be imbedded in one end of the plaster, and the remaining portion of the latter projecting from the heel of the plate trimmed and formed for articulating with the second piece of the antagonizing model in the same manner as described when considering partial dentures. The entrance to the cavity between the two plates is now closed up with a sheet of softened wax or otherwise, and the whole surrounded by a piece of oil-cloth, wax, or other substance, and the second part of the model obtained by pouring plaster in upon the exposed surface of the upper plate and the plaster posteriorly to the depth of half an inch or more. When the plaster is sufficiently condensed, the line across the wax in front should be extended in a direct line across the borders of the plaster model above and below, as, in arranging the teeth, the wax will be cut away, and without this precaution the mesial point of the mouth may be lost. The form of an antagonizing model for an entire upper and

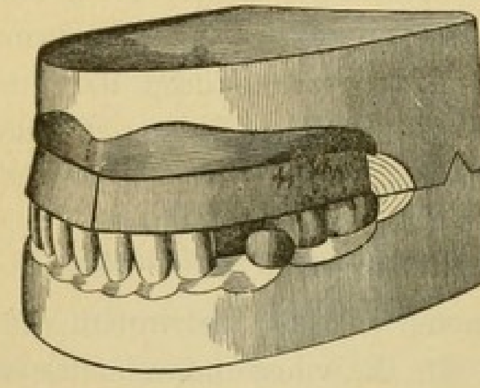
Fig. 110.



lower denture, with the plates and wax attached, the latter being cut away somewhat preparatory to adjusting the teeth, is shown in Fig. 110.

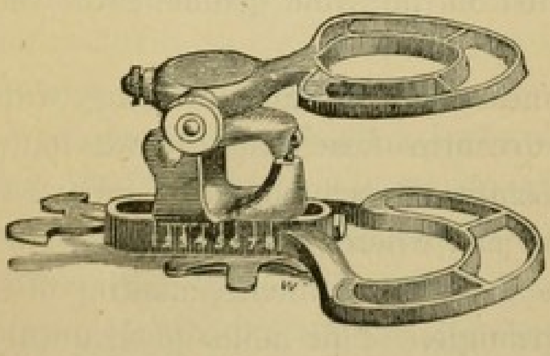
Antagonizing Model for an Entire Upper Denture with the Natural Teeth of the Lower Jaw Remaining.—In forming an antagonizing model to be used as a guide in arranging and articulating a full upper denture where all or a part of the natural organs of the inferior jaw are remaining, a rim of wax should first be adjusted to the borders of the plate, one or two lines wider than the required length of the artificial teeth. When placed in the mouth, the exterior surface of the wax draft should be cut away or added to, until the proper fulness of the parts is restored. The patient should then close the lower teeth against the wax, imbedding them just sufficiently to indicate the cutting edges and grinding surfaces of the opposing teeth. If a fuller impression of the exterior faces of the lower teeth are required, it may be obtained by pressing in a small strip of softened wax against them and the lower edge of the rim of wax upon the plate; or the projecting borders of the latter may be forced down upon the crowns with the fingers. The median line of the mouth is then indicated upon the wax, the plate removed, and its palatal surface imbedded

Fig. 111.



in one end of a layer of plaster spread upon a strip of paper; the portion of plaster extending from the heel of the plate trimmed, grooved, varnished and oiled; the entire piece inclosed, and plaster poured in upon the exposed surfaces of the wax and plaster to the depth of one-fourth or one-half of an inch. The two sections of the model, with the plate and wax

Fig. 112.



attached, the latter being cut away somewhat to receive the porcelain teeth, is exhibited in Fig. 111.

Various *articulators*, or antagonizing frames, have been devised, and may be substituted for the plaster articulator just described. A very excellent adjustable contrivance of the kind, invented by Dr. Hayes, is exhibited in Fig. 112. With this appliance, all the motions of the jaws can be represented, and the relative positions again brought back at pleasure at the starting-point. The screw hinge admits lateral motion. The set screw on the side plays into a slot, securing one central position, to which it can at all times, when desired, be brought back. The long screw in the foot produces back and forward motion, the main hinge up and down motion, and the large nut on the bottom renders all the parts taut and unyielding.

Considerable space is here devoted to the consideration of an ingenious and novel device, introduced to the notice of the profession by Dr. W. G. A. Bonwill, of Philadelphia, Pa., and characterized by him as the

"*Anatomical Articulator.*"

As to the character of this instrument, the author cannot speak personally. Dr. B., whose name is inseparably connected with the electric mallet, dental engine, original methods of attaching pivot crowns described elsewhere, and various other practical devices, says that it holds the same positive relation or position in his laboratory as do the electric mallet and engine in his operating room. In other words, it is indispensable to the perfect articulation of all artificial dentures from one to a full set,—that it is a *sine qua non*. He says:

"It is modelled on the same geometrical system as the human jaw.

"I found by measurement that the average width of the lower jaw from centre to centre of each condyle was four (4) inches, and from the same centre of each condyloid process to the median line of the lower jaw, where the cutting edges of the lower incisors meet, was also four (4) inches, making of the human jaw an equilateral triangle. This holds good in all jaws, and the difference of a quarter of an inch in this radius of a circle of four inches would make but little practical difference as to the results.

"This beautiful law enables us to have the fullest benefit of mastication at the least expense of power and motion in the arc of the circle of four inches as a radius.

"This being an absolute law, I have so made this articulator, and the cast of every case is set therein with the median line at the lower centrals just four (4) inches, by the dividers, from each condyloid process. If an unusually large jaw, then the cast is put a very little distance further out.

"For all full sets, the articulation is so perfect, as made in this, in the laboratory, as to need but a trifling touch in fitting in the mouth.

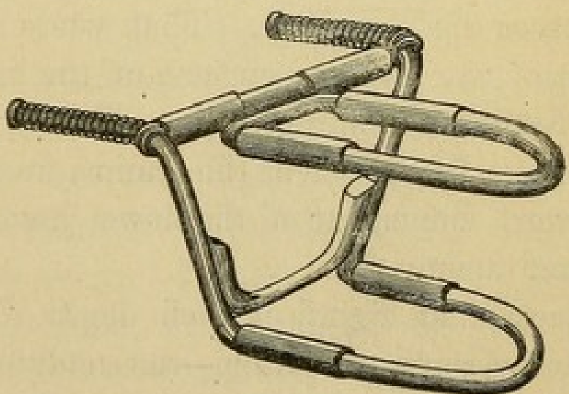
"I found that there is a further positive law in the mechanism of the human jaw that should be regarded in every substitute made therefor, and, that is, just in proportion to the depth of overbite of the centrals, there is a curvature from the mesial surface of the first molars back, through the other molars, up the ramus. That this curvature upwards and backwards at the ramus is due solely to the depth of closure of the upper over the lower jaw. That where there is occlusion or closing of the cutting surfaces of the incisors directly upon each other, then a straight line, directly backwards, is the consequence. If curved at the ramus, in such a case, no lateral or forward movement of the lower jaw could occur,—only the up and down.

"Where there is an eighth of inch depth of bite, then, as you go back to the centre of motion—the condyloid processes—the cusps in the bicuspids and molars grow less deep, and the curvature at the ramus is an eighth of an inch out of line.

"When there is an overbite of an eighth of an inch, then, in opening the lower jaw and carrying it forward to use the incisors for cutting, the back teeth of lower jaw are brought forward; and, as the second molar is higher out of line than the first molar, it comes in contact with the distal surface of the first superior molar, which begins just here to curve upward, and is the highest out of line in the superior jaw, and they meet at same time that the incisors do. And the same law holds good when the lower jaw is turned to the right or left, the molars are brought in contact to equalize the force which would be brought upon the incisors only. Besides, the recognizing of this law enables the cusps or palatal and lingual sides of the molars of both jaws to be utilized in every position the lower jaw may take in mastication. Upon this plan I make all my artificial dentures, most of their articulating surfaces being utilized at every position of the lower jaw. Any human jaw will show this system, which by this system can be made just as complete, and more so, in many cases, than the normal, or such as is found in advanced civilization.

"When a set is commenced in this articulator with the upper overbiting the lower an eighth of an inch, as you set each tooth backward towards the condyloid processes, they will assume the exact angle and depth of cusps, as well as the curvature at the ramus, as found in nature. If both jaws are in

FIG. 113.

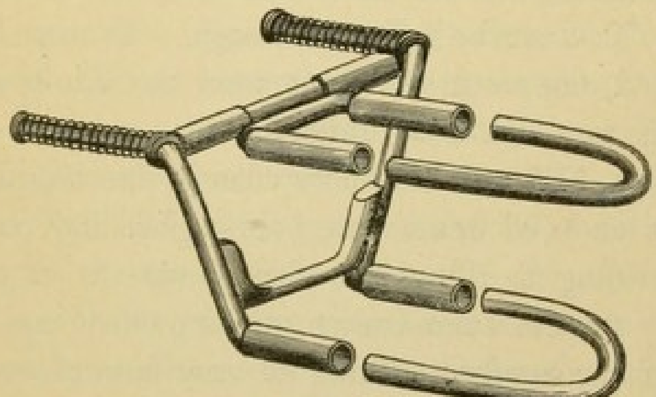


direct apposition at the incisors, then all of the teeth must of necessity be on a perfect plane, or but one would touch when in lateral position.

"With this one base, which Fig. 114 shows, there is a separate bow to each part of base, one for upper and one for lower jaw, which can be removed as soon as the plaster in one case is allowed to harden on the rim. This can be marked and laid away for a year if necessary, and then articulated. A pair of bows can be used for as many separate cases, while only one base is required, which should be made absolutely and geometrically exact—approximately so.

"There is no need for set screws to hold the bows, as they go up just so far and remain so. Nor is there any set screw and prop to hold the jaws or casts apart. This is regulated on the bite in wax, which, before it is taken off the base plate, has the exact height marked by a pair of dividers on the plaster at the median line, measuring from the cutting edge of wax, and then when the first central or block is set, there is no longer any call for a prop to keep open the jaws of the articulator. When this height is taken with the dividers, it is marked on the top of each cast for future reference. It would interfere with the lateral movement if a rigid prop were there. The dividers make each case exact without a scale for measurement.

Fig. 114.



"Articulate the upper set first, and retain on the lower base the wax for length and fulness. When the upper are all on, then the lower incisors are gauged as to the height or length by the dividers while the wax is still on the base plate and taken from the height marked on the lower cast for reference.

"Make the lateral movement as soon as the first tooth or block is in position where the case is an upper one with a good lower jaw of natural teeth.

"When a full set, the upper are first ground on and shaped so as to meet the intended overbite, and when the lower set are ground on, the upper can be changed to suit the lower, so as to allow the whole of every cusp to touch at nearly every lateral movement of jaw.

"When the plaster case is to be set in the articulator, it must be done with the dividers set just four (4) inches, with one point at the median line as formed by the lower incisors, and the other carried over to each condyloid process as marked on the articulator. This makes the centre of jaw equidistant from the condyles. The study of this principle will make one fully realize the beautiful workings of Divinity, which is only governed by positive law in every department of the universe. With this plan, understand one will never again attempt to articulate a set of teeth on the unwritten law, as now universally made and recognized by every dentist in the land.

"Until this system is taught in the schools, and by private practitioners, no truly artistic and fully natural set of teeth can ever be made, for we have been without law in this department. To describe it is not enough. It must be seen and demonstrated, one tooth at a time, until the whole set is made. Only in this way can it be understood.

"The Figs. 113 and 114 show clearly the simple construction. It is made of brass wire (one-eighth inch in diameter), and brass tubing to allow the size of wire to fit closely, and move freely therein when drawn out or pushed up. The spiral spring on either condyle allows of easy lateral motion to the lower part, and from exactly the same standpoint as in nature; that is, one of the lower condyles moves forward in the glenoid cavity while the other remains still. Every part of it is rigid except the movement at the condyles, and the joints or bows are only temporarily so. There is also an up and down motion made at the condyles by raising bow up or down.

"No case, when once fixed in it, can become disarranged. If the bite in the wax is not correct, *no articulator can make it so.* You must go back again to the mouth, and retake it, which is easily done at first by asking the patient to swallow, when the jaws will automatically close and assume their normal position. If now correct, there is never any necessity for a screw to change it when once in this articulator.

"There can be no excuse for failure or unartistic work when this instrument is once understood, and the law controlling the human jaw. As we may forever have to resort to artificial dentures, we should demand of the colleges that such an instrument be used, and it alone, as furnishing the only hope now offered of an approach to high-toned, artistic, mechanical dentistry. Until we can be taught to appreciate that law is the governor of the universe, and applicable in every branch of dentistry, we are false men, and will set 'false teeth,' and never realize our high destiny."

Selecting, Arranging, and Antagonizing the Teeth; Rimming the Plate; Attaching Spiral Springs; Investing, Lining, Soldering, and Finishing.—In *selecting* teeth for an entire upper and lower denture, the special requirements in respect to size, form, and color, will depend, in a great measure, upon the complexion, age, sex, general configuration of the face, etc., of the patient. Every separate denture, therefore, that is constructed in strict conformity with a faithful interpretation of the special requirements of each individual case, will be characterized by shades of differences in the color, form, size, and arrangement of the teeth of replacement. It will be sufficient in this connection to observe that such selection of the teeth should be made as will most perfectly reproduce the lost proportions of the facial contour, and impart to the individual a natural, harmonious, and agreeable expression.

In *arranging* or adjusting single gum teeth to the plate in those cases where the changes in the form of the alveolar ridge consequent on absorption, are completed, the portions applied to the base should be ground away sufficiently to restore the required fulness of the parts and to give proper length and inclination to the teeth. The coaptation of the ground surfaces to the base should be accurate enough to exclude perfectly particles of food, and to furnish such a basis to each tooth as will provide most effectually against fracture when acted upon by the forces applied to them in the mouth. The gum extremities of the teeth should also be accurately united to each other laterally by grinding carefully from their proximate edges until the joints or seams will be rendered incapable of ready detection in the mouth, care being taken that this coaptation of the adjoining surfaces is uniform, for if confined to the outer edge alone, portions of the gum enamel may be broken away in the process of soldering.

In the construction of substitutes designed to fulfil only a temporary purpose, and where the alveolar processes remain in a great measure unabsorbed, and plain teeth (those representing but the crowns of the natural organs) are used, but little skill will ordinarily be required in adjusting and fitting them to the base. If the ridge in front is prominent and but inadequately concealed by the lip, as where the teeth have been but recently extracted, all those portions of the border of the plate in front, anterior to the first or second bicuspid on each side, may be cut away on a line a little within the required circle of the anterior teeth, and scolloped (Fig. 115), permitting the anterior cervical portions of the artificial incisors and canines, and, in some cases, the anterior bicuspids, to overlap the edge of the plate and rest directly upon the gum in front. This abridgment of the plate will not ordinarily materially affect the adhesion or stability of the substitute.

There are cases of a mixed character that render it more difficult to effect a harmonious and symmetrical arrangement of the teeth, as where a limited number of the natural teeth at intervals have been long absent and the excavations in the ridge consequent on absorption alternate with other points upon the ridge in a comparatively unchanged condition. To give uniformity to the denture by restoring perfectly the required circle of the arch in such cases will necessitate the employment of plain and single gum teeth conjointly. Whenever necessary, those portions of the base occupied by the plate teeth may be cut away in such a manner as to permit the latter to be adjusted directly to the unabsorbed gum as before described.

In the process of grinding the teeth to the base, above and below, the operator should commence by first arranging the superior central incisors and then the lower, and so passing back from tooth to tooth, grind and adjust an upper and lower tooth alternately, keeping the upper ones in advance of those of the lower jaw. The central incisors above, should be placed parallel with each other, but the cutting edges of the laterals, and the points of the canines, should incline slightly toward the medium line of the mouth. In arranging the teeth of the upper jaw, the anterior six may be made to describe, with more or less exactness, the segment of a circle, but a somewhat abrupt angle may be given to the arch on each side by placing the first bicuspid within the circle in such a way that, when standing directly in front of the patient and looking into the mouth, only a narrow line of the exterior face of the crowns of these teeth will be seen, while the remaining teeth posterior to them, should be arranged nearly on a straight line, diverging as they pass backward. When arranged in the manner de-

FIG. 115.

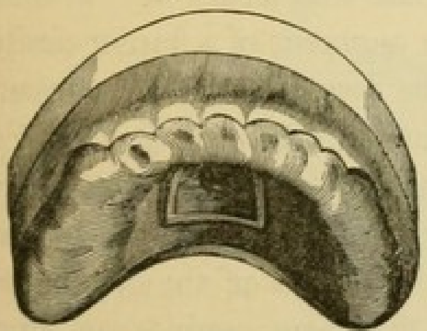
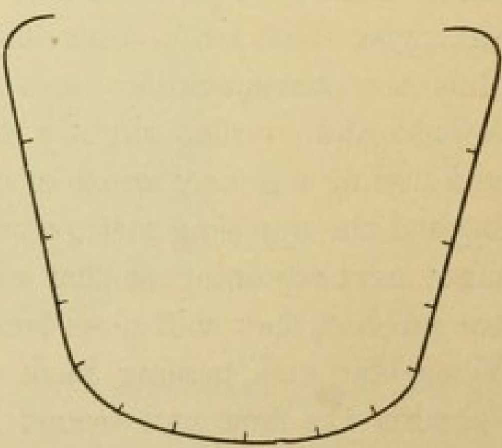


FIG. 116.



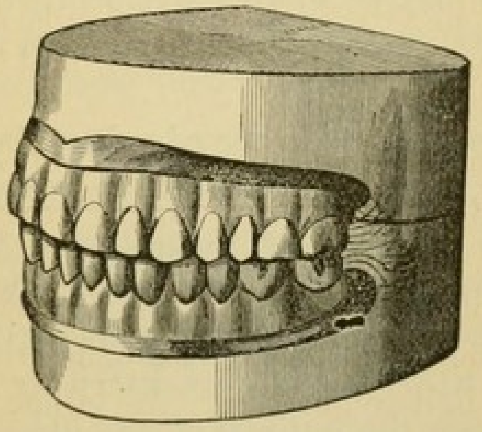
scribed, the peripheral outline of the arch will exhibit somewhat the form presented in the above diagram (Fig. 116).

In regard to the practical efficiency of an upper denture retained in the mouth by atmospheric pressure, it is important that the teeth engaged in the comminution of food, as the bicuspids and molars, should occupy a position directly over the central line of the ridge, and should either be arranged vertically or with a slight inclination toward the centre of the mouth. The liability to displacement of the substitute in mastication will thus be greatly diminished, whereas, if placed outside of the line indicated, and especially with a diverging inclination, the stability of the appliance will be endangered, and the functions of mastication impeded, notwithstanding other conditions necessary to complete success have been fully secured. In arranging the upper and posterior teeth as described, it will sometimes be necessary to give to the opposing under teeth a decided inward inclination in order to effect a satisfactory antagonism of the teeth; and cases occur where a practical articulation cannot be secured without departing in some degree, from the arrangement of the upper teeth spoken of,—as where a great disparity exists between the posterior transverse diameters of the two jaws, a medium-sized, or even small, arch above being associated with an expanded ridge below.

In articulating the upper and lower teeth, the closure or relation of the natural organs should be imitated as nearly as the other essential requirements of the case will admit of. Hence the upper front teeth, describing the segment of a larger circle than the corresponding teeth of the lower jaw, will project beyond and overlap slightly the cutting edges of the latter; and having a greater width of crown, they will extend laterally beyond the opposing teeth, covering one-third of the crowns of those next adjoining, so that when the canines of the upper jaw are reached, they will close between the lower canines and first bicuspids; and, passing back, the anterior superior bicuspids between the first and second bicuspids below; the posterior bicuspids above between the second inferior bicuspids and anterior molars; the first superior molars between the first and second molars below; while the anterior half of the posterior molars above will close upon the posterior half of the inferior second molars, the remaining posterior half of the second molars above extending posteriorly beyond those of the lower jaw. The outer cusps of the superior bicuspids and molars will overlap those of the inferior teeth; while the inner cusps of the teeth of the superior jaw will pass into the depressions in the lower teeth formed by the internal and external cusps, and the external cusps of the inferior teeth will, in like manner, be received into the corresponding excavations of the upper teeth. The relative position and antagonism of the teeth, as they appear in a regularly arranged denture for both jaws, are shown in Fig. 117. An abnormal relation of the jaws, as where undue projection, absolutely or relatively, of either maxilla exists, or where the lower jaw closes on one side or other of the upper, will frequently compel a departure from the ordinary arrangement of the artificial organs, the extent of which must be determined by the necessities of each individual case.

In selecting teeth for a full upper denture in those cases where natural teeth are remaining below, or *vice versa,* the color, size, and form of the latter, will serve as a guide in the

FIG. 117.



choice of teeth appropriate for the opposite jaw. In fitting and arranging the teeth upon the base, and in antagonizing them with the opposing natural teeth, the same general principles apply as those already adverted to in connection with full upper and lower dentures.

Having adjusted the teeth to the base, they should be placed in the mouth, before uniting them permanently to the plate, to detect and remedy any error of arrangement either in respect to prominence, position, inclination, length, or antagonism.

Forming a Rim to the Plate.—If the case is one where single gum or block teeth are employed, and it is intended to form a socket or groove upon the borders of the plate for the reception of the plate extremities of the teeth, the rim forming the groove should be fitted and soldered to the base before investing the piece in plaster. If the alveolar ridge above is shallow, and but imperfectly concealed by the lip, a rim to the plate will be inadmissible, as, when the mouth is opened and the lip retracted, as in laughing, the metallic band will be exposed to view. A rim may be fitted and attached to the base in either of the following ways:

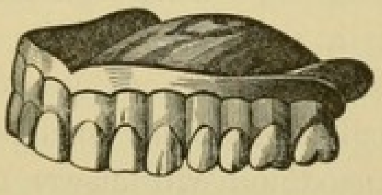
1. A strip of plate from one to two lines in width is adjusted to the plate, with one edge resting on the uncovered border of the plate close to the gum extremities of the teeth, and the other overlapping and embracing the latter. The rim may consist of one entire strip extending from heel to heel of the plate, and passing round the posterior molars to unite with the stays; but it may be more conveniently adjusted by employing two pieces, extending from each heel of the plate, and uniting in front.

2. A half-round wire with the edge bevelled where it joins the ends of the teeth, forming a narrow groove, may, in like manner, be fitted to the plate, furnishing a shallow bed for the gum extremities of the teeth. A narrow strip of plate, about the thickness of a heavy clasp material, may be substituted for the half-round wire. In either case, the better plan is first to trace the outlines of the gum portions of the teeth upon the plate with a sharp instrument; remove the wax and teeth from the plate; draw another line a little within the first all round, and solder the rim to the line last drawn; remove the teeth from the wax, and readjust the latter in its proper place upon the plate; then fit each tooth separately to the rim by grinding away sufficiently from the end of the tooth to effect an acurate adjustment of it to the socket. The ends of the teeth may be ground away to the rim until the platinum pins freely re-enter the rivet-holes in the wax, thus restoring them to their proper position in relation to the base.

3. Another method of forming a rim consists in swaging a strip of plate accurately to the form of the parts to which it is applied. An impression in wax or plaster is first taken of the gum surfaces of the teeth and exposed border of the plate; but as it will be impossible to detach either wax or plaster in per-

fect condition, when encircling the entire arch, or to swage perfectly with a die so unfavorably formed for stamping, separate impressions of the two lateral halves of the piece should be taken,—from these plaster models; and from the latter, dies and counters;—with these, two strips of plate of sufficient width are swaged, each extending from the heel of the plate to a little beyond the median line in front, overlapping slightly at the latter point. The portions of the swaged strips embracing the plate ends of the teeth are then trimmed to the proper width, and scalloped, if desired, in correspondence with the festoons of the artificial gums. An upper denture rimmed in the manner last described is exhibited in Fig. 118. In whatever way the rim is formed, when it has been fitted to the plate and teeth, it may be held temporarily in place with clamps adjusted at two or three points around the plate, and then

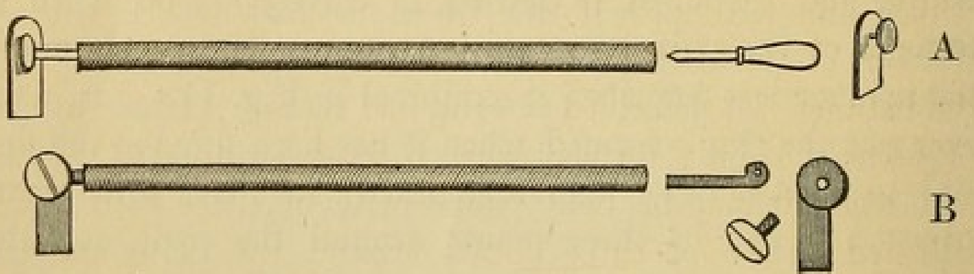
Fig. 118.



transferred to a piece of charcoal, and secured by first tacking it at two or three points with solder. The groove may then be filled with whiting, mixed with water or alcohol, to prevent the solder from flowing in and filling it up; after which small pieces of solder are placed along the line of union next the edge of the plate, and the rim permanently united throughout with the blowpipe; after which the wax and teeth are reapplied to the plate.

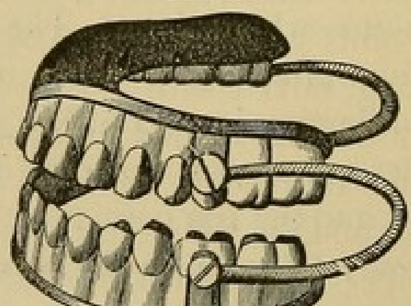
Constructing and Attaching Spiral Springs.—The success which has been attained in the use of atmospheric pressure plates has almost entirely superseded the necessity of employing spiral springs as a means of support; nor should the latter be resorted to except under circumstances that preclude the use of the former. When applied, they should be attached to the base on each side between the posterior bicuspid and first molar below, and opposite the posterior bicuspid above. To the border of the plate near the base of the teeth a narrow strip of plate is soldered, extending up and lying closely against the side of the latter—to the end of which near the grinding surfaces of the teeth is adjusted a small circular cap of gold connected with the standard by a small wire on which the looped extremity of the spring plays. To each end of the spring is

FIG. 119.



attached a gold wire, doubled upon itself in such a way as to form a loop, the closed ends being soldered together and filed to enter the hollow in the wire, A, Fig. 119. B, Fig. 119, copied from Professor Harris's work on dental surgery, represents another method of attaching springs, but the former is more readily constructed and will answer every practical pur-

FIG. 120.



pose. Fig. 120, exhibits the application of springs to an upper and lower denture.

Investing, Lining, Soldering and Finishing the Plate.—The plate, with the wax and teeth in place, is next encased in a mixture of plaster preparatory to lining the teeth and uniting them with solder to the base. For this purpose, plaster and sand may be employed, using as little of the former as will serve to hold the investment together during the subsequent manipulations. Asbestos may be added, and is a useful ingredient. Burnt plaster, or that which has been previously used for investing, may be substituted for the sand and asbestos, adding a sufficient quantity of unused plaster to effect consolidation. Either of the combinations mentioned will suffer but little change in the fire, if properly managed. It is customary to incase the piece in the plaster mixture to the depth of from one-half to three-fourths of an inch, leaving only the lingual surfaces of the plate and teeth uncovered. However comparatively free from change of form the best combinations of plaster may be, yet some slight contraction of the body of the investient doubtless ensues on the application of heat, and it is probable that so large and resistant a mass must tend, in some degree, to produce deformity of the plate in soldering; for, as the investient contracts and the plate at the same time expands when heated, a change in the form of the latter must occur whenever the force exerted by the shrinking plaster exceeds the expansive force of the metal; and when the peculiar form of the upper plate is considered we can readily conceive how a slight contraction of the plaster of the thickness mentioned may "warp" or "spring" the plate when its uniform linear expansion and contraction is so effectively opposed. The change in the form of the base from this cause will, according to the author's observations, be found, in an upper plate, to exist on each side of the sloping walls of the palate, embracing the posterior half or two-thirds of the plate at these two points,—the change manifesting itself in an inward displacement of the lateral walls of the plate midway between the summit of the palatal arch and the most depending portion of the ridge. We would suggest in explanation of this result that, as the plaster contracts with sufficient force to carry the plate with it, the sides of the latter are approximated, while the palatal portion is, at the same time lifted up. Now it seems plain that inasmuch as the portions of plate overlapping the ridge is incased in and embraced by the plaster, and as the palatal portion is arched in form with its convexity presenting to the plaster and therefore self-sustaining in respect to its own peculiar form, the special configuration of these parts cannot suffer any appreciable change; but as they are forced toward the common centre of the mass, their *relation* to each other is also changed, and this changed relation must necessarily eventuate in a deformity of those parts of the plate which offer the least resistance to the contractile force of the plaster. In obedience to this necessity, the sides of the plate along the sloping walls of the palate, which from their form are neither resistant nor self-sustaining under pressure, and whose inward displacement is unopposed by any counter-force, is projected in toward the centre of the palatal excavation in proportion as the borders and central portions are approximated or converged in the direction of the centre of the piece. The practical effect of this approximation of the lateral and posterior borders, and internal displacement of the plate, is to make the latter "bind" upon the outer and posterior borders of the alveolar ridge, and to throw the central portion of the plate from the roof of the mouth. To obviate, as far as practicable, any change in the form of the plate which may result from the contraction of the plaster investient, various expedients have been suggested, but the following will sufficiently counteract the influence of the plaster by permitting an unobstructed expansion and contraction of the metallic base. Take a band of tolerably thick copper plate as wide as the plate and teeth are deep; bend it to the form of the plate, but large enough to leave a space of nearly half an inch between it and the teeth, the ends being united to each other back of the plate by riveting or otherwise. Holes are then made in the band at numerous points throughout its extent, through which wire is introduced and interlaced on the inside in such a way as to form loops, the latter extending in to within a short distance of the teeth. The plaster is then filled into the space between the band and teeth even with the cutting and grinding surfaces of the latter; the palatal surface of the plate is also covered with plaster and may be connected with the outer portion by a very thin layer at the edge of the plate, or the two may be entirely disconnected. The expansion of copper being very nearly that of gold, the body of the plaster, when heat is applied, will be carried in advance of the borders of the plate as the latter expands, while the thin portion of plaster at the edges of the plate will allow the central portion of the latter to expand with but little or no interruption. On cooling, the entire mass will contract together and assume its original form, unless warping is induced by other agencies acting independently of the enveloping plaster, as excess or unequal distribution of solder, irregular heating, etc.

It is not, ordinarily, necessary to provide by any special expedient against warping of the lower plate, as any slight change of form consequent on contraction will not materially affect its adaptation to the lower jaw,—its only effect being to impart to the substitute a slight lateral play upon the ridge. The plaster on the inside of the lower piece may be cut away to the edge of the plate, while that external to the teeth should not be added in greater quantities than is barely sufficient to hold the latter in place whilst lining and soldering them to the base.

The plate being properly invested, all portions of the wax attached to the inner surface of the teeth and plate should be thoroughly removed with suitable instruments; after which stays are to be adjusted to the teeth. In reference to the method of forming and adjusting stays, little need be added to what has already been said when treating of partial dentures. One method, not there specified, consists in first fitting to each tooth separately, in the usual manner, a thin stay formed of platinum, which is temporarily fastened to the tooth by splitting and spreading apart the ends of the rivets with a small chisel-shaped instrument. The teeth are then removed from the investient and partially imbedded side by side in plaster, the platinum strips remaining uncovered. The plaster and teeth may then be raised to a full red heat with a blowpipe or by placing them in the furnace. Small pieces of gold plate, of equal fineness with the base, are then placed upon the surfaces of the platinum stays and thoroughly fused with the blowpipe until they flow perfectly in around the rivets, and uniformly over the surface of the linings. If sufficient heat is applied, the solder will insinuate itself between the stay and tooth, and thus render the coaptation of the two perfect. Small pieces of gold plate should be added until sufficient thickness is imparted to the linings. The backings are then trimmed smoothly and burnished, when they may be placed back in the investient in their appropriate places. The linings which support the teeth may be united to each other laterally in sections or continuously. When the teeth are joined to each other throughout, a very small quantity of solder will be sufficient to support the teeth, provided it is well diffused along the joints uniting them perfectly at all points.

The process of preparatory heating, soldering, pickling, and finishing the plate, is the same in all respects as that described when treating of partial pieces, and need not, therefore, be recapitulated.

In the final adjustment of the finished piece to the mouth, and after any additional grinding of the masticating surfaces of the teeth necessary to perfect the antagonism has been performed, such instructions should be given to the patient in regard to the care and management of the appliances as will best promote their immediate and successful use. The wearer should be impressed with the absolute necessity of early and prompt attention to any injuries inflicted upon the soft tissues of the mouth by the substitutes, as much future trouble and annoyance, if not permanent mutilation of the parts, may result from neglect, but which may be readily averted, in most instances, by a timely removal of the sources of injury. To obviate, in some measure, the tendency to displacement of the base, which usually accompanies the first use of artificial teeth, and especially the upper denture, the patient may be directed, when dividing food with the front teeth, to press the substance backward and upward against the cutting edges of the superior incisors at the same time that the opposing teeth are closed upon each other, thus dividing completely the substance seized. In reference to the mastication of food, it has been suggested to instruct the patient to distribute, by the action of the tongue, the portions of food as equally as possible on each side of the mouth, in this manner distributing the forces applied, and thereby lessening the chances of lateral displacement of the substitute.

CHAPTER XII.

Porcelain Teeth—Carved Block-Teeth.

PORCELAIN TEETH.

The perfection and completeness of results attained at this day in the production of porcelain teeth, approximating so nearly the natural organs in all their more obvious, physical, and distinctive characteristics as to be almost, if not quite, undistinguishable from the latter when applied in obedience to the æsthetic requirements of individual cases, is one of the marvels of ceramic art. Nowhere, perhaps, have the conceptions of genius been embodied in porcelain with more truthfulness or greater fidelity to nature than in the exquisite and wonderful imitations of the dental manufacturing laboratory.

So amply and satisfactorily has the intelligent, progressive, and well-directed enterprise of manufacturers provided for all the ordinary needs of prosthetic practice in the almost endless variety in size, color, configuration, relation, and adaptability of single and sectional teeth, that the work of hand-carving is now rarely demanded of the general practitioner except in extreme cases resulting either from accident or disease. Thus, as aptly remarked by the late Professor Austen, "The depot not only renders service by the superior excellence of the surgical instruments and prosthetic materials which it supplies, but it directly benefits the science and art of dentistry by releasing the practitioner from manufacturing toil, and giving time for the acquirement of increased knowledge and skill. Thus, if the time heretofore given to block-making were devoted to the study of dental æsthetics, patients would have the benefit of an artistic selection from a far larger variety of porcelain dentures than could otherwise be possibly made."

As affording some curious as well as practical information in regard to the composition and manufacture of porcelain teeth, the following descriptions will be found of interest:

Components of Dental Porcelain.—Manufactured single and sectional mineral teeth, carved block-teeth, continuous-gum material, etc., are composed of two distinct portions,—the *body* or *base,* and *enamel.* The chief mineral substances which compose the body, are, *silex, felspar,* and *kaolin.* The enamel, both crown and gum, consists principally of *felspar.*

The various tints or shades of color are imparted to the porcelain by certain metals in a state of minute division or their oxides. The more general properties of the mineral ingredients will be first described.

Silex.—Silex, silica, or silicic acid, is a white powder, inodorous, and insipid. It forms the chief part of many familiar mineral formations, as quartz, rock crystal, flint, agate, calcedon, and most sands and sandstones, in some of which it occurs nearly pure. Silica, in its pure state, is insoluble in water or acids, and is infusible in the highest heat of the furnace; it melts, however, in the flame of the oxyhydrogen blowpipe, passing into a transparent colorless glass. Its specific gravity is 2.66; and it is composed of silicon, 48.04, and oxygen, 51.96. Only the purest varieties of silex are employed in the manufacture of porcelain teeth. It is prepared for use by subjecting it to a white heat and then plunging it into cold water, after which it is ground to a very fine powder in a mortar.

Felspar.—This mineral substance occurs crystallized in oblique rhomboidal prisms, and is a constant ingredient of granite, trachyte, porphyry, and many of the volcanic rocks. The felspathic mineral formations present either a pearly or vitreous lustre, and vary in color, being red, green, gray, yellow, brown, flesh-colored, pure white, milky, transparent, or translucent. Felspar yields no water when calcined; melts at the blowpipe into a white enamel, and is unaffected by acids. It is composed, according to Rose, of silica, 66.75; alumina, 17.50; potash, 12; lime, 1.25; oxide of iron, 0.75. It is found in various localities throughout the United States, the purest and whitest kinds being employed in the manufacture of mineral teeth. It is prepared for use in the same manner as silex.

Felspar, from its ready fusibility, serves to agglutinate the particles of the more refractory ingredients, silex and kaolin; and when diffused throughout the mass imparts to the porcelain a semi-translucent appearance.

Kaolin.—Kaolin, or decomposed felspar, is a fine white variety of clay, and is composed chiefly of silica and alumina, the latter being the characteristic ingredient of common clay. It is found in various localities throughout the Eastern States, and in parts of Asia and Europe. Kaolin is refractory or fireproof, but is rendered more or less fusible by the contaminations of iron and lime with which it is usually combined. The opaque and lifeless appearance characteristic of the earlier manufacture of mineral teeth was due to the introduction of a relatively large proportion of this clay into the body of the porcelain. The peculiar translucent and lifelike expression which distinguishes the beautiful imitations of the present day, is due, in great part, to the comparatively small proportion of kaolin clay, and an increased amount of the more fusible and vitreous component, felspar.

Kaolin is prepared for use by washing it in clean water; the coarser particles having settled to the bottom, the water holding the finer ones in solution is poured off, and when the suspended clay is deposited at the bottom of the vessel, the water is again poured off, and the remaining kaolin dried in the sun.

Coloring Materials.—The following metals and oxides are employed in coloring mineral teeth; titanium, platina sponge and oxide of gold being those chiefly used in producing the more positive tints, and by combining which in varying proportions, any desired shade of color may be obtained.

Metals and Oxides.	Colors produced.
Gold in a state of minute division,	Rose red.
Oxide of gold,	Bright rose red.
Platina sponge and filings,	Grayish-blue.
Oxide of titanium,	Bright yellow.
Purple of Cassius,	Rose purple.
Oxide of uranium,	Greenish-yellow.
Oxide of manganese,	Purple.
Oxide of cobalt,	Bright blue.
Oxide of silver,	Lemon yellow.
Oxide of zinc,	Lemon yellow.

As the preparation of most of the above colors requires great care, and a somewhat intimate knowledge of chemistry, and as the most delicate manipulations are necessary to secure accurate and satisfactory results, it is better for the mechanical operator to procure the coloring ingredients already prepared from some competent chemist, rather than attempt their production himself. For a particular description of the various modes of preparing them, the reader is referred to Piggot's *Dental Chemistry and Metallurgy*, and other works treating fully of the subject.

Manufacture of Porcelain Teeth.—The subjoined account of the processes concerned in the manufacture of porcelain teeth is descriptive of those at present employed in the manufactory of the late S. S. White, and which, in the main, are doubtless the same as those of other leading establishments.

The felspar is first *calcined* by throwing it in large masses into a furnace, and subjecting it to a red heat and then plunging it into water, which renders it brittle and easily broken by the hammer into small pieces, so that all foreign matters, such as mica or iron, with which it may be mixed, can be separated. It is then crushed between flint stones, and when fine enough is afterwards ground under water in a mill in which heavy blocks of French burr stone revolve upon a nether millstone of the same material, until sufficiently pulverized, when it is floated off and allowed to settle. After this the water is drawn off or evaporated, and the deposit of spar dried and sifted.

The silex is subjected to the same treatment.

The kaolin, already of the desired consistence as found in nature, is prepared for use by first washing out impurities, and then drying.

The mineral ingredients are ground somewhat coarsely, but the coloring materials are reduced to an impalpable powder by means of a mortar and pestle machine of great power.

When properly prepared, the several materials are combined in suitable proportions to form the body and enamels, and are then mixed with water, and worked into masses of the required consistence for moulding. The degree of plasticity of the body and enamel pastes differ with the methods of manufacture. Formerly, the teeth, when moulded, were first exposed to a heat just sufficient to produce partial baking of the body, and this was called cruising or *biscuiting*, after which a thin paste of enamel material was applied with a camel's-hair brush, and the whole subjected to a second heat for complete and final fusion. This preliminary process of biscuiting is essential in carved block and continuous gum work, but in the S. S. White factory, and probably others, this partial baking is dispensed with, and the body and enamel pastes of the uniform consistency of putty are introduced into the moulds in the first instance, properly distributed, and final fusion effected by a single exposure to heat.

The moulds are made of brass and are in two sections, one-half of the tooth being represented on either side. The exact form of the tooth or teeth is carved out with great care and precision, and must be anatomically correct and mechanically perfect, while the matrix is made about one-fifth larger than the required size to compensate for shrinkage of the materials in baking. Holes are drilled in each half of the mould to receive the platinum pins, and the exact closure of the two pieces of the mould secured by guiding pins.

The moulds having been previously greased, and the platinum pins, which vary in length and thickness to meet special requirements, placed with small tweezers in the holes provided for them, the crown and gum enamels are first carefully laid in with small steel spatulas in the required quantity and position. The body is then added, in quantity exceeding somewhat the capacity of the mould, when the sections of the mould are closed upon each other and subjected to a pressure sufficient to insure compactness of the inclosed mass. When thoroughly dried by a slow heat, to which the moulds are exposed, the teeth are readily disengaged when the matrix is separated, and will be found at this stage extremely friable and tender, requiring great care in handling them.

They are then sent from the moulding to the trimmer's room, where, after critical inspection, all defective ones are either repaired or condemned, all excess of material filed smoothly away, and the arch of the gum over each tooth made true and smooth with fine pointed instruments. They are then placed on beds of coarse quartz sand, on fire-clay trays or slides ready for the furnace.

Referring to this stage in the process of manufacture, an intelligent observer writes:

"Beyond this, no tool can follow them. Imperfections heretofore could be repaired, but in the future, beyond the fire, the tooth is either perfect or a failure irremediable. The furnace is an institution entitled to respect for its intensity. In its centre is a muffle of fire-clay, entirely surrounded by the glowing fuel, a charge of half a ton's weight of coal, itself carefully bricked up before firing, that no impurities of dust or vapor shall reach the teeth. Take out the small half-oval door of the muffle and you will see an inner glow the eye shrinks from registering, an incandescence that startles you by its fervor. In from fifteen to thirty minutes, teeth and fire-clay slide, glowing like the oven, are taken out done and finished. The dull enamel has become as glass. The lustreless oxides have yielded their color, and the tooth that went in friable and brittle has come out adamant. But there is an intermediate skill, the acquisition of which is one of the marvels of the mechanic arts. A little too long in that heat and the teeth are ruined, and the evils of '*underdone*' are equally to be guarded against as in the housekeeper's baking. It is a trained judgment, a skill of eye and handling that enables the burner to lend success to the work of those who have gone before him, and at the precise point where a shade of failure is utter ruin.

"The teeth are now done and ready for the curious, characteristic red wax cards, on which they go to the trade."

We cannot close this account of the composition and manufacture of porcelain teeth more appropriately than by quoting from an excellent popular treatise, entitled *The Teeth*, by Dr. J. W. White, the present accomplished editor of the *Dental Cosmos:*

"If it is true of any pursuit, it is emphatically true of the attempt to imitate natural dentures, that 'the beauty of the result well repays the highest exercise of art.' The manufacturer should furnish teeth in accordance with nature's types, and each tooth in a set should harmonize with the rest; for though each may be an exact representation of a natural tooth, the general effect is spoiled unless they are, in all their distinguishing features, of the same family or class of teeth. No two teeth in a natural set are alike; every one has its distinctive contour, and besides possessing individuality, indicates the character of the adjoining teeth. In an artificial set, unless these distinctive differences and resemblances have been faithfully studied and copied, their artificial character is apparent.

"The observant dentist will take into the account complexion, age, sex, height, the color of hair and eyes, and other characteristics of the individual when selecting teeth to replace lost ones; and the manufacturer should be skilled in the observance of the varied classes of dentures required. To inattention in this direction on the part of the dentist, or to dictation on the part of the patient, is to be charged the unseemly incongruities constantly staring the observer in the face from mouths whose lost organs have been replaced in disregard of this universal law.

"No matter how anatomically correct, or how skilfully adapted for speech and mastication, an artificial denture may be, yet if it bear not the relation demanded by age, temperament, facial contour, etc., it cannot be otherwise than that its artificiality will be apparent to every beholder.

"This law of correlation, harmony, running through nature, attracts and enchants us by an infinite diversity of manifestations; the failure to recognize its demands by art is correspondingly abhorrent to our sensibilities.

"In the social gathering, a lady who appreciates the law of harmony delights the eye by the taste displayed in her attire; another, though more elaborately and expensively adorned, yet failing to harmonize the details of her costume, attracts attention only by the impression of incongruity. We hear frequently from a lady who is selecting a bonnet, or from a gentleman purchasing a hat or other article of wearing apparel, the question to a friend, does this become me? the query indicating the recognition that, however exquisite the material, or excellent the manufacture of the article, a certain law of fitness prevails, the failure to comply with which makes the wearer appear ridiculous. We meet in the street one the color of whose hair we expect, by the law of association, to be fair, or sandy, and if otherwise, a wig or a dye is instantly suggested.

"There is a relation between the physical form and the voice, from which we are led to infer in advance the character of the tones which from any given individual may be expected. This law of association in any case, having led us to anticipate a bass voice, the anomaly, should a falsetto greet us, is almost ludicrous.

"There is a similar relation between other physical characteristics and the teeth. A broad, square face, or an oval; a large, coarse-featured man, or a delicately-organized woman; a miss of eighteen, or a matron of fifty; a brunette or a blonde,—these and other varieties present as many differing types, with teeth, in size, shape, color, density, etc., corresponding. If, then, teeth correlated in their characteristics to those which nature assigns to one class, be inserted in the mouth of one whose physical organization demands a different order, the effect cannot be otherwise than displeasing to the eye, whether the observer be skilled in perception, or intuitively recognizes inharmony without understanding the cause.

"Artificial teeth should be natural as to shape, color, and vital appearance; there should be a nice blending of the colors of the body and enamel, not an abrupt union of the two; there should be the precise amount of translucency, and the peculiar texture of the surface, and these characteristics should be maintained by artificial light as well as by daylight; for many teeth which in daylight look reasonably well have a very artificial appearance when exposed in the mouth to an artificial light. They should also possess strength sufficient for the uses for which they are designed. This strength should come from the quality of their composition, the skilful distribution of bulk to parts most requiring it, and the due form, position, and proportion of the pins, rather than from any increase in bulk and weight beyond that of the natural organs. Besides all this, there must be taken into the account the varying forms of the jaw or maxillary ridge, so that the dentist may be enabled to select teeth which are adapted to each particular case, and which can be made to articulate nicely with each other or with the natural teeth, if there are any remaining in the mouth; otherwise his best efforts will not secure a good appearance, comfort to the wearer, or usefulness in mastication.

"To meet all these requirements, the reader can easily perceive, is no easy task, and cannot be accomplished without an amount of care and attention to every detail which effectually excludes artificial teeth from the list of cheap manufactures. The difference in all the essential characteristics which they should possess, appears when what are called cheap teeth are compared with the best. First upon the skill of the manufacturer, and then upon the judgment of the dentist, depends whether an artificial set of teeth shall be pleasing or disagreeable to the observer; whether they shall disarm the suspicion of artificiality, or proclaim it to every beholder.

"Those who desire the result of experience, skill, and culture in manufacture and application, who seek the advantages of artistic taste and faithful service, should ponder the significance of the following remarks by one who, in his time, contributed largely to the development of the art to which he was devoted:

"'All works of taste must bear a price in proportion to the skill, taste, time, expense, and risk attending their invention and manufacture. Those things called dear are, when justly estimated, the cheapest; they are attended with much less profit to the artist than those which everybody calls cheap. Beautiful forms and compositions are not made by chance, nor can they ever, in any material, be made at small expense. A competition for cheapness, and not for excellence of workmanship, is the most frequent and certain cause of the rapid decay and entire destruction in arts and manufactures.'"

CARVED BLOCK-TEETH.

The fabrication of porcelain block-teeth constitutes a somewhat distinctive branch of practical dentistry, and from the delicate nature of the manipulations and long experience necessary to attain to any considerable degree of excellence in the various processes connected with their manufacture, their construction is seldom attempted by those engaged in general practice. Cases occasionally present themselves, however, which, by reason of unusual or unequal absorption, or extensive and irregular loss of tissue as the result of accident or disease, demand, for their successful treatment, specific forms of dental substitutes not obtainable from any collection of ready-made teeth, single or in sections, however large or varied. To meet properly such possible exigencies of practice, either the services of an experienced block-workman must be obtained, or the demands of the case must be supplied by such skill as the general practitioner can bring to the work. To the latter, the following descriptions of the process may prove helpful.

A description of the general properties of the several ingredients, earthy and metallic, used in the formation of block-teeth, has already been given in the preceding part of the present chapter. The method of compounding and preparing the materials will next be given, with various approved recipes for body and enamel.

Composition and Preparation of the Body.—The porcelain paste for the body of block-teeth may be compounded from either of the following formulas. There are a great variety of recipes, differing more or less in the proportion of the component ingredients, but the following will be found to answer every practical purpose, and are such as are generally employed at this time by experienced block-workmen.

NO. I.

Delaware spar,	12 oz.
Silex, . .	2 oz. 8 dwts.
Kaolin, . .	7½ dwts.
Titanium, . .	18 to 36 grs.

NO. II.

Delaware spar,	16 oz.
Silex, . .	3½ oz.
Kaolin, . .	½ oz.
Titanium, . .	20 to 60 grs.

NO. III.

Spar, . .	12 oz.
Silex, . .	2 oz. 8 dwts.
Kaolin, . .	12 dwts.
Titanium, . .	24 grs.

NO. IV.

Spar, . .	8 oz.
Silex, . .	1½ oz.
Kaolin, . .	4 dwts.
Titanium, . .	22 grs.

NO. V.

Spar, . .	2 oz.
Silex, . .	8 dwts.
Kaolin, . .	2 dwts.
Titanium, .	4 grs.

The titanium is first ground in a mortar until reduced to an impalpable powder; the silex is then added and ground from one to three hours, or until there is no perceptible grit; after which the kaolin is added and thoroughly ground; and lastly the spar, adding small portions at a time, and grinding the whole until perfect comminution and intermixture of the several ingredients are effected, say from half an hour to an hour. The ingredients may be ground dry or in water,—in the latter case a sufficient quantity of clean rain-water should be added, from time to time, to form a mixture of about the consistence of thick cream. After sufficient comminution is effected, the surplus water may be abstracted by pouring the mixture upon a clean, dry slab of plaster of Paris. When it acquires about the consistence of thick dough, it should be beaten with a wooden mallet, or thrown repeatedly and forcibly upon a marble slab, and, if prepared in quantities for future use, it should be preserved in its plastic state by confining it in a closely-stopped earthen jar. When ground dry, the materials are prepared for immediate use by adding to the powder clean rain-water in sufficient quantity to form a thick paste; it is then well beaten on a porcelain or marble slab, and pressed, just before using, between folds of cloth, to expel perfectly all particles of air that may be confined in the body of the paste.

Composition and Preparation of Crown Enamels.—The enamel, which forms the external covering to the crowns of porcelain teeth, is composed wholly of felspar, with such coloring matters as serve to communicate to it the various tints or shades of complexion characteristic of the natural organs. The more positive tints, grayish-blue and yellow, are produced by titanium, platinum sponge, and oxide of gold; intermediate colors being produced by varying the special combinations of these ingredients.

The following recipes will furnish various tinted enamels, the varieties of *grayish-blue* being applied to the points or coronal extremities of the teeth—the *yellow* to the necks: the two colors being so blended when applied as to run imperceptibly into each other.

Grayish-blue Enamel.

NO. I.		NO. III.	
Spar,* . . .	2 oz.	Spar, ...	2 oz.
Platina sponge, . .	¼ gr.	Platina sponge, . .	¾ gr.
Oxide of gold, . .	½ gr.	Oxide of gold, . .	½ gr.
NO. II.		**NO. IV.**	
Spar, ...	2 oz.	Spar, ...	2 oz.
Platina sponge, . .	½ gr.	Flux,† . . .	24 gr.
Oxide of gold, . .	½ gr.	Platina sponge, . .	½ gr.

* The Boston spar is preferred on account of its greater fusibility.

† *Flux* is composed of silex, 4 oz.; borax, 1 oz.; sal tartar, 1 oz.; these are ground to an impalpable powder and packed in the bottom of a clean, light-colored crucible. A piece of fire-clay slab is then fitted into the top of the crucible and luted with kaolin clay. It is then exposed to the heat of a furnace until completely fused, when it is removed, and when cold the crucible is broken, all foreign particles or discolored portions thoroughly removed, and the remainder well pulverized.

Yellow Enamel.

NO. I.		NO. III.	
Spar,	2 oz.	Spar,	2 oz.
Titanium,	10 grs.	Titanium,	16 grs.
Platina sponge,	½ gr.	Platina sponge,	½ gr.
Oxide of gold,	½ gr.	Oxide of gold,	½ gr.

NO. II.		NO. IV.	
Spar,	2 oz.	Spar,	2 oz.
Titanium,	14 grs.	Flux,	20 grs.
Platina sponge,	½ gr.	Titanium,	10 grs.
Oxide of gold,	½ gr.		

In compounding enamels from the foregoing recipes, the coloring ingredients should first be ground to a very fine powder, with five or six dwts. of the spar; the remaining portions of the latter should then be added, a little at a time, and ground for half an hour or more. The shades of color may be varied almost indefinitely by changing the proportions of the coloring matter.

Grayish-Blue Enamel.

NO. I.		NO. II.	
Spar,	1 oz.	Spar,	1 oz.
Blue frit,*	5 grs.	Yellow frit, †	4 grs.
		Gold mixture,‡	20 grs.

Composition and Preparation of Gum Enamels.—Either of the following recipes will furnish a good gum enamel, and may be used in connection with any of the compositions for body heretofore enumerated.

NO. I.		NO. II.	
Gum frit, No. 1,	3 dwts.	Gum frit, No. 2,	3 dwts.
Spar,	9 to 12 dwts.	Spar,.	3 to 18 dwts.

* *Blue frit* is composed of spar, ½ oz.; platina sponge, 4 dwts.; powder finely, make up into a ball with water, and fuse very slightly upon a slide in a furnace. It is then plunged into water while hot, and when dry, finely pulverized.

† *Yellow frit* is made by mixing intimately ½ oz. of spar with two dwts. of titanium, and heating as above.

‡ *Gold mixture* is prepared by dissolving 8 grs. of pure gold in *aqua regia*, and then stirring in 12½ dwts. of very finely pulverized spar. When nearly dry, it is formed into a ball fused upon a slide, and then coarsely pulverized.

It is recommended, in order to impart a granular appearance to the gum, to grind the spar somewhat coarsely; any required shade or depth of gum color being obtained by varying the proportions of the frit,—the latter containing the coloring ingredients.

Gum frit, No. 1, is composed of felspar, 700 grs.; flux, 175 grs.; oxide of gold, or metallic gold in a state of minute division, 16 grs.

The above are ground in a mortar for five or eight hours, or until they are reduced to an impalpable powder; they are then packed in the bottom of a clean Hessian crucible, coated on the inside with a thin mixture of pulverized silex, and on the outside with kaolin. A piece of tile or slab is then luted with kaolin to the top of the crucible, when it is placed in the furnace for from one to two hours, or until complete vitrification is effected. It is then removed, and when cold, the crucible is broken and all traces of adhering silex ground off; it is then broken in pieces and ground until it will pass through a sieve, No. 9, bolting cloth.

Gum frit, No. 2, is composed of spar, 700 grs.; flux, 175 grs.; purple cassius, 8 grs.

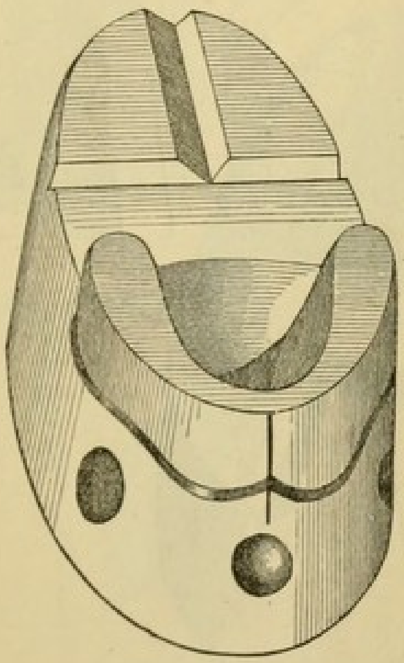
The purple cassius is first thoroughly ground in a mortar, after which the flux is added in small quantities at a time, then the spar in the same manner, grinding until perfect comminution and intermixture of the several ingredients are effected. It is then packed tightly in the bottom of a clean white crucible, the inside lined with silex, and a slab luted to the top, as before, and the whole exposed to a heat sufficient to fuse perfectly. It is then removed from the fire, and when cold, all foreign substances are ground off and the remaining portions pulverized until it will pass through a sieve of No. 9 bolting cloth.

Having given the composition and mode of preparation of the various compounds which enter into the formation of the body and crown and gum enamels, it only remains to describe the different processes concerned in the construction of porcelain blocks from the several compositions given, and first of the method of procuring an antagonizing model.

Antagonizing Model for an Entire Upper and Lower Denture Constructed of Block-teeth.—The first step in the process of constructing block-teeth, for either a full upper set with the natural teeth of the opposite jaw remaining, or for entire dentures for both jaws, is to secure an antagonizing model. For the latter, or complete dentures, above and below, the method does not differ from that employed when single gum teeth are used. A rim of wax is adjusted to each plate in the manner heretofore described, and the plates placed in their proper positions in the mouth ; the wax drafts are then trimmed until the exact fulness and contour of the lips and cheeks are secured and proper relative width is given to the wax rims. Great exactness should be observed in these latter manipulations, inasmuch as the wax drafts are the only guides in the formation of the blocks, both as respects the form and fulness of the arch and the length of the teeth. The proper relation of the two pieces in the mouth is now secured, the wax rims attached to each other, and the median line of the mouth indicated on the wax, and being removed from the mouth, an antagonizing model procured in the same manner as described in a former chapter.

Antagonizing Model for an Entire Upper Denture with the Natural Teeth of the Opposing Jaw Remaining.—A rim of wax, half an inch or more in width, is attached to the ridge of the plate and the latter placed in the mouth. The patient is then directed to close the jaws until the cutting edges and grinding surfaces of the teeth of the opposing jaw are fairly imbedded in the wax. The piece is then removed from the mouth and the wax rim detached from the plate by holding the latter for a moment over a spirit-flame. The wax is then placed upon a strip of paper with the side indented by the teeth looking upward, the surface of the wax oiled and a batter of plaster poured upon it, filling the imprints of the teeth and running back an inch and a half or more behind the wax, raising the plaster to a level of half an inch above the wax. When the plaster is sufficiently condensed, it is turned over, the wax removed without fracturing the plaster teeth, and a crucial groove made in the surface of the model posterior to the teeth. This constitutes the lower section of the antagonizing model, and is a representation of the teeth of the lower jaw. The upper section is next obtained in the following manner: A second rim of wax, in width equal to the required length of the teeth, is adjusted to the plate as before and placed in the mouth. The exact contour and fulness of the arch required is then given to the external or labial surface of the wax draft, and the lower edge cut away until the required approximation

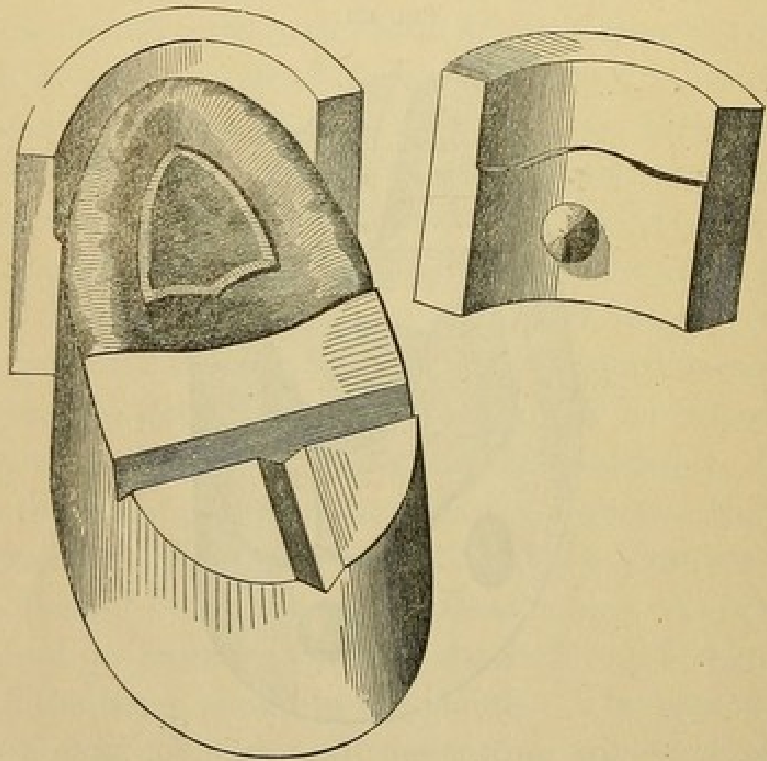
Fig. 121.



of the jaws is secured, and the points of all the teeth remaining below touch the wax at the same instant. The patient is now required to close the jaws gently upon each other until a slight indentation is made in the wax by the opposing teeth; the median line of the mouth is then marked upon the wax and the plate removed. The plate and wax are now adjusted to the lower section of the model, the points of the plaster teeth being received into the indentations in the wax made by the natural teeth. The upper and posterior surface of the lower section of the model having been varnished and oiled, and the exposed surface of the plate also oiled, a mixture of plaster is poured in upon the latter and back upon the model, raising the whole to a level of half an inch above the plate. The two sections, when the latter portion of plaster has consolidated, are then separated, reserving the lower part of the antagonizing model for future use.

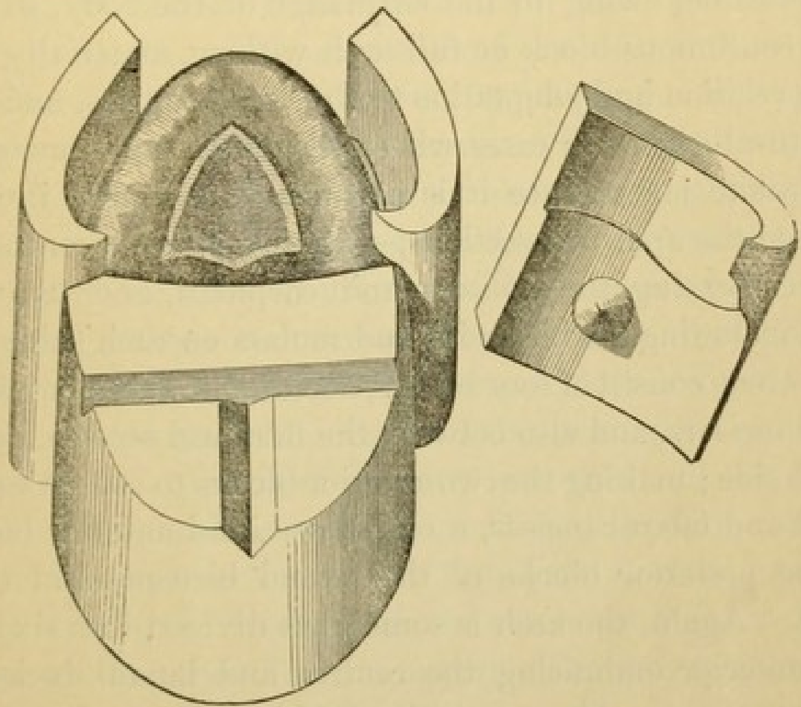
Forming a Matrix for Moulding the Body Preparatory to Carving the Teeth.—As the process of forming a matrix in which to mould the porcelain paste, giving the general form and

FIG. 122.



outlines to the blocks before carving the teeth, is the same for an upper and lower denture, it will be sufficient to describe the method as it relates to the superior arch. A matrix for an entire denture above or below, whether consisting of three, four, or six blocks, is ordinarily made to consist of three distinct pieces independently of the plate and model, and is constructed in the following manner: Three conical shaped holes are made in the sides of the model, one in front and one on each side, to furnish a fixed articulation for the three sections forming the external walls of the matrix. The appearance of the model when thus prepared with the plate and wax rim in place is exhibited in Fig. 121. The sides of the model and external face of the wax are now oiled, and both surfaces covered with a batter of plaster to the depth of a fourth or a half of an inch, extending from the base of the model to the lower edge of the wax, and posteriorly about half way on each side of the model to form a matrix for the front block, or the

Fig. 123.



two anterior blocks, if the arch is made to consist of more than three sections. Supposing the wax removed from the plate and this front piece in place, the several parts will present the appearance shown in Fig. 122. The plaster rim forming the external wall of the front block being removed, plaster is again added, as before, to the outer surfaces of the model and wax, extending it from the heel of the plate on each side forward an eighth or a fourth of an inch in advance of the posterior extremities of the plaster rim first formed. When hard the plaster is trimmed even with the edge of the wax draft, and the two pieces removed from the model. The matrices formed by these lateral sections when readjusted to the model with the wax removed are shown in Fig. 123. Having thus provided a matrix determining the general outline and length of the teeth for the entire arch, the wax draft is removed and the plate thoroughly cleansed preparatory to moulding the paste,—before doing which, however, the line upon the wax indicating the median point of the mouth should be extended across the model.

Moulding the Porcelain Paste Preparatory to Carving the Teeth.—In the process of constructing an entire denture, it is impracticable, owing to the shrinkage of the body, to form a single continuous block or full arch without materially changing its relation and adaptation to the metallic base, and also to the natural organs in cases where the latter are remaining in the opposite jaw; hence it is customary, as before intimated, to divide the arch into sections,—usually three; a central front block embracing the incisors and cuspidati, and two lateral blocks including the bicuspids and molars on each side; or the denture may consist of four blocks, dividing the arch between the central incisors, and also between the first and second bicuspids on each side; making the two anterior blocks to consist each of a central and lateral incisor, a cuspidatus, and anterior bicuspid, and the posterior blocks of the second bicuspid and the two molars. Again, the arch is sometimes divided into six blocks,—an anterior embracing the central and lateral incisor and cuspidatus, a central comprising the bicuspids, and a posterior including the molars. If constructed in three sections, as is ordinarily the case, the front block should be moulded and carved first. The material for the body, if in a dry state, is mixed with a sufficient quantity of clean rain-water to form a thick batter, and mixed thoroughly in a mortar. It should then be poured upon a dry slab of plaster of Paris, and when the excess of water is absorbed, removed, and well beaten with a spatula on a marble or porcelain slab until it assumes a somewhat pasty form; it may then be well pressed between folds of cloth to force out any remaining portions of confined air. The plaster rim forming the matrix for the front block is now adjusted in its proper position to the model, and its inner surface, as well as that of the plate, oiled; the porcelain paste is then packed into the matrix as compactly as possible, filling it even with the upper edge of the plaster rim. When the paste has been worked in as solidly as possible, patting it with the fingers or suitably formed instruments as successive portions are added, it should be trimmed even with the edge of the plaster rim and the palatal surface cut away to near the thickness required for the teeth included in the block, leaving it somewhat thicker, however, to compensate for the shrinkage of the body, and to allow for small portions which will be cut away in carving the teeth. The plaster rim forming the external border of the matrix is now loosened by tapping gently upon the model and then carefully removed. The mark upon the model, showing the mesial line of the mouth and indicating the proper position of the central incisors, is then extended across the block, after which the width of each adjoining tooth is lined off, making each one as much broader than will be required in the finished piece as the porcelain composition will shrink in baking,—this, in a block embracing the six anterior teeth, will be equivalent to about one-third or one-half the width of a bicuspid on each side. If the case is one requiring a full denture above and below, the operator should next proceed to mould the front block for the lower arch in the same manner as described for the upper. The two sections of the antagonizing model are then placed together, and the proper relative width for the lower teeth indicated upon the inferior block,—the drawn lines upon the upper block serving as a guide. The points to which the posterior extremities of the front block extend on each side of the plate should be marked upon corresponding points of the model above and below, to enable the manipulator to determine how far the side blocks should be extended anteriorly when moulding the paste for the latter,—the marks upon the model being subsequently transferred to the lower edges of the lateral sections of plaster concerned in the formation of the side matrices. Before removing the front blocks from the plates preparatory to carving the teeth, the surface of the paste may be dried somewhat by throwing upon it, with a blowpipe, a broad spreading flame from a spirit-lamp. The blocks are then carefully detached by rapping lightly upon the model, assisted by gentle traction with the fingers. The front blocks being removed from the upper and lower plates, the side sections of plaster concerned in the formation of the posterior matrices are adjusted to the model, and, being oiled, the paste filled in as before described, extending each block forward beyond the point occupied by the cuspidatus of the front block a distance equal to about one-third or one-half of the width of the latter. These are then cut away even with the edges of the plaster rims and trimmed on the palatal sides, leaving them somewhat thicker than will be required for the bicuspids and molars. The plaster walls of the matrices are then removed; the two parts of the articulating model placed together, and the relative width and position assigned to the upper and lower teeth by drawing lines across the external surface of the blocks. They are then separately removed from the plates in the manner before described, and the necessary additional portions of paste added to the grinding surfaces to compensate for the contraction of the body in baking. In constructing a full upper denture with all or a portion of the natural organs remaining below, the proper width to be given to the upper teeth, as well, also, as the required relation or antagonism of the artificial with the opposing natural teeth, may be readily determined by applying the lower portions of the antagonizing model representing the teeth of the under jaw, and marking upon each block, as it is being moulded, the necessary width and position of each tooth above,—being careful to make allowance for shrinkage by adding to the length, width and thickness of each block as much as will compensate for the contraction of the body. In every other particular, the process is conducted in the same manner as heretofore described.

Carving the Teeth.—The teeth are first separated by drawing between them a thread attached to a small bow, and it may be observed in this connection that the most careful and delicate manipulation is required in handling the blocks while carving to prevent portions of the paste from crumbling away, a tendency that may be counteracted, in some measure, by moistening the paste occasionally with a little water taken up on the point of the carving knife. The general outline of each tooth having been traced upon the exterior surface of the block with the point of the instrument, the operator proceeds next to give the distinct and characteristic form to the crowns, and the harmonious and agreeable effects produced will depend upon the fidelity with which the manipulator copies nature in the form and arrangement of the teeth. The requirements of individual cases are too varied in their nature to admit of specific directions in respect to their formation,—a careful study of the modified forms of the natural organs, combined with some degree of manipulative tact, will enable any one, after sufficient experience, to attain to satisfactory results in this particular.

FIG. 124.

After the teeth are formed, and the body of the block is reduced to the required thickness, superfluous portions extending from the ends of the block should be cut away, leaving enough, however, projecting to allow for grinding when jointing and adjusting the several blocks to the metallic base. Fig. 124 exhibits the general form of the blocks when carved, showing also the platinum pins, but which are not usually attached to the blocks until after the latter are first biscuited.

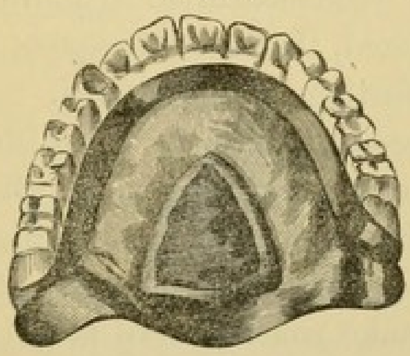
Crucing, or Biscuiting.—The blocks being carved, are next placed on a fire-clay slab with their palatal surfaces resting on a bed of silex. As soon as the paste has become thoroughly dry, the slab may be gradually introduced into the muffle of a baking furnace (Fig. 15), and exposed to a full red heat until semi-fusion of the body takes place. This partial vitrification of the body serves to agglutinate the particles of the compound, and is termed *crucing* or *biscuiting*. When removed from the furnace, and cool, the platina pins should be introduced into the blocks before applying the gum and crown enamels, and is accomplished in the following manner. One or two small holes, as the case may require, are drilled into the body of the block immediately behind and below the crown of each tooth, extending about half way through the block; into these, platinum pins or wires are introduced, a head being formed to the end of the pin entering the block. A small portion of the body composition, mixed with water to the consistence of thin cream, is then worked into the hole around the pin with a sharp-pointed carving knife or camel's-hair brush, its introduction being facilitated by first immersing the block in water immediately before inserting the pins.

Application of the Crown and Gum Enamels.—The gum enamel is applied first, the material being first prepared by mixing the gum composition with sufficient clean rain-water to form a batter of about the consistence of thin cream. This is then taken up with a camel's-hair brush and applied uniformly to all parts of the external surface of the block representing the natural gum. It should be applied very carefully to the necks of the teeth, forming a neat and well-defined festoon at these points. In applying the crown enamel to the labial surfaces of the teeth, it is customary, in imitation of the natural organs, to so distribute the more positive tints as to give to that portion of the crown representing the neck of the tooth a somewhat yellowish hue, and to the points, a grayish-blue tint. To effect this, the material for the yellow enamel, reduced to the consistence before mentioned, is first applied to the necks, uniting it carefully with the gum enamel; and afterwards the grayish-blue to the points, extending it a little below the cutting edges of the incisors, and the cusps of the cuspidati, bicuspids, and molars, giving to the teeth, at these points, a translucent appearance. It is only the external and lateral surfaces of the teeth that are enamelled, the palatal surfaces remaining unglazed. The yellow and blue enamels should be so blended when applying them to the crowns that the one shall fade away imperceptibly into the other.

Final Baking.—The enamelling completed, the blocks are placed upon a bed of silex on a slide, and the latter carefully and slowly introduced into the mouth of the furnace. The fire should then be urged to a clear white heat, and when perfectly dry, the blocks should be carried with the slide into the body of the muffle, and the mouth of the latter closed tightly with a fire-clay plug. Some knowledge of the requisite degree of heat and time necessary to effect perfect fusion of the ingredients composing the blocks is required, and these are ordinarily well known to experienced block-workmen, but those unaccustomed to the process will better determine the completion of the baking by introducing into the muffle along with the blocks a small portion of the body covered with enamel attached to one end of a platinum wire, the other passing through a small stopper fitted to the centre of the plug closing the end of the muffle, and which may be removed and the wire withdrawn from time to time to observe the effect of the heat upon the test-piece. When this is seen to be perfectly fused, as evidenced by a uniform glossiness of the surface, the slab should be drawn to the mouth of the muffle, the draft cut off, and the blocks allowed to cool gradually with the furnace. In place of using a test-piece, however, it will answer the purpose to withdraw the slide to the mouth of the muffle occasionally, where it may be readily inspected and the progress of baking noted. When sufficiently cool to be taken in the hand, the blocks are removed from the furnace.

Fitting and Attaching the Blocks to the Metallic Base.—On applying the blocks to the plate, it will be found that a greater or less change of relation between the two has occurred in the process of baking, so that the base of the former will not fit the portion of the plate on which they rest as accurately as when first moulded. It will, therefore, be necessary, when adjusting each block, to grind away somewhat from the base of the latter until the coaptation of the two surfaces is as perfect as practicable. The several blocks should also at the same time be accurately united to each other laterally, grinding away from the ends, and approximating the sections as the articulation of the opposing dentures may require to effect a proper and efficient antagonism, and which may be determined by the use of the antagonizing model employed in moulding the blocks. After the blocks are fitted, and the teeth antagonized, and before uniting the former permanently to the plate, a rim should be formed and attached to the borders of the metallic base to form a socket for the plate extremities of the blocks, and which, extending around the margins of the plate, should be continued across the heel of the latter on each side and made continuous with the band of lining on the palatal sides of the teeth. The manner of forming and attaching the rim does not differ from the method heretofore described in connection with full dentures constructed of single gum teeth, and to which the reader is referred. The rim fitted, and the blocks replaced, the whole is invested in the usual way, the wax removed from the plate, and a continuous band or lining adjusted to each block. The latter is accomplished by first cutting a pattern of the band from sheet lead of the length of the block, and of the required width, trimming the edge applied to the plate in such a manner that when adjusted to the backs of the teeth it will lie in uniform contact with the base; this is then pressed against the pins with sufficient force to perforate it. The lead pattern is then placed upon a strip of gold of the required thickness, and the counterpart of the pattern cut from the gold plate, marking at the same time the points to be perforated for the platinum rivets. This is then pierced with a plate-punch, and the strip bent to the proper curve and applied to the block, when it is bound to the latter by splitting and spreading apart the ends of the rivets. A band is thus applied to each block. Solder is then applied along the joints, and over the pins, and all parts united with the blowpipe in the usual manner. The piece is then finished up the same as ordinary gold work. Fig. 125, exhibits a palatal view of an upper set of block-teeth mounted on a metallic base. When skilfully executed, the finished work presents a beautiful and highly artistic appearance. The application of sectional porcelain blocks to the necessities of mechanical practice has been greatly extended in connection with the vulcanite and celluloid bases, and, to a limited extent, with other processes. Their construction, however, is modified somewhat by the requirements of these special processes, and as made for the latter are of such approved manufacture, and are supplied in such abundance and at so reasonable a cost by all the principal dental furnishing establishments, that the general practitioner, we apprehend, will ordinarily find it more convenient and economical to purchase rather than manufacture them himself.

Fig. 125.



The subjoined account, descriptive of a new method of making block-teeth, by Dr. William Calvert, was inadvertently omitted in the former edition of this work. The process has received marked commendation by competent persons who have investigated its merits, and will be highly esteemed by those who desire to excel in this beautiful but difficult art.

"The first preparatory step to be taken, after having correct articulating models, is to select single teeth so defined as may either suit the taste of the operator or the peculiarity of the case, and supposing the case to be an upper denture, it will be necessary to have *two* front and two lateral incisors, two canine or cuspids, two bicuspids (or if more convenient the cuspids), and four molars, all of which should be sufficiently large to compensate for shrinkage, in the material of which the teeth are to be composed.

"The plate upon which the blocks are to be made, and to which they are to be subsequently fitted, being upon its corresponding model, a rim of wax may be placed upon it, and the teeth arranged upon the wax, articulating with the antagonizing model, allowing sufficient in the length of the teeth for shrinkage. Beginning with the front incisors, the teeth should be set to the wax (as above) as far back on each side as the first bicuspids, inclusive; then leaving a space equal to the width of *half a tooth*, the arch may be completed by the addition of the molars, two on each side. The teeth having been thus arranged upon the wax, with reference to regularity or irregularity, height, etc., the desired outline of gum may be filled up with wax.

"Special care is requisite in so trimming the wax where joints are contemplated, that no subsequent alteration will be needed during the further manipulations.

"It will be necessary, previous to making the moulds, to make some provision for replacing them, after they have been once removed, so that they shall occupy the same position as they did previous to their first removal. For this, it will be only necessary to make some conical holes in the face of the cast, say two on each side, between the centre and the first bicuspid teeth, and two opposite the molar teeth of each side. These holes need not be more than about a quarter of an inch deep, and should be but a short distance below the edge or line of the plate. The face of the cast, including said holes, should now be varnished, when the case is ready for making the moulds.

"The first mould to be made should be that including the four incisors, two canine, and two first bicuspids, eight teeth in all. This may be done by simply oiling the face of the teeth, outline of gum, and plaster cast, and pouring plaster of Paris of a proper consistency over the surface of the same, allowing it to fall slightly over the cutting edges, so as to form a more perfect mould. This mould should be divided in the centre, making two sections, which can be done by cutting through the plaster while in the state of hardening; or, what is perhaps better, before applying the plaster, make an incision in the wax outline of gum, in which place a thin slip of sheet lead, letting it extend a little above the cutting edges of the teeth, and as far down the face of the cast as is desired to extend the mould. When hard, remove from the cast and teeth, and we have the untrimmed mould for said eight teeth. Previous to making the moulds for the back teeth, it is necessary to remove the *first* bicuspids, or the cuspids representing them, from the position they occupied in making the mould just described, and placing them beside the first molars so as to represent the *second* bicuspids. Care is to be taken in removing and replacing them, so that the original form of the wax may be preserved, otherwise the end thereby intended to be secured will be defeated, and the joints at these points will be irregular and unsightly.

"For the purpose of rendering clear a point necessarily left somewhat obscure in the foregoing description, it may be well here to state that the space of *half a tooth*, left between the first bicuspids and the first molars, is to compensate for shrinkage in the length of the arch, for after the first bicuspids are removed and set adjacent to the first molars, thereby representing the second bicuspids, they occupy the entire vacancy first left and one-half the space formerly occupied by said first bicuspids; hence the extension of the back moulds toward the centre is equivalent to the shrinkage of the entire arch.

"As the foregoing is applicable where the case of fourteen teeth is to be divided into four blocks, as is usual in soldering, I would say that when the intention is to make pin-holes for riveting, the space of *half a tooth* must be left between the canine and bicuspids, instead of between the bicuspids and molars.

"The moulds for the back teeth may now be made in the same manner as those of the front ones. After the moulds have been made as already described, they should be so trimmed that in the process of moulding the blocks there would be no liability of removing portions of the enamel off the teeth in withdrawing the moulds. The moulds should now be varnished with some spirit varnish, and after it becomes dry are ready for use.

"The moulds being prepared, the next step is the enamelling of the teeth in the moulds. The enamels should be moistened with a little clean water, and having previously oiled the section or sections of the mould, the blue or point enamel may be first applied (as stiff as it will work) with a very small spatula made for the purpose. This enamel should be *thin* at the base, and gradually thickening with the concavity of the mould to the cutting edges of the teeth. The yellow or base enamel is next applied *heavy* at the base, and gradually terminating near the point.

"After the enamelling has been completed so far as is designed to be moulded at one time, a small quantity of the body about the consistency of a thick paste may be spread over the surface of the moulds and of the enamels, the moulds replaced upon the model, and the body carefully filled in, at first rather soft, but subsequently harder and harder, until the mould is sufficiently full. Then applying the flame of a spirit-lamp for a few minutes with the blowpipe, the body will be toughened enough to work well, when the moulds may be removed. The teeth may then be separated and trimmed, the blocks divided as desired, the *gum* enamel applied, etc., and so completed.

"The process of enamelling and moulding being precisely the same with all the blocks, it needs not that I should go into further detail.

"I have already said, that when the blocks are intended to be riveted upon the plate, the moulds are required to be somewhat different. There is also another difference; that is, the moulding of the pin or rivet holes, which may be done by removing the plate from the model, placing the moulds upon the model, and drilling a small hole upon the prominence of the ridge opposite the centre of each tooth, in which insert a piece of wire of a desired size. The enamelling, etc., may then be done as before described, and after the body has been hardened sufficiently, the pins may be removed, leaving the holes neatly moulded, perfectly smooth, and straight. The blocks may then be finished at once, before removing from the cast."

CHAPTER XIII.

Uniting Single Porcelain Teeth to Each Other and to a Metallic Base with a Fusible Silicious Compound, forming a Continuous Artificial Gum.*

The process of uniting single mineral teeth to each other and to a metallic base by means of a porcelain cement, was attempted as early as 1820, by Delabarre, of Paris, France, but with such imperfect and unsatisfactory results as induced its early abandonment. At a later period, Dr. John Allen, a distinguished practitioner of dentistry in America, devised a method embracing original and important modifications of practice both in the preparation and combination of materials, and the modes of manipulating them; and after an extended series of experiments, commencing in 1844, succeeded in obtaining certain mineral compounds which vitrified at a heat much below that employed by Delabarre, and the contraction of which corresponded so nearly with that of the platina base

* The attentive reader of the first edition of this work will not fail to note that the statements involving the question of *priority*, contained in the introductory portion of the above chapter, are at variance with those originally published. A more extended examination and careful analysis of the evidences as they appear upon record—evidences not fully accessible to the author at the time of the publication of the first edition—establish beyond reasonable doubt the just claims of Dr. Allen as the originator of that special and distinctive method here considered, by which the attachment of the teeth to the plate is effected by direct fusion of the gum material. Dr. Hunter's earliest and contemporaneous experiments contemplated simply a union of all the teeth, by means of a fusible cement, forming a single, continuous block, which was afterwards united to the base by riveting or soldering.

This brief explanation is here introduced as an act of simple justice to Dr. Allen, who has devoted the best energies of his life to the successful development of a process which stands unrivalled in all the chief requisites of an artificial denture.

to which it was applied, that the shrinkage incident to baking conflicted in no material degree with the practical utility of the work in the mouth.

In the construction of dentures upon this principle, plain single teeth, made for the purpose, are arranged and soldered to a plate properly fitted to the mouth, after which different mineral compounds, made to represent the natural gums, roof, etc., are applied to the plate and teeth in a plastic state, then carved and trimmed in proper form, and by means of a strong furnace heat these compounds, which are called the body and the gum enamel, are fused, thus producing a continuous gum, roof, and ruga of the mouth, without seam or crevice.

The compounds at present employed in this process, as well as the more fusible preparations used for repairing purposes, are manufactured in quantities sufficient to meet the wants of the profession, and may be procured at all the dental furnishing houses throughout the United States.

The intimate but later identification of Dr. W. M. Hunter with the above process has rendered his name familiar as one whose skill and devotion to this specialty of mechanical practice has contributed to its development in a modified form. Dr. Hunter's formulas, and modes of manipulating his compounds, will be introduced hereafter.

Following Dr. Hunter's descriptions, the reader will find practical and valuable instructions in this method of substitution, contributed for this edition, at the solicitation of the author, by Dr. S. P. Haskell, of Chicago, Ills., and Professor George S. Field, of Detroit, Mich., both of whom are recognized experts, and whose long experience and intimate familiarity with the most approved methods of constructing continuous gum dentures impart special value to the subject-matter of their communications.

Before introducing an account of Dr. Allen's modes of procedure, the author would premise that it is unnecessary to repeat in this connection what has already been fully described in regard to impressions of the mouth, or the manipulations connected with the formation of plaster models and metallic swages, these processes being essentially the same as in the construction of ordinary gold work. Whenever a rim is to be formed to the border of the plate extending from heel to heel of the latter, and this is to be accomplished by swaging, the model should be shaped as described in connection with Fig. 37. If it is designed to enamel the entire lingual surface of the plate (a method now commonly practiced), the shoulder upon the model should be extended across the heel of the latter from each extremity of the ridge on a line with the posterior border of the hard palate, to form a groove in swaging similar to, and continuous with, that on the outside of the ridge. The edges thus turned in swaging will flare more than is required,—the operation must, therefore, be completed by carefully turning them over sufficiently with the pliers. In place of swaging the rim, however, it may be formed by fitting and soldering along the border a narrow plain strip of platinum, extending it as before, if desired, across the posterior edge of the plate. Or a triangular piece of wire may be soldered on, bevelled somewhat so as to overhang the base slightly, thus forming a shallow groove. The border to the palatal portion of the gum at the heel of the plate is sometimes formed in swaging by adjusting a wire across the heel of the model, which will be transferred to the plate in the form of a ridge. The latter should be raised a line or more from the posterior border of the plate, and should incline gradually to the edge, while the anterior surface should present an abrupt shoulder to the margins of the gum enamel.

The process of forming the rim is sometimes deferred until after the first portion of the body is baked, and before the gum enamel is applied. In this case, the borders of the plate, to the depth of from a line to a line and a half, are left uncovered by the base; after the latter has been baked, the uncovered margins are turned over upon the body with pliers and burnisher, and the gum enamel afterwards applied flush with the edge or surface of the rim.

In whatever way the rim or socket is formed, it is practically of the first importance that the exact dimensions of the plate required should be ascertained before the groove is formed, as it will be impossible to subsequently diminish the extent of the borders without, to some extent, impairing the integrity of the finished work. The mouth, therefore, should be carefully examined, and the precise location, extent, and fulness of the muscles and integuments along the external borders of the ridge above and below, the glands underneath the tongue, and the extreme boundaries of the hard palate carefully noted and accurately traced upon the plaster model, to serve as a guide in determining the dimensions of the plate.

Additional strength will be imparted to the metallic base by doubling the central portion of the plate as described in Chapter XI. The following additional remarks on the method by Dr. Hunter are introduced:

"Platina as usually applied I think objectionable, wanting stiffness; my method of using it is similar to that proposed by Delabarre, but possessing greater strength than even his method, and by it can be made as light as a good gold plate got up in the ordinary way. I first strike a very thin plate to the cast, and cut out a piece the size of the desired chamber, taking care not to extend it forward to embrace the palatal artery. Add wax to the plate for the depth of the cavity, diminishing it neatly as it approaches the alveolar ridge. Cement this plate to the cast and take another metallic cast, strike another thin plate over the whole, and solder throughout with an alloy—of gold twenty-two parts, platina two parts—or with pure gold. The chamber thus formed is precisely the same as 'Cleveland's Patent Plate,' but the space *between the plates*, for which he obtained his patent, is subsequently filled up, leaving a cavity resembling Gilbert's, but with a sharper edge when so desired. This space is filled up with base and enamel, and gives great stiffness without the ugly protrusion of the struck chamber. The plate thus formed assimilates much more closely to the palatal dome, not interfering with pronunciation; another great advantage gained by it is the impossibility of warping. I say *impossibility*, because I have submitted plates so constructed to the severest tests, and never had them to warp.

It is well to rivet the two plates together before proceeding to solder, especially gold plates, and to bring the heat carefully upon them; once prepared there is no danger of change in the succeeding manipulations."

Dr. Allen's Methods.

The following descriptions, contributed by Dr. Allen, embrace a clear and concise account of the manipulations at present practiced by him in the construction of artificial dentures with continuous gums.

"The plate or base is formed of platinum, or platinum and iridium. The plate being properly fitted to the mouth, and wax placed upon it for the bite, as in ordinary plate work, the teeth are arranged thereon, with special reference to the requirements of the case. They are then covered with a thin coating of plaster mixed with water to the consistence of cream. After this has become firmly set, another mixture of plaster and asbestos with water, somewhat thicker or more plastic than the first, is placed round on the outside of the previous covering and the plate. A convenient way of applying the second covering is to turn the mixture out of the vessel upon a piece of tin, say four or five inches square, thus forming a cone, upon which the plate, with the teeth upward, is pressed gently down until within an inch or less from the tin. Then with a spatula the mixture is brought up over the teeth, forming an investient that will not crack in the process of soldering. Sand may be used with the plaster for this purpose, but I think asbestos preferable.

"When the covering has become sufficiently hard, the wax is removed, and a rim of platinum is then fitted to the lingual side of the teeth, below the pins, and to the base plate. The pins in the teeth are then bent down upon the rim, and soldered with pure gold, or a mixture of gold and platinum, at the same time the rim is soldered to the plate. This rim, which forms the lining for the teeth, is usually about the thickness of the plate upon which they are set, say twenty-eight to thirty; but should the case require more than ordinary strength, a double or triple thickness of rim should be used. This may become necessary in cases where the natural molar teeth are standing firmly in the opposite jaw, and antagonize with the artificial piece, or where from any cause an undue strain is brought to bear upon the artificial teeth. To attain successful results, the dentist must take into consideration all the circumstances or conditions of each particular case, and then exercise his best judgment in executing the work.

"In soldering platinum with pure gold, flat surfaces of this metal should be brought in positive contact, in order to become firmly united. Therefore in mounting teeth upon a plate of this kind the backing or inside rim should be a little wider than the distance between the pins in the teeth and the plate, say from an eighth to a fourth of an inch. This extra width of rim should be bent at right angles along the base of the teeth, so as to admit of being pressed down upon the plate after the rim is adjusted to the teeth, and the pins bent down firmly upon it. In this way flat surfaces of the rim and plate are brought together and soldered. The pins in the teeth are also soldered to the rim at the same time. When the parts are thus united, they will remain so during the subsequent bakings; but if the edge of the rim only is fitted to the plate and soldered like gold or silver work, the subsequent heatings for baking the body and gum will cause the gold to become absorbed in the platinum, and leave the joints not united. It may be asked, Why not use common gold solder for this style of work? Answer, Because the alloy in the solder will greatly injure the color of the gum enamel in baking. Copper alloy will turn it to a greenish shade, and silver will give it a yellow tinge. Although pure gold requires more intense heat to melt it (being about two thousand degrees) than ordinary gold solder, yet when melted it flows much more freely than the latter. The best way to solder the teeth upon platinum plate is, to place small pieces of gold upon the joints or parts to be soldered, with wet ground borax, and then slowly introduce the piece with the investient into a heated muffle, and bring the whole mass up to a red heat; then withdraw it from the furnace, and bring it quickly under the blowpipe to flow the gold. In this way the teeth do not become etched, as they are liable to be if the soldering is done in the furnace.

"The piece being soldered and cooled, the covering is removed from the teeth, taking care to preserve the base unbroken for the plate to sit upon during the subsequent bakings of the body and gum enamel.

"All particles of plaster or other foreign matter should be removed from the teeth and plate by thoroughly washing and brushing them. It is well to immerse the piece for a short time in sulphuric acid, after which rinse and brush it well with water. This done, a colorless mineral compound, called the body, is applied in a plastic state (with spatulas or small instruments for the purpose) to the teeth and plate. It is then carved to represent the gum, roof, and rugæ of the mouth, taking care to keep the crowns of the teeth well defined. The piece is then placed on the base upon which it was soldered, and set upon a slide on the apron in front of one of the upper muffles of the heated furnace,—and every eight or ten minutes it should be moved forward into the muffle, say two or four inches each time, until the piece shall have passed the centre of the same, which should be at a red heat. It is then withdrawn and passed into a lower muffle, where the heat is greater, in which the body soon becomes semivitrified, which is sufficient for the first bake. It is then taken out and (together with the slide on which it was baked) placed in a cooling muffle, the mouth of which should be closed to prevent the change of temperature from being too rapid, and causing the teeth to become brittle. When the piece is sufficiently cool to handle, a second application of body is made for the purpose of repairing any defects that may have occurred in the baking; this done, the piece is again introduced as before into the upper muffle, then in the lower, allowing the second bake to become a little harder than the first, but not so much as to appear glossy. It is then withdrawn, and cooled as described above.

"A flesh-colored compound is then applied, which is called the gum enamel. This is also made plastic with water, and a thin coating is put over the body, and closely packed and carved around the teeth with small instruments made for the purpose,—still taking care to keep the crowns of the teeth clean and well defined. Small camel's-hair brushes are used wet with water, to cause the gum enamel, and also the body, to settle more closely around the necks of the teeth; other brushes are also used dry to remove all particles of body, gum, or other substances from the crowns of the teeth.

"After the application of the gum enamel, the piece is again subjected to the heat of the furnace as described for baking the body, with this difference: The heat should be a little greater than for either of the preceding bakes. It should be a strong, sharp heat, in order to produce a smooth glossy appearance, which is required for the enamel. These different degrees of heat for the first, second, and third bakings should be carefully observed for the purpose of getting an even temper in the piece, and thereby preventing it from crazing or cracking in cooling.

"The enamel being thoroughly fused, the piece is withdrawn from the heated muffle, and passed into another, outside of the furnace. This muffle should be made quite hot before the denture is placed in it, in order to prolong the cooling process; for if the piece is cooled too rapidly it is rendered more fragile. It is well to let the case remain in the cooling muffle, with the mouth of it closed, several hours before exposing it to the air. By baking just at night the piece will be in proper condition to finish up the next morning.

"The finishing process consists simply in smoothing and polishing the plate, and burnishing the rim. It is then ready to be adjusted to the mouth. In baking, great care is necessary to prevent the piece from becoming gassed. This can be avoided by allowing the gas to escape entirely from the burning coal or coke in the furnace before the piece is introduced into the muffle. The presence of gas is indicated by the blue flame escaping from the coal. When the fire becomes clear, it is then safe to introduce the case to be baked (as before described) into the muffle. Pure anthracite coal is the best for this purpose, as it maintains a longer and stronger heat than coke.

Bituminous coal is not good for this kind of work unless first converted into coke.

"It often occurs that the natural gums will change more or less after the teeth are inserted. In such cases a new impression should be taken from the mouth, and a fusible die formed. The denture is then placed upon the die, and it will be seen at once where the change has taken place; then with the piece resting upon the die the artificial gum may be chipped off with a small hammer and chisel. The platinum plate being soft can be refitted to the die very accurately with a burnisher, hammer, and small driver made for the purpose. A new coat of body is then applied where the plate has been refitted, and then baked, cooled, enamelled, and baked again,—still observing the same directions as detailed in the management of new pieces.

"If the tooth gets broken (a mishap which seldom occurs by use in the mouth), it can be replaced with another, by grinding out the remaining portion of the broken tooth, and the gum which covers the fang, and then fitting a new one in the place. This tooth need not be soldered to the inside rim; it is sufficient to grind a small notch or groove in the enamel which covers the lingual side of the rim for the pin of the tooth to fit into. The pin resting in the groove is covered with the body at the same time it is applied around the base of the tooth, and when this body is baked the tooth will become firmly fastened in place of the broken one. Any number of teeth that may be required can be replaced in this way. If it is desired to change the position of one or more teeth, or to make them longer, this can also be done as described above, with this additional precaution, which is simply to press softened wax upon the inside of the teeth and palatal arch of the denture before the others are removed,—this wax will serve as a guide or index as to the relative change to be made, and also to sustain the teeth in place while they are being fitted as desired to the denture. The wax soon becomes hard, and is readily removed as each successive tooth is ground and adjusted in its proper place.

"When the teeth are thus fitted with each pin accurately pressed into the groove prepared for it, and the wax being placed upon the inside to support the teeth in proper position,—body is filled in around the base of the new ones, which are carved, trimmed, and brushed, so as to save the crowns of the teeth clean and properly defined. The wax is then carefully removed from the piece, and more body is filled in around the teeth upon the inside,—filling up the grooves over the pins, and then carving, trimming, etc., as before, to give it the desired form. This done, if the teeth are set a little apart, and it is desired to keep them in that position, take a small piece of asbestos and gently press it in between the teeth at the cutting edges; this will prevent them from being drawn together when the body is being baked. The piece is now ready for the furnace, but it should not be baked hard enough to gloss the newly applied body; it should have more the appearance of Parian marble.

"This being done, it is then withdrawn from the furnace and transferred to a cooling muffle as before described. When sufficiently cool, the gum enamel is applied and baked with a sharp heat until it becomes smooth and glossy. To prevent the old gum from bleaching or becoming lighter colored in consequence of repeated bakings, a very thin coating of fresh gum enamel should be lightly brushed over the entire enamelled surface of the piece. The enamel thus applied should be mixed with water, quite thin, so as to flow evenly over the surface when applied with a camel's-hair brush. This should be done before the last baking, that the whole may be fused at the same time. Experience and judgment are essential requisites in order to produce good practical results. For example, if the carving of the body is not properly done, the form and shading of the gum and roof will not appear natural when the work is finished; if the gum enamel is put on too thick it will produce a dark-red color; if not thick enough it will be too light; if fused too hard it will be liable to craze or crack; if not hard enough it will be rough or granular; if the piece becomes gassed in baking it will be porous and of a bluish color. Again, the teeth of different persons vary as much as any feature of the face, and present as great a variety of expressions. Therefore, in the construction of artificial dentures, the dentist should select and arrange the teeth with special reference to each individual case. The length, size, form, shade, and position of the teeth should be varied to meet all the different physiognomical requirements that occur in dental practice.

"This system also combines with great advantage the restoration of the face in cases where the muscles have become sunken or fallen in from the loss of the teeth and consequent absorption of the alveolar processes. Here, again, the artistic skill of the dentist is brought into requisition. He should study the face of his patient as the artist studies his picture, for he displays his genius not upon canvas but upon the living features of the face; and of how much more importance is the living picture, that reflects even the emotions of the heart, than the lifeless form upon canvas. He should know the origin and insertion of every muscle of which the face is formed, and what ones he is to raise, otherwise he will be liable to produce distortion instead of restoration. This improvement consists of prominences made upon the denture of such form and size as to bring out each muscle or sunken portion of the face to its original fulness; and when these are rightly formed they are not detected by the closest observer. There are four points of the face (of many persons) which the mere insertion of the teeth does not restore, viz., one upon each side beneath the malar or cheek-bone, and also a point upon each side of the base of the nose, in a line toward the front portion of the malar bone.

"The extent of this falling-in varies in different persons, according to their temperaments. If the lymphatic temperament predominates, the change will be slight. If nervous or sanguine, it may be very great. The muscles situated upon the sides of the face, and which rest upon the molar or back teeth, are the zygomaticus major, masseter, and buccinator. The loss of the above teeth cause these muscles to fall in. The principal muscles which form the front portion of the face and lips are the zygomaticus minor, levator labii superioris alaeque nasi, and orbicularis oris.

"These rest upon the front, eye, and bicuspid teeth, which, when lost, allow the muscles to sink in, thereby changing the form and expression of the mouth.

"The insertion of the front teeth will in a great measure bring out the lips, but there are two muscles in the front portion of the face which cannot, in many cases, be thus restored to their original position; one is the zygomaticus minor, which arises from the front part of the malar bone, and is inserted into the upper lip above the angle of the mouth; the other is the levator muscle, which arises from the nasal process and from the edge of the orbit above the infraorbitar foramen. It is inserted into the ala nasi or wing of the nose and upper lip.

"The prominences before mentioned, applied to these four points of the face, beneath the muscles just described, bring out that narrowness and sunken expression about the upper lip and cheeks to the same breadth and fulness which they formerly displayed. If skill and judgment have presided over all parts of the operation, the result will be highly pleasing, and of practical utility."*

Dr. Hunter's Formulas and Modes of Practice.—The following methods of compounding and applying the continuous gum materials, as practiced by Dr. W. M. Hunter, are reproduced from his latest published descriptions in 1852.

The following is a description of the materials and compounds employed:

"*Silex* should be of the finest and clearest description, and kept on hand ready ground, the finer the better.

"*Fused spar* should be the clearest felspar, such as is used

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* Inasmuch as the improvement for restoring the face has been claimed by others, the reader is referred for the evidences establishing the claim of Dr. Allen to priority of invention to the historical record which appears in the old American Journal of Dental Science of 1845. In the published proceedings of the American Society of Dental Surgeons of that year, it will be seen that a medal was awarded to one of its members, inscribed, "Awarded to Dr. John Allen, for his invention for restoring the contour of the face, August, 1845." This, in connection with the fact that no other record upon this subject is found in our dental literature, fixes the date of this improvement.

by tooth manufacturers for enamels, completely fused in a porcelain furnace, and ground fine.

"*Calcined borax* is prepared by driving off the water of crystallization from the borax of commerce, by heating in a covered iron vessel over a slow fire, and it is better to use immediately after its preparation, as it attracts moisture. It should be perfectly clean and white, and free from lumps.

"*Caustic Potassa Optimus.*—Known also as potassa fusa.

"*Asbestos.*—Take the ordinary clean asbestos, free it from all fragments of talc or other foreign substances, and grind fine, taking care to remove any hard fragments that may occur.

"*Granulated Body.*—Take any hard tooth material (I use the following formula: spar 3 ozs., silex 1½ ozs., kaolin ½ oz.) and fuse completely. Any very hard porcelain, wedgewood ware, or fine china will answer the same purpose. Break and grind so that it will pass through a wire sieve, No. 50, and again sift off the fine particles which will pass through No. 10 bolting cloth. It is then in grains about as fine as the finest gunpowder.

"*Flux.*—Upon this depends the whole of the future operations, and too much care cannot be taken in its preparation. It is composed of silex 8 oz., calcined borax 4 oz., caustic potassa 1 oz. Grind the potassa fine in a wedgewood mortar; gradually add the other materials until they are thoroughly incorporated. Line a Hessian crucible (as white as can be got) with pure kaolin, fill with the mass, and lute on as a cover a piece of fire-clay slab with the same. Expose to a clear strong fire in a furnace with coke fuel for about half an hour, or until it is fused into a transparent glass, which should be clear and free from stain of any kind, more especially when it is used for gum enamels. Break this down, and grind until fine enough to pass through a bolting cloth, when it will be ready for use.

"*Base.*—Take flux 1 oz., asbestos 2 oz., grind together very fine, completely intermixing. Add granulated body 1½ oz., and mix with a spatula to prevent grinding the granules of body any finer.

"*Gum Enamels.*—No. 1. Flux 1 oz., fused spar 1 oz., English rose 40 grains. Grind the English rose extremely fine in a wedgewood mortar, and gradually add the flux and then the fused spar, grinding until the ingredients are thoroughly incorporated. Cut down a large Hessian crucible so that it will slide into the muffle of a furnace, line with silex and kaolin each one part, put in the material, and draw up the heat on it in a muffle to the point of *vitrifaction*, not *fusion*, and withdraw from the muffle. The result will be a red cake of enamel, which will easily leave the crucible, which, after removing any adhering kaolin, is to be broken down and ground tolerably fine. It may now be tested, and then (if of too strong a color) tempered by the addition of covering. This is the gum which flows at the lowest heat, and is never used when it is expected to solder.

"No. 2. Flux 1 oz., fused spar 2 oz., English rose 60 grains. Treat the same as No. 1. This is a gum intermediate, and is used upon platina plates.

"No. 3. Flux 1 oz., fused spar 3 oz., English rose 80 grains. Treat as the above. This gum is used in making pieces intended to be soldered on, either in full arches or in the sections known as *block-work*. It is not necessary to grind very fine in preparing the above formulas for application.

"*Covering.*—What is termed covering is the same as the formulas for gum, *minus* the English rose, and is made without any coloring whatever when it is used for tempering the above gums which are too highly colored, and which may be done by adding, according to circumstances, from 1 part of covering to 2 of gum, to 3 of covering to 1 of gum, thus procuring the desired shade. When it is to be used for covering the base prior to applying the gum it may be colored with titanium, using from two to five grains to the ounce.

"*Investient.*—Take two measures of white quartz sand, mix with one measure of plaster of Paris, mixing with just enough water to make the mass plastic, and apply quickly. The slab on which the piece is set should be saturated with water, to keep the material from setting too soon, and that it may unite with it.

"*Cement*.—Wax 1 oz., rosin 2 oz. The proportions of this will vary according to the weather; it should be strong enough to hold the teeth firmly, and yet brittle enough to chip away freely when cold. A little experience will enable any one to prepare it properly."

(Inasmuch as the method of constructing the platinum base, with Cleveland's modification of chamber as described by Dr. H., has already been introduced, this portion of the description is omitted in this connection.)

"After the plates are perfectly adapted to the mouth, place wax upon each, which trim to the proper outline as regards length and contour of countenance, marking the proper occlusion of the jaws and the median line. These waxen outlines are called the *drafts*, and are carefully removed from the mouth, and an articulator taken by which to arrange the teeth.

"When the absorption is considerable and the plate in consequence is rather flat, it is necessary to solder a band or rim along the line where the upper draft meets the plate, about one-sixteenth or one-eighth of an inch wide, and fitting up against the outline of the draft. When the ridge is still prominent, the block will not of course be brought out against the lip so much, and a wire may be soldered on instead of the wider band. I think one or the other necessary, as it gives a thick edge to the block, rendering it far less liable to crack off than if it were reduced to a sharp angle; it also allows the edge of the plate to be bent in against the gum, or away from it, as circumstances may require, and affords in many cases a far better support for the plates than can be given to one in which the band is *struck up*, or the edge turned over with pliers, where the block must extend to the edge of the plate. Some few cases do occur when the band may be struck as far back as the bicuspids with advantage, and some in the lower jaw where it is necessary to solder on the band, but the general practice is not so.

"The upper teeth are first arranged on the plate antagonizing with the lower draft, supported by wax or cement, or both. Then remove the lower draft and arrange the lower teeth so that the coaptation of the cutting edges of the teeth shall be perfect as desired. The patient may now be called in again, and any change in the arrangement made to gratify his or her taste or whim. Now place the plates with the teeth thereon, on their respective casts, oil the cast below the plate and apply plaster of Paris over the edge and face of the teeth and down on the cast, say an inch below the edge of the plate. This will hold them firmly in their place while you remove the wax and cement from the inside, and fit and rivet backs to the teeth. When backed, cut the plaster through in two or more places, and remove. Clean the plate by heating. Cut the plaster so that while it will enable you to give each tooth its proper position, you can readily remove it from the teeth when they are cemented to the plate. Adjust the sections of plaster and the teeth in their proper positions. The plaster may be held by a piece of soft wire. *Cement* the teeth to the plate and strengthen the cement by laying slips of wood half an inch long along the joint and against the teeth. (I generally use the matches which are so plenty about the laboratory.) Remove the sections of plaster, being careful not to displace any of the teeth. If it be intended to cover the strap with enamel, you should solder a wire after backing, and previous to replacing the teeth, along the plate parallel with the bottom of the straps, and about $\frac{1}{8}$ or $\frac{1}{4}$ of an inch from them.

"The teeth are now backed and cemented to the plate, and present an open space between the plate and the teeth, which is to be filled up with the base, using it quite wet to fill up the small interstices, filling in the rest as *hard and dry as possible.* Fill the cavity *between* the plates in the same manner, and oil the edge. Oil the surface of the base, envelop in the investient (precisely as you would put an ordinary job into plaster and sand for soldering), and set on a fire-clay slab previously saturated with water. When hard chip away the cement, cooling it if necessary with ice, until it is perfectly clean. Along the joints place scraps and filings of platina very freely, and cover all the surface you wish to enamel with coarse filings, holding them to their place by borax ground fine with water. Apply pure gold as a solder quite freely, say two dwt. or more to a single set. Put in a muffle and bring up a gradual heat until the gold flows *freely*, which heat is all that will be needed for the base; withdraw and cool in a muffle. Remove the investient and fill up all crevices and interstices not already filled, with covering No. 2; cover the straps and base with the same, about as thick as a dime, and cover this with gum No. 2 about half that thickness. At the same time enamel the base in the chamber, and cover with thick soft paper. Set the plate down on the investient on a slab, with the edges of the teeth up. Fuse in a muffle, and the work is completed. Blemishes may occur in the gum from a want of skill in the manipulation; should such occur, remedy by applying gum No. 1.

"Should the patient object to the use of platina as a base, the work can be made as above on an alloy of gold and platina 20 carats fine, and soldered with pure gold, etc., as above. In all cases, however, where it is used, the upper plate should be made as I have described above, but with platina any kind of plate can be used.

"*Ordinary Alloy.*—Blocks may be made and soldered to the ordinary plate if the absorption is sufficient to require much gum, without any platina. Arrange the teeth on wax on the plate, fill out the desired outline of gum, and apply plaster one-fourth of an inch thick over the face of the teeth, wax and cast. When hard, cut it into sections (cutting between the canines and bicuspids), remove the wax from the plate and teeth, bind the sections of the plaster mould thus made to their places with a wire, oil its surface and that of the plate, fill in the space beneath the teeth with the base, wet at first, but towards the last as hard and dry as possible, and thoroughly compacted. Trim to the desired outline on the inside, oil the base, and fill the whole palatal space with investient, supporting the block on its lingual side. Remove the plaster mould, and cut through the block with a very thin blade between the canines and bicuspids. Take the whole job off of the plate, and set on a fire-clay slab with investient, the edges of the teeth down; bring up the heat in a muffle to the melting-point of pure gold. When cold, cover and gum with No. 3 gum and covering.

"Another mode is to back the sections with a continuous strap (using only the lower pin), fill in the base from the front, use covering and gum No. 3, finish at one heat. When the blocks are placed upon the plate, the other pin is used to fasten the gold back, which is soldered to it and the platina half-back; neither of these backs need be very heavy, as soldering the two together gives great strength and stiffness. Very delicate block-work can be made in this way, and it is applicable also, where a few teeth only are needed.

"A very pretty method, where a section of two or four teeth (incisors) is needed, and only a thin flange of gum, is to fit gum teeth into the space, unite by the lower platina with the continuous back, and unite the joint with gum No. 3. A tooth left ungummed by the manufacturer would be best for the purpose. The same may be applied to blocks for a full arch, remembering not to depend entirely upon platina backs.

"The method I prefer for full arches on ordinary plate, is to take a ribbon of platina, a little wider than the intended base, and of the length of the arch, cut it nearly through in five places, viz., between the front incisors, between the lateral incisors and canines, and between the bicuspids. Adapt it to the form of the alveolar ridge with a hammer and pliers, and swage on the plate along where the teeth are to be set. Solder up the joints with pure gold, and proceed to back the teeth, etc., as before; making preparations for fastening, and removing the slip of platina from the gold plate before enveloping in the investient, when proceed as before.

"When the teeth are arranged, insert four platina tubes, about one line in diameter, two between the molars, and two between the cuspidati and bicuspids, and solder to the platina base. These are designed, after the teeth are finished, to be the means of fastening to the gold plate, either by riveting in the usual way, or by soldering pins to the gold plate passing up through the tubes, fastening with sulphur or wooden dowels.

By these methods we are enabled to readily remove the block and repair it, should it meet with any accident, and also, in case absorption should go on, to restrike the plate, or to lengthen the teeth. The rim should be put on the gold plate after the block is finished; it gives great additional strength and a beautiful finish.

"*Memoranda.*—In preparing material always grind dry, and the most scrupulous cleanliness should attend all of the manipulations. In all cases where heat is applied to an article in this system, it should be raised gradually from the bottom of the muffle and never run into a heat. Where it is desired to lengthen any of the teeth, either incisors or masticators, or to mend a broken tooth, it may be done with *covering*, properly colored with platina, cobalt, or titanium.

"In preparing a piece of work, wash it with great care, using a stiff brush and pulverized pumice-stone. Bake over a slow fire to expel all moisture, and wash again, when it will be ready for any new application of the enamel. Absorption, occurring after a case has been some time worn, by allowing the jaws to close nearer, causes the lower jaw to come forward and drive the upper set out of the mouth. By putting the covering on the grinding surface of the back teeth in sufficient quantities to make up the desired length, the coaptation of the denture will be restored, and with it the original usefulness.

"Any alloy containing copper or silver should not be used for solder or plate, if it is intended to fuse a gum over the lingual side of the teeth, as it will surely stain the gum. Simple platina backs alone do not possess the requisite stiffness, and should always be covered on platina with the enamel, and on gold with another gold back. In backing the teeth, lap the backs or neatly join them up as far as the lower pin in the tooth, and higher if admissible, and in soldering, be sure to have the joint so made *perfectly soldered.*"

Dr. Haskell's Methods.

"It should be borne in mind that the strength of this work depends mainly upon the *metal*, and not upon the *porcelain*, though the latter adds to its strength. While platinum is a very soft metal, yet, by means of various devices, the plate, with the teeth properly soldered on, and ready for the porcelain, can be made very stiff and strong, therefore everything that can be done to secure a strong foundation should be carefully observed.

"The plate should be of the best French material (not remelted scraps and old plates), 29 to 30 gauge for the upper, and 26 to 28 for the lower, and should be swaged on Babbitt metal dies. The plate is then tried in the mouth, and if the fit is found to be correct, arrange the articulating wax, secure the 'bite,' and make the articulating model.

"The back of the plate should be doubled, for the following reasons: It imparts increased strength; leaves some margin for change, in case of necessity, after the work is in the mouth; protects the edge of the porcelain; and admits of a neater finish. This 'doubler' should be about three-sixteenths of an inch wide, with the edge turned up slightly to receive the porcelain. Around the outer edge, solder a flattened wire, one-sixteenth, or less, of an inch wide, and 22 gauge, bringing the ends to meet the turned edge of the doubler. This strengthens the plate, and affords a good round finish to the edge, as well as protection to the porcelain. This is easily put on after a little practice, and is far preferable to *turning* the edge of the plate with pliers, or otherwise. Pure gold should always be used for soldering, and with just enough borax (using very little) to give direction to the flow of solder.

"Then comes the arrangement of the teeth, and this should always be done in the mouth, the articulating model being only a preliminary guide; for by the mouth alone can one determine the correct expression and arrangement desired; and it is just here that three-fourths or more of the artificial dentures fail in an utter lack of artistic skill. In this work there is ample opportunity for the display of taste and skill, so that perfection itself is attained at the hands of the true artist.

"The *investing* process comes next. First, a coat of shellac over the teeth to prevent etching (although if this occurs, it is not a matter of much account, as the baking remedies it). Then a *thin* coat of clear plaster; next plaster and asbestos, one part of the latter to two of the former. Let the portion under the plate extend at least one inch back of the latter, as this bottom portion is to be retained to bake the case on; invest the whole one-half inch thick. Warm the case until the plate is sufficiently heated to remove the wax easily; dash boiling water over it (this is the best method to remove wax adhering to teeth and plate in all kinds of work). The backings should be *continuous*, and be *lapped* on to the plate, for in this is the main stay of the work for strength. Cut patterns in tin or lead, three pieces, one for the six front teeth, and one for each side, lapping over the eye-teeth; the foot-piece should lap on to the plate about three-sixteenths of an inch. No borax is needed. The gold should be melted and rolled into a ribbon as thin as possible, and cut in small pieces and laid under the lap, or foot-piece, and a piece under each pin. The backings can be fitted more easily by slitting the foot-piece. The most convenient method of soldering is in the furnace, being careful not to let it remain too long, so as to fuse the enamel on the teeth. If a pin should fail to solder, it is not material, as the 'body' will hold it.

"After cooling, remove the plaster, and save the base. If any teeth are etched, sandpaper them and remove every particle of plaster; with a sharp instrument scarify the surface of the plate. Place the plate on the articulating model, and if it is sprung, press it into place, which is very readily done.

"The 'body,' and enamel or gum color, as prepared by S. L. Close, is the only reliable material to be had, as Dr. Allen no longer furnishes it for the trade. Apply the 'body' mixed with water, quite thin, by means of an oval-pointed knife, occasionally jarring with handle of spatula, and as the moisture comes to the surface, absorb with a cloth; after it is well filled into all interstices, apply it thicker, jarring, absorbing, and packing hard, until enough is on the outside to produce the proper shape and contour of the lips. Then apply, with the *curved* point of knife, the body to the lingual side of the plate, same as on the outside, but only a thin coat on the plate. Trim around the necks of the teeth, remove all particles from *between* with a quill toothpick, and brush all particles off the surface of the teeth and exposed portions of plate, and the case is ready for baking.

"The Philadelphia furnace, sold by all dealers in dental goods, we prefer. It is always best to use the largest size, No. 1, yet No. 2 will do if the larger size cannot be had. Be sure of a good draught. The furnace can be used as it comes; a better plan is to knock the bottom out of the lower section, get longer bars, that will extend some distance through the front, the two centre ones at least 18 inches. Build a hearth, two bricks thick and three feet square; build an inclosure of brick, about 12 inches high, large enough to set the furnace on, and line with fire-brick. Provide a sheet-iron cover for the front to close the draught.

"In setting the 'muffle,' see that the vent-hole in the top is clear; this is for escape of gas that may be in the muffle, and would injure the work. Fasten the front end with fire-clay, but leave the back end free.

"The fuel to be used must be anthracite coal, or else coke; Lehigh, range size, is the best.

"A sheet-iron shelf, the edge bent into the space between the furnace and cover, and with a leg riveted to it and resting on the long bars, is needed to set the case on, to heat up and run into the muffle gradually. Set the case ten or twelve inches from the opening, move forward, every ten or fifteen minutes, a couple of inches, until it is in the muffle; place it within two inches of the back, and close the door. If the heat is right, five or ten minutes will suffice; still it must be looked at so as not to get too much heat. This first bake should be only a glaze. Remove to a muffle on the hearth, and close up tight. When cool, place on the model, and, if sprung, press it into place. Next fill up all the cracks with very thin body, jarring with handle of the spatula often, so that the material will fill up thoroughly; then spread on thicker until the proper shape and fulness are secured, trimming around the teeth, and doing as previously described, and bake as before, only more so; it should be *glossy*. After cooling, the enamel is to be put on the same as the body, applying only a thin and uniform coat. The rugæ can be produced in the body or in the gum. The enamel should have a thoroughly glossy appearance when ready to remove from the furnace. Heated cooling muffles are unnecessary, as the case itself will heat the muffle all that is necessary.

"Lower sets are better without a binding, as it is sometimes necessary to file or grind away the edge. Use plate No. 8, or even thicker, and solder on the edge a narrow strip, *flat*.

"The case is finished by filing and polishing the exposed metal surface, not doing anything to the upper surface.

"A 'defined' air-chamber is rarely necessary,—a Cleveland chamber, never. Raise the plate over the hard palate with a thin film of wax on the plaster cast, chamfering off the edges completely; scrape the plaster model across the back, except right in the centre, according to the softness of the palate.

"This work *is not advisable* for partial sets, except in some partial lower cases where there are no detached teeth. In these cases, the plate should be at least two thicknesses across the back of the front teeth, and resting well up on the necks of the same.

"Very few seem to know how to *prepare* a case for repairing. Invest it in plaster and asbestos at least one-half of an inch deep *entirely;* place in the muffle before lighting the fire, and allow it to remain with the door open, as the fire comes up, until it is *red hot;* then remove, cool, and clean off the plaster thoroughly, preserving the *base*, and it can be run into the furnace with as little danger of cracking as if it had never been worn.

"Grind out the remains of the teeth below the margins of the gum; select a *rubber* tooth, as it is easier to get and just as good as one made for this work, filing off the pins; hold with wax until a little plaster and asbestos can be placed over it and the adjoining teeth; remove the wax thoroughly and put on *repairing* body, and bake; cool, put on the gum, having previously ground off a portion of the old gum if it is a very old case, and put on just a little new, and bake as at first.

"If blisters occur, grind into them and fill with *body and gum*, three to one, press hard, and enamel."

Dr. Field's Methods.

"When the platinum has once touched the metal dies, never place it under the blowpipe without its having been *thoroughly pickled*. This is often neglected, and the consequence is that the plate will become more or less discolored from the absorption, under heat, of the baser metal into the platinum. When the teeth are properly arranged with wax on the plate, as directed by Dr. Allen, invest, *but use no sand*, simply plaster and asbestos. My reason for this I will give further on.

"After the investment has become sufficiently hard to handle, the backings may be adjusted, and here I shall differ somewhat with Dr. Allen, for, instead of the *continuous* backing, I back each tooth separately, and for two reasons, one of which is, that I think my job will be *stronger* when completed, by allowing the body to be well worked in between, below, and completely around the teeth without a platinum wall, as it were, separating the body on a line running completely around the alveolar ridge, and only just touching over the top of this platinum.

"My second reason is that, should the teeth be drawn out of place any, as they are sometimes by the investings cracking and pulling away from the plate, the single backing of each tooth admits of a much easier and more perfect readjustment than when the backing is continuous. Make the backings of a somewhat V shape, that is, let them be a little narrower at the top than where they come in contact with the plate; bend up the lower part of the backing to the extent of about one-sixteenth of an inch, and at such an angle that when placed in position behind the platinum pin, to which it is to be soldered, it shall fit fairly and squarely on the plate; put in position and press down your pin on it, first having placed a piece of, say number 20, gold foil, folded two or three times on itself, one-sixteenth of an inch square, against the backing, so that when the pin is bent down upon it, it shall hold it from slipping away; then with a pair of ordinary plugging pliers squeeze the foil up to and around the pin; then place one or two pieces of solder (pure gold) just *behind*, and close against, the heel of the foot-shaped backing. By placing it here, the danger of it slipping away when the borax calcines under heat is avoided. The *less solder* you use, and still have your teeth fastened, the better, for the reason that the gold flowing at a less heat than that required for the fusing of the body, *the gold is in a state of fusion when the body has set*, and there will be no adhesion between the gold and the body. Now solder as most convenient. I find the Fletcher furnace an admirable contrivance for this purpose, ten minutes being all the time necessary to complete the work. Remove the investing carefully, *and preserve it all* for future use. The plate is then tried in the mouth, and the teeth nicely adjusted to those with which they are to antagonize.

"Everything is now ready for the first baking. Pour out upon a clean butter plate the amount of body required, into which pour sufficient pure water to make a *thin* paste, and then begin the work of moulding and carving your job by filling in between and under all the teeth, tapping your plate gently from time to time; this will bring the water to the surface and settle the body into every nook and crevice. After each tapping, absorb the surface water with a clean napkin; by so doing, you will the better hold the body to its place, and prevent its running where not wanted. Build over the roots of the incisors and cuspids *boldly*, leaving a corresponding depression between the teeth; thus, when the piece is completed, you will have that natural and lifelike appearance as of the roots of the teeth showing slightly through the gum.

"Now take that part of your investing material that covered the teeth when the piece was soldered, and grind up fine, and with it make a cushion on the slab that is to hold the case in the furnace. This cushion should be about one-fourth of an inch thick; then place your piece on this base, *teeth downwards*, and take a small spatula and work the powdered material well up against the teeth, so that the bearing shall be equal under every tooth; this, if properly done, will prevent any *drawing away* of the teeth from their proper position, as is frequently the case when the plate is placed in the muffle with the teeth upwards, the cause being the shrinkage of the body; and now comes my reason for *not using sand* in this investing material, viz., the sand acting as a flux would attach itself more or less to the teeth themselves, and I have seen this thing carried so far, when the heat was a little too high, as to solidly fuse teeth and slab together.

"The piece is now ready for the first baking, and this should be carried no farther than to *shrink* the body as much as possible, not going beyond a semi-fuse. After this is completed, and the case cooled, proceed to fill up all cracks and shrinkage by the application of more body, when the case is ready for the second baking. This should be done with the plate reversed, teeth upwards, using for a support that part of the investing which came in contact with the platinum, and which should be preserved unbroken. In this second baking of the body, care should be taken that it be not overdone. A piece properly baked will present a beautifully granulated appearance, the tips of the granules sparkling like little dewdrops. Carrying the heat beyond the stage necessary to produce this effect, vitrifies the body, thereby very much lessening the strength of the work when completed.

"If now it is found that a third body is not required (and it rarely is if proper care has been taken with the work so far, although occasionally it may be necessary) proceed with the enamelling as directed by Dr. Allen. Should there be any little rough spots on the teeth, caused by overheating when soldering, paint them over with a little clean pulverized borax mixed with water; this will flow the tooth enamel, and cause them to come out from the muffle as bright and smooth as when they first left the factory.

"The work is now ready for its third and final baking, which should be with a quick, sharp fire. When fused, draw to the front part of the muffle; put in the muffle plug, and then dump the fire, and leave until the furnace is *cold;* by so doing, the case is well annealed, and all danger of checking the enamel avoided. Twenty or thirty minutes now are all that are necessary for what little finishing the plate will require, when it will be ready for the mouth.

"Let it be remembered by the beginner that on the *carving of the first body* largely depends the artistic beauty of the work. Keep your patient's face well before you in your mind's-eye, and reproduce in the porcelain all those little minor details which, when properly arranged and blended together, shall so counterfeit nature's handiwork that that of man's can hardly be detected."

Application of Continuous Gum to Partial Sets.—The following method of constructing partial sets of artificial teeth with continuous gum is taken from a practical and well-written paper on this process by Dr. W. B. Roberts:

"Partial cases may be made of continuous gum; but the work is so various in its nature, that the dentist must necessarily depend much upon his own judgment. Difficult cases will constantly present themselves, that will require the exercise of much study and ingenuity; in which the general instruction that can be given in words, may be of but little service. The first attempt of this kind in my own experience, was in replacing two central incisors. Taking two continuous gum teeth, I placed upon them a platinum lining, slitting this down along the edge of one tooth nearly through the piece and up the edge of the other tooth by a parallel cut, leaving the two parts joined together by a narrow slip. This allowed sufficient motion between the teeth, so that they could be adjusted as desired. I then placed a bit of tissue-paper on the plaster model, covering the spot to be occupied by the teeth and gum, to prevent the adhesion of the body to the plaster, and holding the two incisors in their places, I worked the body into all the depressions of the gum and around the roots of the teeth. I then removed the whole from the model, and placed the piece in a paste of pulverized silex, or plaster and asbestos, upon a slide, and baked as described for full sets. The little slip of platinum kept the two teeth in place. The work shrunk somewhat; but this was remedied by again placing the piece upon the model with the intervention of tissue-paper covered with a thin coating of body. Into this I pressed the piece, till it occupied its true place, and then filled in again with more body all the crevices around the roots of the teeth, and rebaked.

"After enamelling, if the work has been carefully and skilfully done upon this plan, it will be as fine a piece in appearance and fit, as can be made. It may then be soldered to a gold plate, and the little strip of platinum between the teeth be cut out. With the body and gum formerly in use many difficulties were often encountered from discoloration of the gum, or from other injuries incurred in soldering. But with Roberts's material, these are easily avoided, and the piece can be treated the same as a block or single gum teeth. In partial sets on entire plates of platinum, I have sometimes found trouble, from the enamel giving way upon the small narrow points that connect the teeth with the plate, by the shock occasioned in biting. I have consequently left these points uncovered, and used two or three thicknesses of platinum to give greater strength. But where this is likely to occur, gold plates would be preferable, if nicely adapted with single gum teeth, or blocks of continuous gum, as the case might require. I have also applied continuous gum in cases where the natural teeth, from one to five in number, were left in the mouth, by making the plates as in full sets, cutting out around the natural ones, and raising a small bead, or placing a light wire around, about one-eighth of an inch or more from the teeth, against which the gum or body is to be finished. The points around the teeth are to be left free, in order to be burnished down in case of imperfections caused by the difficulty of obtaining exact impressions in these places. In such cases I have sometimes formed a strong standard of several thicknesses of platinum fitting closely against one or more natural teeth, leaving a loophole through which to run a gold clasp for afterward securing the artificial set.

"I have also secured the gold to the standard by rivets of platinum, and sometimes by two or three gold screws, not providing, in these cases, the loophole. These methods are to be preferred to using solder for fastening; for, in case of repair, the clasps are easily removed without leaving any foreign substance; but in case of soldering, however carefully they may be removed, there will remain some alloy, which in the baking heat to which the piece is to be exposed, will be incorporated with the platinum. Even so small an amount of silver as may be in gold coin used for solder will communicate a yellowish tinge to the gum, spoiling the whole work. Many operators in their early practice, I doubt not, experienced this result; and learned that no alloys, especially of silver or copper, can be admissible for soldering this work. I have tried platinum clasps without success, as no elasticity could be obtained, and therefore would not hold upon the teeth. Another source of mischief may properly be noticed in this place. In baking, especially with a new furnace, or with muffles lately renewed, either at the first or second heat, or it may be in enamelling, the piece is sometimes changed in its texture and color, as is supposed by the gases present, and the phenomenon is called gassing the piece. The body becomes porous like honeycomb, and of a bluish color. When this occurs there is no remedy but to place it on the metallic die, remove the whole of the injured part, and replace it with a new coating of body and gum. The teeth are seldom, if ever, thus affected. As a precaution, the muffles should be well ventilated with holes for the passage of the heated air and gases."

CHAPTER XIV.

Vulcanite Base.

While there are undoubtedly many important uses to which vulcanized india-rubber may be applied in the practical departments of dentistry, and for which it would be difficult to find an adequate substitute, yet there are accumulating evidences leading to the conclusion that its total abandonment, as a base for artificial dentures, by intelligent and conscientious practitioners everywhere is an event of the near future.

This anticipated result, in respect to a material which has been almost universally employed as a base for the past twenty years, is assured by the confirmed and steadily increasing distrust of its suitableness for the purpose indicated, and the growing tendency in the profession to return to higher and less objectionable forms of substitution as respects both material and construction.

While what has heretofore been stated in regard to rubber as a base in former editions of this work reflected, as the author then believed, the estimate of its fitness by the profession generally, so, it is believed, does what is now written embody the present judgment of the mass of enlightened practitioners in reference to its unsuitableness and the necessity of its abandonment as a base. That the latter is a consummation "devoutly to be wished," and that it would be in the interests not only of the profession but of all concerned, is scarcely any longer a disputed question, and should the present work ever reach another edition, the author hopes to find in a still more advanced professional and public sentiment authority for classifying it, as a base, among the obsolete methods of substitution.

General Properties of India-rubber.—Caoutchouc, gum-elastic or india-rubber, exists as a milky juice in several plants, but is extracted chiefly from the *Siphonia cahuca*, which grows in South America and Java. It is discharged through numerous incisions made in the tree through the bark, and is spread upon clay moulds, and dried in the sun, or with the smoke of a fire, which blackens it. The juice when first obtained is of a pale yellow color, of about the consistence of cream, and has a specific gravity of about 1.012. In the process of drying, 55 per cent. is lost, the residuary 45 being elastic gum. It immediately coagulates, by reason of its albumen, on the application of heat, the elastic gum rising to the surface. The specific gravity of the juice is diminished by inspissation, becoming 0.925 when hard, and cannot be permanently increased by any degree of pressure. When once stiffened by cold, or continued quiescence, it cannot be restored to its original condition of juiciness.

The inspissated juice, or crude rubber of commerce, is altogether insoluble in water or alcohol, but is readily soluble in ether deprived of its alcohol by washing, affording a colorless solution. On evaporation of the ether, the gum resumes its original condition. It swells to thirty times its bulk when treated with hot naphtha, and if triturated in this condition in a mortar, and pressed through a sieve, furnishes a homogeneous varnish employed in the preparation of a waterproof cloth.

Caoutchouc is soluble in the fixed oils, but is not readily decomposed by cold sulphuric acid or diluted nitric acid, and is unaffected by either muriatic acid gas, sulphurous acid gas, fluosilicic acid, ammonia or chlorine, nor is it dissolved by the strongest caustic potash lye, even at a boiling heat, and is therefore highly esteemed as an appliance of the chemical laboratory. According to the experiments of Ure, Faraday, and others, caoutchouc contains no oxygen, as almost all other solid vegetable products do, but is a mere compound of carbon and hydrogen, in the proportion of three atoms of the former to two of the latter. From its property of resisting the corrosive action of acid vapors, and its tenacity of adhesion to glass, caoutchouc, when melted, forms a very excellent lute for chemical apparata.

Such are some of the properties of this remarkable product, the uses of which have been almost immeasurably extended since the first successful efforts to produce artificial induration by Charles Goodyear in 1844.

Compounding Rubber for Dental Purposes.—India-rubber is prepared for vulcanizing by incorporating with it, in varying proportions, either sulphur alone or some of its compounds, sulphur being an essential component of all vulcanizable gum compounds. For dental purposes, the coloring is effected in most preparations by the introduction of vermilion (sulphuret of mercury). These substances, properly combined, are subjected to artificial heat for a specified time, producing a hard, elastic, hornlike substance, possessing the qualities of lightness, strength, durability, imperviousness to fluids, insolubility in the oral secretions, unchangeableness in exposure to ordinary temperatures, etc.

Method of Constructing an Entire Denture in a Base of Rubber.—As the manipulations concerned in the construction of a full upper set differ in no essential respect from those required in the formation of a denture for the inferior arch, except as the two differ in conformation, requiring corresponding modifications of practice which will readily suggest themselves, it will be sufficient to describe the method of constructing an entire denture for the upper jaw.

An impression of the mouth is first secured in the usual manner, and, for full sets, plaster of Paris is preferable to any other material for the purpose. In all practicable cases the same substance may be employed in cases of partial pieces. As rubber, when rendered plastic by heat and subjected to pressure, receives a distinct and perfect impress of the face of the model, it is important that the latter should be as smooth upon its surface, and as free from faultiness of form or surface blemish as possible. From the impression a plaster model is obtained, and if an air-chamber is required, it may be secured either by cutting out from the impression before filling in with plaster for the model, or it may be raised upon the model after the latter has been separated from the impression. For the latter purpose, lead is often used, but sheet tin, cut to the required form, is preferable, as the former leaves a tenacious coating of oxide adhering to the plate.

A temporary or model base plate is next conformed as accurately as possible to the face of the model, and for this purpose the *prepared gutta-percha* is the best, though sheet wax may be used. The former may be softened either by subjecting it to a dry heat until sufficiently plastic, or by immersing it in hot water. The face of the model being previously well saturated with cold water to prevent the wax or gutta-percha from adhering, the latter is pressed or moulded accurately to the model with the fingers moistened with cold water, heating such portions from time to time as do not readily yield to pressure until an accurate adaptation of all portions of the plate is secured; then trim to the required dimensions.

Having fitted the temporary plate to the model, it is placed in the mouth with a wax guide or rim attached, when the latter is trimmed to the required width, fulness, and contour, and the "bite" of the under teeth secured; it is then removed and placed in its proper position on the model, and the heel of the latter extended an inch or more posteriorly to form an articulating surface for the remaining section of the antagonizing model, the latter being obtained in the manner described in connection with metallic plate base. The mode of procedure in case of entire dentures for the upper and lower jaws differs in no respect from that practiced when gold or other metallic plate is used as a base.

Arranging the Teeth.—Having secured an antagonizing model, the teeth are selected and arranged upon the temporary gutta-percha plate in the usual manner. The porcelain teeth used in this process are more commonly in the form of blocks or sections, although either single gum or plate teeth may be employed. Preference is given to the former, because a fewer number of seams or joints are presented for the intrusion of rubber, which, though forming ever so minute a line of separation, mars the beauty of the finished work by an unsightly contrast in color with the porcelain gum, and which is not always possible entirely to exclude. The increased strength of attachment formed by the greater number of pins also renders them more permanent and enduring than single teeth. Teeth made expressly for rubber base were originally manufactured with plain platina pins, longer and heavier than those used in connection with metallic plates (Fig. 126); these, when used, were curved and pressed together, forming loops or hooks to prevent them withdrawing from the rubber. Subsequently, however, the detachment of the teeth was more securely and certainly provided against by the substitution of headed pins (Fig. 127), which rendered their withdrawal from the rubber impossible. For this valuable improvement the

FIG. 126.

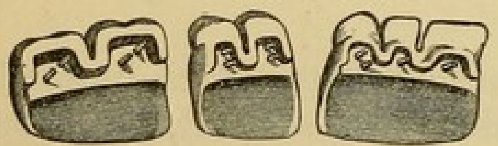
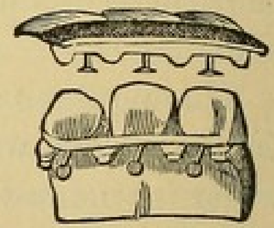


FIG. 127.



profession is indebted to the late Dr. S. S. White, whose genius, enterprise, and intelligence were so long and unceasingly tributary to the needs of the dental practitioner.

In arranging the teeth, portions of the wax rim are cut away to form a bed for each tooth or block, as the case may be, grinding from the base of the latter and from their proximate edges until the proper position is assigned to the teeth, and the required antagonism is secured. The teeth, whether single or in the form of blocks, should be united to each other laterally with the greatest possible accuracy to prevent, as far as practicable, the intrusion of the gum material between them. To further provide against this, various expedients have been resorted to with the view of cementing or packing the joints in order to render them impervious to the rubber. The substances usually recommended for this purpose are, plaster or finely pulverized silex or felspar moistened with dilute liquid silex; os-artificial; soluble glass; gold or tin foil, or fusible metal packed into the joints, etc. Of the more destructible substances mentioned, Professor Wildman very justly observes:* "All of these, in course of time, will yield to the action of the fluids of the mouth; and then the ill-fitted joints will be receptacles for soft particles of food, which will be more objectionable than having them filled with good solid rubber. The best filling is an accurately fitted joint; when so made, if the enveloping plaster is of good quality and properly mixed, and no undue force is used in bringing the section of the flask together, there is little danger of the rubber insinuating itself into the joints." As properly remarked, there is no expedient which will so certainly and effectually exclude the rubber as *close-fitting joints*, and if the precaution is taken to secure an accurate and uniform coaptation of the ground surfaces where they unite in front, and the "enveloping plaster is of good quality and properly mixed, and no undue force is used in bringing the sections of the flask together," there will, at most, be but a very thin film of rubber, nearly imperceptible in the finished work, and wholly so in the mouth. To better effect the object stated, the author has been accustomed, when uniting porcelain blocks, to use a small magnifying glass, which reveals inaccuracies of coaptation not apparent to the naked eye.

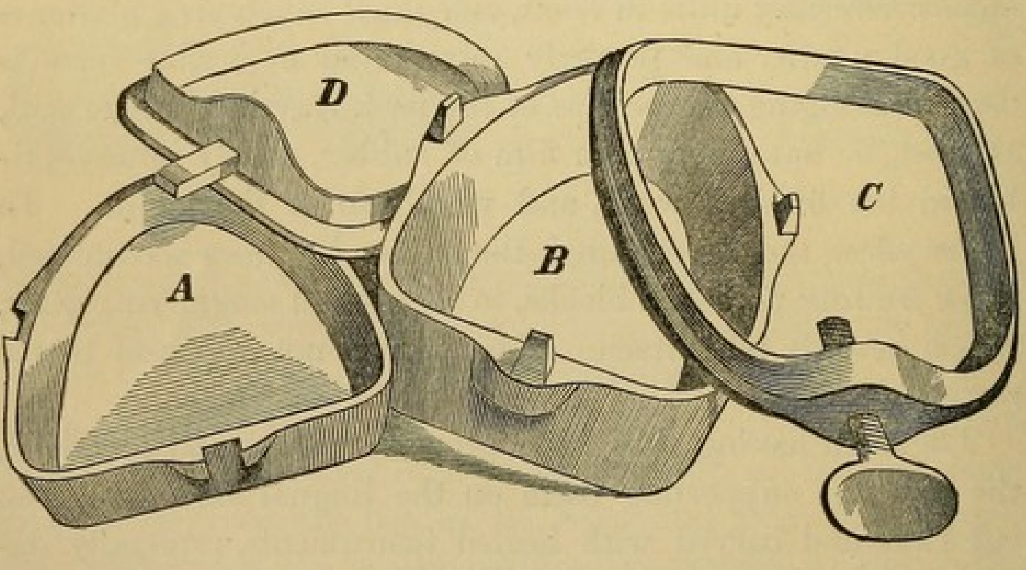
The teeth having thus been properly united and arranged, the wax rim supporting them on the lingual side should be cut away and carved with heated instruments, especially designed for that purpose, until the required form and fulness are obtained, adding wax, if necessary, to the palatal portion of the plate, making it just enough thicker than that required in the completed set to compensate for waste in the process of final finishing. Any considerable excess of material should be avoided, since it will not only materially increase the labor of dressing the vulcanized plate, but tend to induce sponginess of the rubber under heat. A rim of wax should also be extended around the front and lateral borders of the plate, overlapping, somewhat, the extremities of the gum portions of the teeth.

* Instructions in Vulcanite, p. 19.

Wax used for the purposes indicated should be of the cleanest and purest varieties. A model set prepared in the manner described will present the appearance represented in Fig. 129.

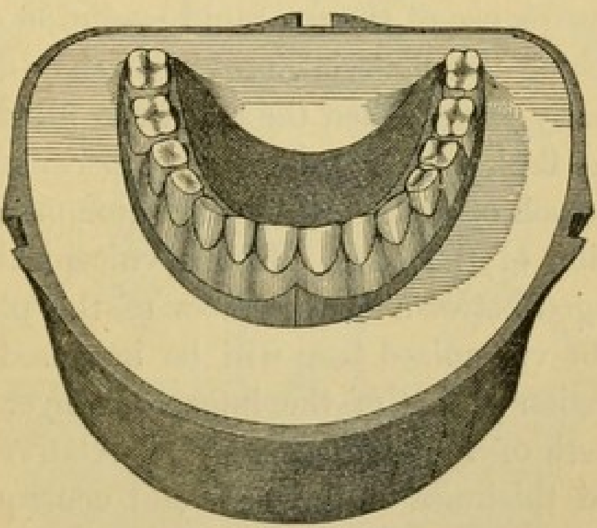
Formation of the Mould or Matrix.—The process having been conducted thus far,—any defects in the arrangement of the teeth having been previously corrected upon trial of the plate in the mouth,—the next step in the operation is the formation of a mould or matrix in which the gum material is packed and pressed preparatory to being indurated or vulcanized. In forming a matrix, a vulcanizing flask is used, the various parts of which are separately represented in Fig. 128.

FIG. 128.



The lower section of the flask *A*, is first filled one-half or two-thirds full of plaster mixed with water to the consistence of cream. Into this the base of the model, previously moistened with water (the plate and teeth being attached to the model), is immersed and additional portions of the plaster added, if necessary, filling the cup even with the upper edge, and extending it up the sides of the model to the lower edge of the external rim of wax attached to the borders of the gum plate. The base of the model should be cut away, so that when placed in the flask the lower edge of the gum plate will extend but little above the level of the upper borders of the cup. The surface of the plaster is then trimmed smoothly, and coated with varnish and then oiled; all the exposed portions of the gum plate and wax are also oiled, leaving the surfaces of the teeth untouched. The several parts will now present the appearance represented in Fig. 129. The upper section of the flask *B*, is next placed in its proper position over the lower,—the slides formed in one, and corresponding grooves in the other, determining an accurate relation of the two pieces. Into the upper rim of the flask, plaster, mixed to the consistence before mentioned, is now poured, filling it completely. The lid or cap *D*, also filled in with plaster, is then applied to

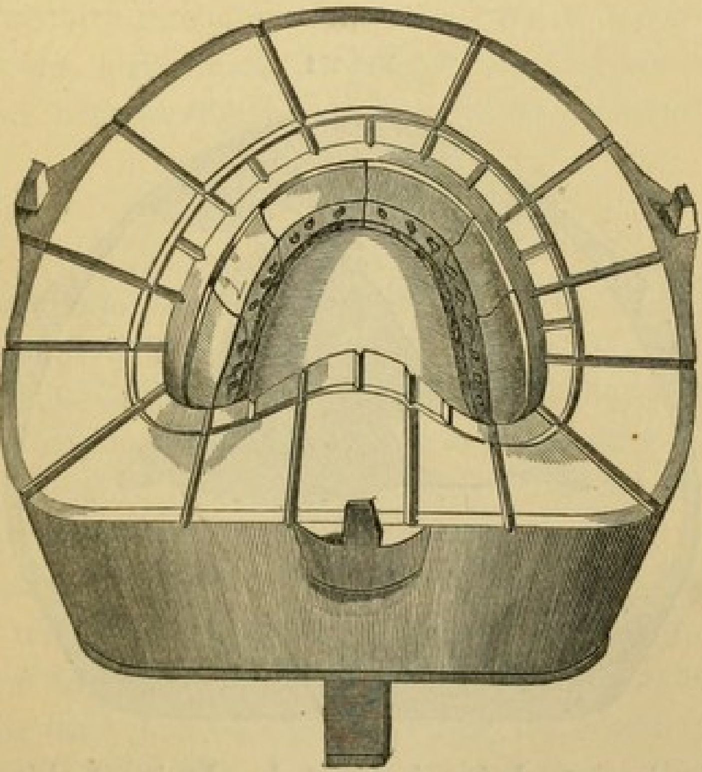
Fig. 129.



the opening above, and the several parts of the flask compressed by placing them within the clamp *C*, and forcing them together with the screw, impacting the plaster and driving out the excess through the joints of the flask. As soon as condensation of the plaster takes place, the flask should be placed in a hot-air chamber or on a stove, and heated throughout sufficiently to soften, but not melt, the wax. The clamp is then removed and the two sections of the flask carefully separated by forcing a small chisel-shaped instrument in at different points between them, the lid closing the opening above remaining in place. On separating the flask, the teeth, with the wax and temporary plate, will be found attached to the section of the matrix last formed, the portions of the crowns of the teeth not covered with wax being imbedded in the plaster and their plate extremities presenting towards the matrix, as seen in Fig. 130. The gutta-percha plate and wax should now be carefully detached with such instruments as will best enable the operator to work out confined portions around the platinum pins and from the interstices between the teeth, being careful at the same time not to deface the plaster surface of the mould. To relieve the matrix more perfectly of all traces of wax not accessible to instruments, the section containing the teeth may be subjected to a heat sufficient to induce its complete absorption by the plaster. The flask should be heated gradually, otherwise the contents may be suddenly and forcibly ejected in consequence of the too rapid evolution of vapor.

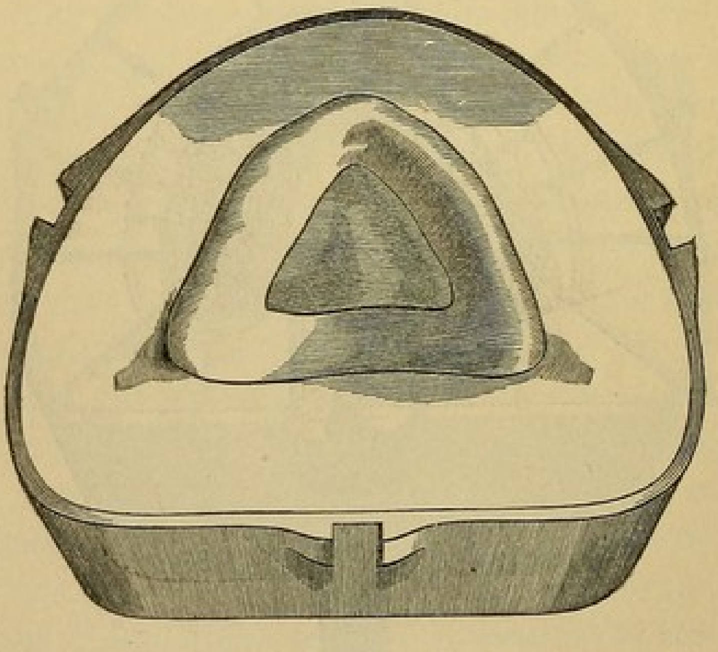
Before packing the material, provision should be made for the escape of any excess when the matrix is filled and the two sections of the flask are forced together, permitting the latter to close upon each other in exactly the same manner as before the introduction of the gum. If the vulcanizable substance becomes engaged between the surfaces of the plaster around the matrix, the vulcanized base will be increased in thickness just in proportion to that of the interposed layer of gum, and hence the teeth of replacement will be relatively elongated. This increased thickness of the base and consequent changed relation of the teeth to the maxillary ridge and to those of the opposing jaw, if but slight, may be immaterial in the application of full sets of teeth, but it is far different in the construction of partial pieces, where the perfection of the finished work depends in so great a degree upon a faultless preservation of the exact position originally assigned to the organs of replacement in the several vacuities on the ridge. If, for example, in replacing the superior incisors, the approximation of the two sections forming the mould is obstructed by the intrusion of the gum material between the plaster surfaces, the teeth, whether plate or gum, will be relatively elongated in proportion to the increased thickness imparted to the base consequent upon the incomplete closure of the flask, and however accurately or skilfully the porcelain teeth may have been originally fitted to the vacuity in front, the artificial will be found to depart from the natural gum, while the porcelain crowns will be displaced and projected below those of the contiguous natural organs. Such displacement in the cases last referred to, however small in degree, cannot fail either to impair or destroy the value, both as respects appearance and utility, of the sub-

Fig. 130.



stitute. The usual method of furnishing an exit to redundant material, is to form a series of conduits or grooves in the surface of the plaster containing the teeth, extending them from the edge of the matrix to the rim of the cup. The escape of the gum will be facilitated by filing notches at intervals around the rim of the flask, making the grooves in the plaster continuous with them, the grooves being an eighth or a fourth of an inch apart. To still more effectually prevent the intrusion of the vulcanite material between the surfaces of the opposing sections of plaster, a circular groove may be cut in the plaster within a line or two of the margins of the matrix, into which narrow channels at short distances are made leading from the mould; others, again, are made at wider intervals from the circular groove to the outer margins of the flask, terminating as before in small notches formed in the rim of the cup. Fig. 130 exhibits the section of the flask containing the teeth with the channels formed as described; the remaining section containing the model is shown in Fig. 131; the two pieces when closed upon each other forming the matrix. Into the grooved section of the mould, the vulcanizable substance is

FIG. 131.



packed previous to being indurated. It is at this stage that the materials employed to exclude the rubber from between the teeth, and noticed in another place, are packed into the joints before the gum material is introduced. The face of the model should also be coated with some substance which will prevent the rubber from penetrating the pores of the plaster, and its adhesion to the surface of the model. Barker's ethereal solution, or the collodion of the shops, may be used for the purpose. Preference is given by Professor Wildman to soluble glass or liquid silex, as being more readily detached from the surface in finishing than the preparation mentioned. The latter should be allowed to dry perfectly before packing. Either of these substances is best applied with a small brush, coating the face of the model uniformly.

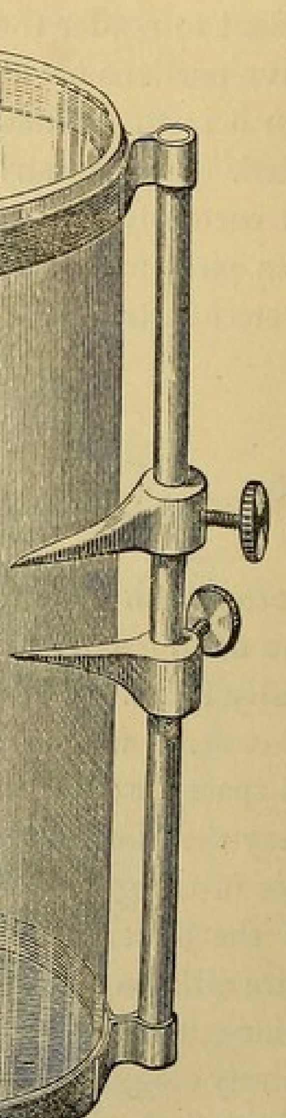
Packing the Mould.—The portion of the flask containing the teeth should be first heated in an oven or furnace, or over the flame of a spirit-lamp, until the temperature of the whole is sufficient to render the vulcanizable gum soft and pliable as successive portions are applied and pressed into the mould, and to retain it in that condition until the operation of packing is completed. Narrow strips of the gum material should first be worked carefully into the contracted groove underneath the platinum pins with small curved or straight-pointed spear-shaped steel instruments (Fig. 132), adding on small pieces at

FIG. 132.

a time after each successive portion is thoroughly impacted, until the main groove of the matrix over the base of the teeth is partially filled. The palatal convexity of the mould may then be covered with a single piece cut to the form of the uncovered space; a smaller piece of the same general form as the latter may then be added, giving to the central portion a double thickness of the gum plate material, so that when the two sections of the flask are brought together, the excess of gum in the centre will be forced gradually to the margins of the mould, diminishing, thereby, the liability of the grooves becoming prematurely clogged with the material before the opposing sections of the flask close upon each other. Especial care should be taken in the process of packing to avoid contact of the instruments with the surface of the mould, as fragments of the broken plaster are liable to mix with the gum and render the surface of the finished work imperfect by forming small pits wherever such particles occur.

In regard to the quantity of rubber necessary to fill the matrix perfectly, experience in its use will enable the operator to estimate the capacity of the mould with tolerable accuracy. Some small *excess* of rubber should always be provided. The required quantity, however, can be more certainly determined by *measurement* or *weight*. A very simple instrument (Fig. 133), contrived by Mr. E. T. Starr, may be used to determine the

FIG. 133.



quantity by measurement. The vessel being partly filled with water, the lower point is adjusted and fixed with a screw to mark its height. Into this every particle of the model plate is immersed, and the rise of water indicated in the same manner by the upper point. The vessel is then emptied and well cleansed, clean water filled into the level of the lower point, when rubber is added in sufficient quantity to bring the surface of the water on a level with the upper point; to this is to be added the necessary excess of rubber before recommended.

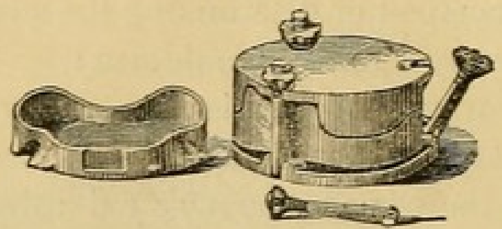
The following method of determining the quantity of rubber by *weight* is given by Professor Wildman:

"The specific gravity of wax is .96. I have found that of the American Hard Rubber Company's prepared gutta-percha to be 2.454, and the same company's red rubber to be 1.572. Hence, to fill the mould, when pure wax is used for a model plate, it will require to one part of wax, by weight, 1.6 of the Company's red rubber; and when the plate is made of prepared gutta-percha, it will require to one part of it, by weight, .6 of red rubber. When the wax is colored, the disparity in weight will not be so great as with pure wax.

"Of the two methods to ascertain the quantity of rubber, that by measure offers an advantage over that by weighing, in the facility with which it can be arrived at, especially when Starr's instrument is used, the calculation being based upon bulk only; whilst by weight, when the model plate is composed of more than one substance, as it frequently is, of gutta-percha, wax, and sometimes wires introduced to give stiffness, quite an intricate calculation must be made to ascertain the exact quantity."

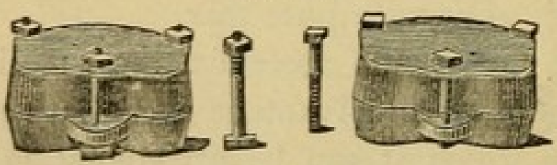
Having completed the packing of the mould, the two portions of the flask are reapplied to each other in exactly their original relation, being careful that the apposition of the two is such that, when approximated, the guides attached to one division of the flask shall pass directly and without obstruction into the grooves or slots in the one opposite. With the flasks first introduced, some difficulty and uncertainty were often experienced in effecting the desired closure of the flask on account of inherent defects of construction, but more recent improvements have entirely obviated this difficulty. Those manufactured by Drs. Hayes and Whitney enjoy deserved popularity, and are, perhaps, in most general use. Fig. 134 represents one of Hayes's flasks, with improved clamps. The lug-joint is so constructed that the strain all comes upon the casting. The pin only serves to keep the lug in place while not in use. The several pieces all being attached together, are

FIG. 134.



not liable to get lost or mislaid. Whitney's flasks, original and improved forms, are shown in Fig. 135. The improvement in construction consists in reversing the position of the

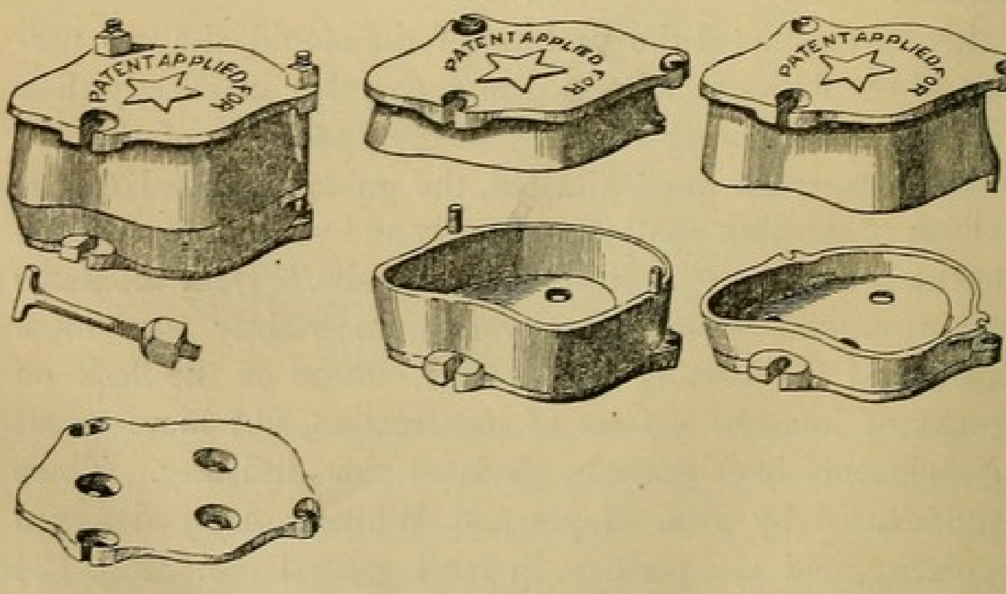
FIG. 135.



bolts, fitting the head into the hole in the lower part of the flask, and using a nut on top.

What is known as the "Starr Flask" is highly commended as fulfilling very perfectly the requirements of practice. An

FIG. 136.



admirable flask, happily meeting some important indications, is represented in Fig. 136. Every operator of experience is familiar with the annoyance and difficulty sometimes attending a satisfactory adjustment of models of unusual depth, often of lower sets, and partial pieces, where the porcelain teeth are secured by the surrounding plaster to the model—difficulties arising from the shallowness of the lower section of flasks as ordinarily constructed. The "*Reversible Flasks,*" invented by Mr. E. T. Starr, the different parts of which are represented in the accompanying cuts, provides very perfectly for any exigency that may arise in the class of cases mentioned. The following description of this flask is taken from the advertising columns of the *Dental Cosmos:*

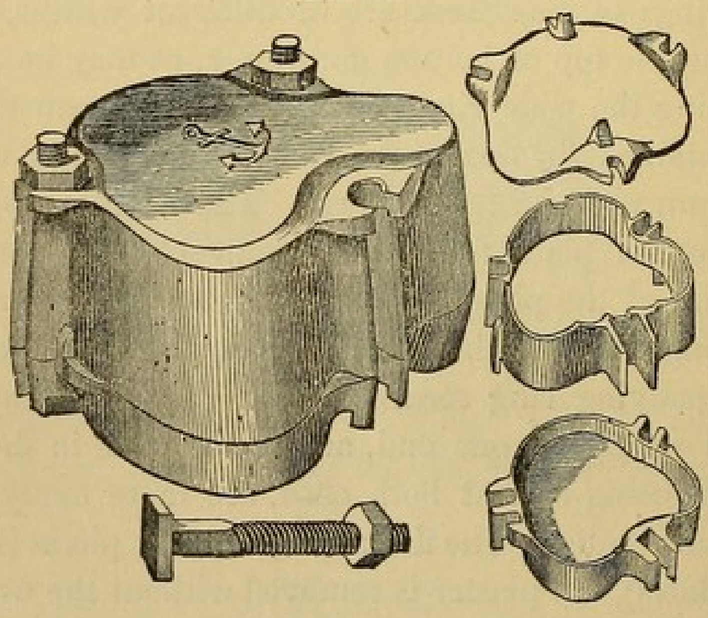
"The rings of this flask are of different widths, either of them fitting the top or bottom accurately, as may be required.

"By using the wide ring next to the bottom, an admirable flask is obtained for deep cases and partial sets, or where the artificial gum rests on the natural. The narrow ring is used next the bottom plate, for whole dentures, where the parting is at the rim of the plate. The bottom has three countersunk holes, through which the plaster runs, and, when set, holds the accompanying ring securely to it. The fastenings of the flask are T-shaped at one end, and fit the slots in the bottom plate; and, being free at both ends, are more easily adjusted than ordinary bolts. The flask being in four pieces (two rings and two plates), the plaster is removed without the usual trouble. The cuts represent the flask in different positions."

The author has, for the past several years, used exclusively, and with the greatest satisfaction, a flask constructed with detached T-shaped bolts fitting accurately into slots or grooves extending continuously from top to bottom of the flask, as represented in Fig. 137. The closure of the sections by this arrangement, with the bolts in place, is unerring, and is accomplished with the greatest facility. It is called the "*Anchor*" flask, furnished by the Philadelphia Dental Manufacturing Company, but the author is unadvised of the name of the inventor.

Whatever flask is used, the entire mass of inclosed rubber should be rendered uniformly plastic, after packing, by subjecting it to either a dry heat, such as may be obtained with a conveniently constructed sheet-iron furnace, the baking apartment of an ordinary cooking stove, or any other available means by which a diffused and uniform temperature may be secured, being careful not to overheat; or, if moist heat is employed, by immersing the flask in boiling water for a time sufficient to soften the rubber. The approximation of the sections of the flask should be effected interruptedly,—alternately heating the entire mass and tightening by means of the screw-bolts until all the redundant material is expelled by degrees

FIG. 137.



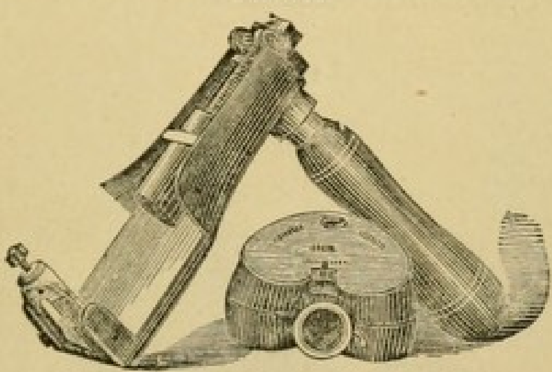
through the outlets provided for it, and the sections of the flask close accurately upon each other.

A somewhat novel and ingenious device employed in packing the mould is exhibited in Fig. 138, known as "Hayes's Condensing Flask."

To form the mould, first smear over the plunger with soap, put into the flask and secure it in place by a turn of the set-screw. Pour in the plaster and place the model in the usual way, allowing the plaster to flow up and take the imprint of the lower half of the plunger. When the teeth are in place the back edge of the plate must be connected with the plunger by a broad strip of wax reaching across its entire face, to form a gateway, or, if an under set, two strips connecting the plunger with the mould on each side opposite the molar teeth. These strips may be thickened a little where they connect with the plunger, to allow a free flow of rubber into the mould. Also lay a narrow strip of wax from the mould to the notch in the front edge of the flask, from which the rubber will protrude and show when the mould is full. Then put on the upper section, fill with plaster, and drive on the cover before the plaster sets.

When hard, first withdraw the plunger, then open the flask and remove the wax in the usual way. Take once and a half as much rubber by measure, or three times as much by weight, as there was of the wax. There is no occasion to warm either

Fig. 138.



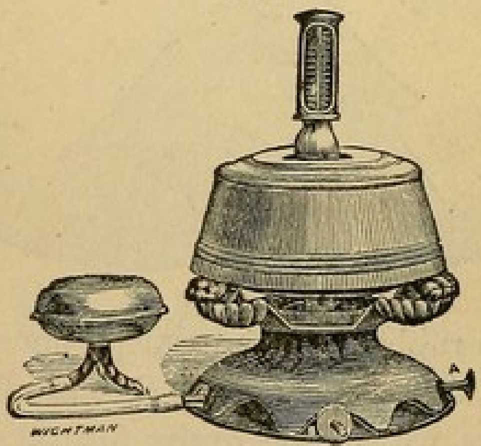
the mould or the rubber. Cut into strips, lay as much into the mould as may be without preventing the flask from closing, and place the balance within the cavity formed by the plunger. Now close the flask, again smear the plunger with soap and press it into the flask as far as it will go. Then connect the flask with the screw-press, turn down the set-screw firmly upon the flask, and place the whole in the open vulcanizer two-thirds filled with water. When it boils freely, turn down the screw—not faster than one revolution a minute—till rubber appears at the opening in front left for that purpose.

Should there be a surplus of rubber, it may be withdrawn with the plunger, by leaving the end without soap; or it may be left in and removed with the plaster after the piece is vulcanized. In either case there is no need of closing the cylinder while vulcanizing, as the rubber in the mould will not be displaced. If desired, however, the cylinder may be filled with plaster or a cork. Should the plunger be used without soap, the rubber will adhere somewhat, but will do no harm, as it is easily removed by a cloth moistened with kerosene or naphtha. In driving on the cover, or removing it from the flask, a few light blows with a small mallet serves the purpose best, and will not batter the metal.

The packing accomplished, the piece is ready for the vulcanizing process.

Vulcanizing.—The process of vulcanizing or hardening the various rubber compounds employed for dental purposes is effected by subjecting them for variable periods of time to the action of heat, the substances to be acted on being confined within a steam-chamber constructed for the purpose. The

FIG. 139.



time and temperature necessary to produce the requisite induration differ with the various compounds in use, and, to some extent, are influenced by the kind of vulcanizing apparatuses employed and which present various modifications of form and mechanism, being constructed, in part, with reference to the source and mode of application of the heat, the former being derived either from coal or charcoal, or other solid combustible substances, or from the flame of a spirit-lamp, gas, or coal oil or some of its products.

As fuel is no longer employed in vulcanizing, any description of the apparatuses specially adapted to this mode of producing heat is deemed unnecessary. They have been entirely superseded by others of improved form and construction adapted to the use of either gas, alcohol, or coal oil and its products, for heating purposes. Fig. 139 represents one of Dr. Hayes's Single Flask Iron-clad Ovens, convenient and compact in form, and capable, it is claimed, of vulcanizing in 40 minutes at a temperature of 320°, with one ounce of alcohol. Instruments of similar construction are produced by the same manu-

FIG. 140.

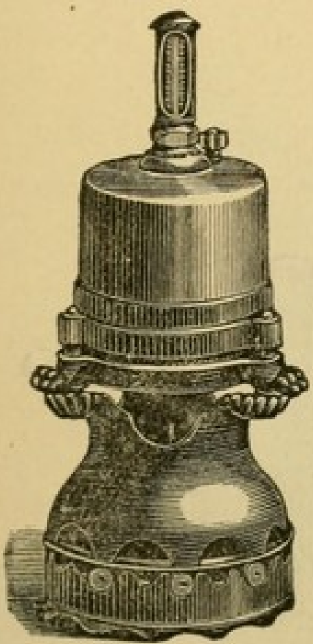
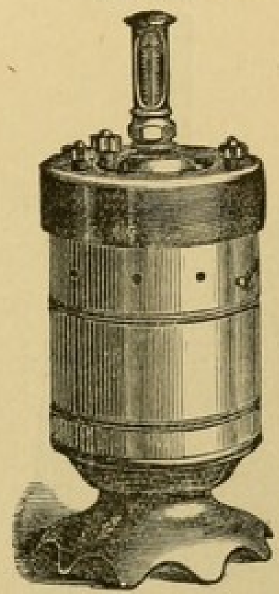


FIG. 141.

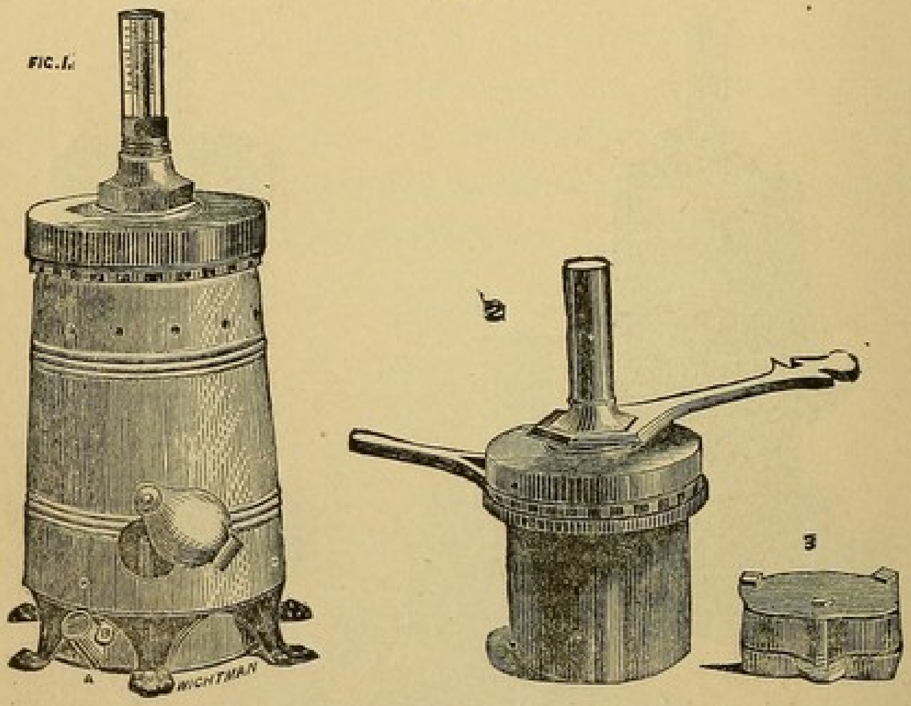


facturer with a larger boiler capacity for from one to three cases, Figs. 140, 141.

The iron-clad improvement in these machines is designed as a protection from the dangers of explosion consequent upon a gradual thinning of the copper boiler from corrosion, a safeguard of great practical value and concern to those who are continually exposed to the perils of such an accident. The shell is made of malleable iron, $\frac{1}{8}$ inch thick—strong enough to resist many times the strain required; and can never be exposed to deterioration. The copper lining is made the same thickness as the copper boilers now in use, and the machine may be used with perfect safety, even when the copper has become as thin as paper, and then, when an opening has been fairly eat through, steam will escape from between it and the iron shell, below the packing joint, giving timely notice that a new lining is required, which can be inserted at moderate expense, and render the vessel good and safe as new.

A peculiar and important feature of these vulcanizers is in placing the thermometer bulb within a mercury bath, outside the steam-chamber, relieving it entirely from the danger of being crushed or checked by the pressure of steam, as is liable

FIG. 142.



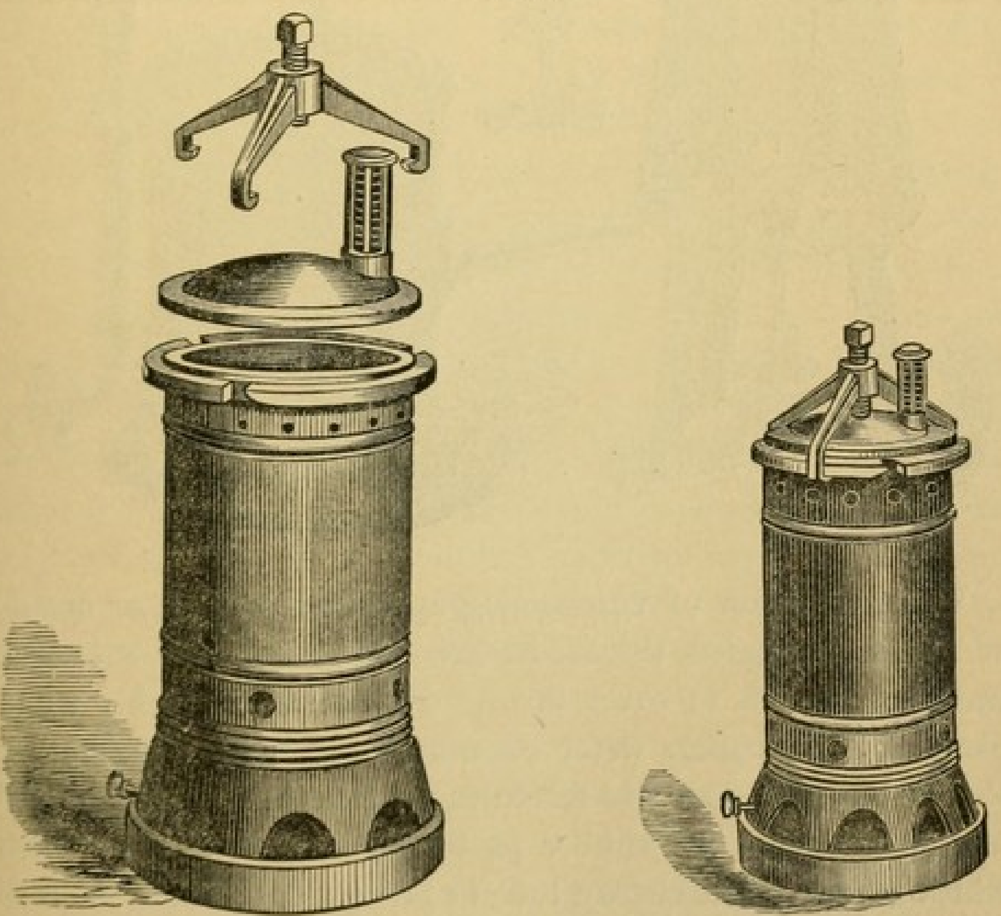
to happen when it is exposed to the steam itself, necessitating its frequent replacement.

A not less convenient, safe, and reliable vulcanizer is that known as Dr. Whitney's, represented in Fig. 142, having a steam-chamber capacity for from one to three flasks. The boiler is made of wrought copper; the top or cap, which is screwed on, being provided with a thermometer, and an aperture filled with fusible metal, which renders explosion of the boiler, unless materially weakened by corrosion, impossible. The author has had one in constant use for many years without any perceptible deterioration.

A well-approved instrument, called the "Buckeye Vulcanizer," invented by Dr. C. H. James, of Cincinnati, Ohio, is exhibited in Fig. 143. The mechanism of this instrument is remarkably simple and ingenious, the relation of the different parts being plainly exhibited in the accompanying cuts. The top is very quickly and readily adjusted, and is clamped and held securely in place, making a steam-tight joint, by a single set-screw acting upon the centre of the cover.

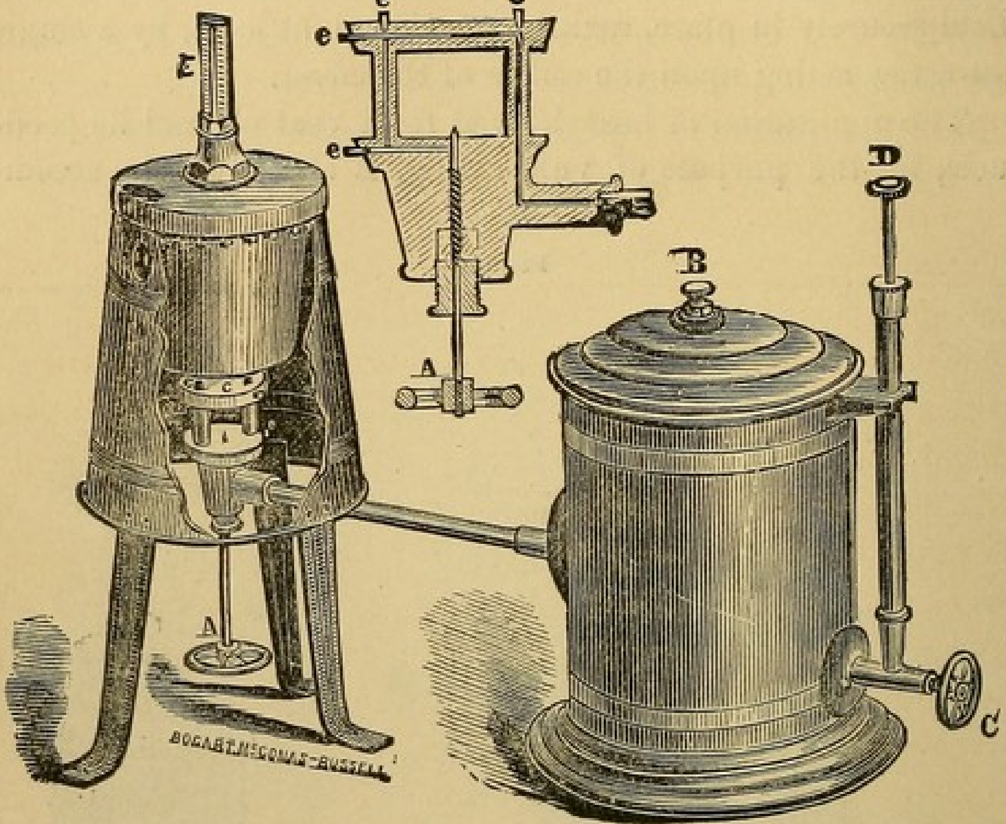
The application of heat derived from coal oil and its products, for the purpose of vulcanizing, is shown by the accom-

FIG. 143.



panying cut (Fig. 144), which represents what is advertised as "*Hull's Petroleum Gas Burner*," and which the inventor claims is "a lamp by which coal oil and its products can be substituted for gas or alcohol for heating purposes. This apparatus will burn BENZINE with perfect safety, and with greater heat than either gas or alcohol, and free from smoke. The cut will show its adaptation for vulcanizing, and can be used for any other purpose. There is an attachment for a compound blowpipe."

Fig. 144.



Whatever form of vulcanizing apparatus is used, or means of heating adopted, the flasks are introduced and sufficient water poured in to cover them. If the flasks are hot when placed in the boiler, water of nearly the same temperature should be added to avoid fracturing the teeth. Before screwing on the cap, the rubber packing should be dusted with whiting or pulverized soapstone to prevent adhesion. As it is very important to secure a steam-tight joint, the packing should be of uniform thickness, firm, and securely fixed. The webbed rubber is the best for the purpose. In arranging a new packing, cleanse well the groove in the boiler which receives the rim of the cap, and fit the packing accurately. Before screwing on the top, dust the surface of the packing as before recommended, and as the heat rises tighten the screw from time to time until the rubber no longer yields. If the latter precaution is not observed, the packing is either liable to blow out or the joint leak steam. To insure uniform results it is necessary that there should be absolutely no leakage.

When the flasks are properly secured within the steam-chamber, heat is applied and continued until the requisite induration of the gum is effected. The time and degrees of heat necessary to effect this result differ somewhat with the rubber compounds and kind of vulcanizer employed. The heat should be raised gradually until the thermometer indicates the proper vulcanizing temperature, when the flame should be lowered, and the heat maintained at this point until vulcanization is completed. In all cases it is best to raise the heat slowly until it reaches 320°, which temperature should not be attained in less than from one-half to three-quarters of an hour. Where there is any considerable or unusual body of rubber, the time taken to raise the heat to that point should be extended to one hour or longer, for if the mass is heated too rapidly, porosity or sponginess of the thicker portions of the rubber will almost certainly ensue. This result would seem to be due to the energetic evolution of sulphuretted hydrogen gas under a quick heat, the proper elimination of which is checked and the gas confined within the body of the mass by a too rapid surface induration of the rubber. The evolution of this gas is demonstrated by Professor Wildman in the following experiment:

"To ascertain if sulphuretted hydrogen is given off during vulcanization, a bulb was blown at the end of a glass tube; this was filled with red rubber; the tube was then drawn out very small from immediately above the bulb, and curved so that the small part when the bulb was in the paraffin bath could be inserted into a vessel beside it.

"The bulb was then placed in a paraffin bath, and the curved end of the tube inserted in a vessel containing a solution of acetate of lead. The heat was raised to 320° F., and retained at that point for one hour and a quarter.

"The mean result of several experiments conducted in this manner was, that during the first thirty or forty minutes after the heat had attained to 320°, bubbles of sulphuretted hydrogen came over at short intervals, and at the expiration of this time it was evolved in a continuous stream, which continued for a few minutes, causing a copious precipitate of sulphide of lead. After this, until the expiration of the hour and a quarter, the gas was only given off sparingly at intervals. This experiment gives us ocular demonstration that this gas is evolved during vulcanization, and in large quantities, and conclusively shows that in thick pieces, especially, the heat should be slowly raised, and the rubber should be under strong pressure to insure a successful result."

When the American Hard Rubber Company's red rubber is used, the heat should be maintained at 320° for about one hour and ten or twenty minutes. Induration may be effected at a lower heat, but the time must be proportionally extended; or a higher heat being employed, a less time will be required to vulcanize. With the use of the rubber mentioned, the author has obtained good results by vulcanizing for 45 minutes at 340°. Care, however, should be taken not to overheat, as the rubber is thereby rendered dark and brittle, and the important property of elasticity impaired. The time and degrees of heat first mentioned, therefore, may be regarded as the safest, and as yielding the best results, though with other rubber compounds, and the use of modified forms of vulcanizers, corresponding differences in time and temperature may be required, and which can only be accurately determined by vulcanizing test-pieces of rubber.

In this connection the reader's attention is called to some practical observations on the subject of steam pressure in vulcanizing, and the reliability of thermometers as indicators of heat, and which acquire additional interest if it be true, as alleged, that many of the vulcanizers in use by dentists are insecure, by reason of inherent defects of construction, or faultiness in the modes of indicating the elastic force of steam. In commenting on this subject, Professor Wildman observes:*

"As high steam is used in vulcanizing, it is important that the operator should be conversant with the nature of the agent which he employs to accomplish his end. It is perfectly safe; but the following will show him that it must be used with

* Instructions in Vulcanite, p. 26.

discretion and judgment. Numerous experiments have been made by scientific men to ascertain the elastic force of steam at different temperatures. The results of their investigations are not uniform; although they all agree in showing the immense force exerted by this agent at high temperatures. Haswell's tables are looked upon as good authority. The results of the investigations of the Franklin Institute Committee, in the higher degrees, give a greater elastic force than the table below quoted. I shall, however, quote the results of the experiments of the commission of the French Academy, appointed by the French government to investigate this subject, for the reasons that, from the manner in which they were conducted, they are probably as reliable as any, and that they are extended to a more elevated temperature than the others.

Elasticity of steam, taking atmospheric pressure as unity.	Temperature F.	Pressure per square inch, pounds.
1	212°	14.7
1½	233.96°	22.05
2	250.52°	29.4
2½	263.84°	36.75
3	275.18°	44.1
3½	285.08°	51.45
4	293.72°	58.8
4½	300.28°	66.15
5	307.05°	73.5
5½	314.24°	80.85
6	320.36°	88.2
6½	326.26°	95.55
7	331.70°	102.9
7½	336.86°	110.85
8	341.78°	117.6
9	350.78°	132.3
10	358.88°	147
11	366.85°	161.7
12	374.00°	176.4
13	380.66°	191.1
14	386.94°	205.8
15	392.86°	220.5
16	398.48°	235.2
17	403.82°	249.9
18	408.92°	264.6
19	413.78°	279.3
20	418.46°	294

"I would here call the attention of those using high steam to an important consideration. In raising steam, *the ratio of increase of pressure or elastic force is far greater than that of the increase of temperature.*

"By referring to the above table, commencing at 212° and taking steps as near fifty degrees as is given in the ascending scale, we find this exemplified. Thus:

Increase of temperature.	Increase of force per square inch.	Giving a force per square inch.
From 212° to 263.84° = 51.85°	22.05 lbs.	36.75 lbs.
" 336.84 to 314.24° = 50.40°	44.10 lbs.	80.85 lbs.
" 314.24 to 366.85° = 52.61°	80.85 lbs.	161.85 lbs.
" 366.85 to 418.46° = 51.61°	132.15 lbs.	294 lbs.

"This comparison shows clearly how rapidly the pressure increases at high temperatures, and warns the operator that a strong instrument, combined with care and judgment in its treatment, are indispensable to safety. Besides the rapid increase of pressure, it must be borne in mind that at high temperatures, copper, of which the boiler is composed, becomes weakened, and in a measure loses its power to resist this great imprisoned force. Copper, in passing from 212° to 230° F., loses about one-tenth of its strength, and at 550° it has lost one-fourth of its tenacity."

In a paper read before the Massachusetts Dental Association, January, 1865, Dr. A. Lawrence affirms that "most vulcanizers are now made of sheet copper one-sixteenth of an inch in thickness, and, agreeably to the foregoing facts, have a tensile strength of 1875 pounds; and one four inches in diameter will not sustain a pressure of more than 150 pounds per square inch, or a temperature of 363°.

"Let us next ascertain what force of steam is exerted upon the boiler within a short range of temperatures. We find by the tables of Haswell, King, and others, that at 320° the pressure is 85 pounds; at 324°, 90 pounds; at 328°, 95 pounds; and at 332°, it is 100 pounds per square inch. These figures I have verified by a steam gauge connected with my own vulcanizer, and which I now use in preference to the thermometer, as I consider it more convenient, safer, and less liable to accidents.

"Practical engineers concur in the opinion that a force of not over one-half the sustaining capacity of the boiler can be safely applied."

The logical deduction from these statements is plain. If a boiler four inches in diameter, constructed of sheet copper one-sixteenth of an inch thick, will not sustain a pressure of more than 150 pounds per square inch, and, accepting as true what is affirmed by practical engineers, "that a force of not over one-half the sustaining capacity of the boiler can be *safely* applied," then every operator who, with the use of such an instrument, vulcanizes at a heat of 320° is in hourly jeopardy of life and limb.

Intimately connected with the process of vulcanizing is the question of the reliability of thermometers as *indicators* of heat, or steam-pressure. Dr. Lawrence, commenting on this subject, says: "Suppose the bulb of the thermometer gets slightly fractured, and, the accident not being discovered, the vulcanizer is put to use, what then?

"If the damage is slight, the mercury may still be made to rise in the tube at high temperatures, but will not truly indicate the full heat or force within. Some time ago, I had some difficulty in producing a desirable shade in my vulcanite work; it was too dark, as is the case when overheated, and I came to the conclusion that the gum had deteriorated in quality. Other samples of gum were tried, and at varying lengths of time, yet with the same result.

"No defect could be discovered in the thermometer by the naked eye, but a microscope revealed a slight crack in the bulb, and the mystery was solved. But what force of steam was produced during these almost despondent trials?

"Although my vulcanizer would safely bear a pressure of one hundred pounds per square inch, I concluded to use a steam gauge for the future, and now feel a security in its use positively refreshing."

The unreliability of thermometers, in connection with vulcanizers, has been recognized by many in the profession who have testified to their uncertainty and insecurity as a means of determining with exactness at all times the amount of steam-pressure employed in the process of vulcanizing at a high heat. The *steam gauge* (Fig. 145), spoken of by Dr. L., seems very perfectly to fulfil the requirements of the dentist, and may justly claim favorable consideration from the commendation bestowed upon it by the distinguished gentleman who has brought it to the notice of the profession. The following is the author's own account of the instrument: " The gauge most suitable for the purpose in question, somewhat resembles a small circular clock; is about six inches in diameter and marked to register one hundred and forty or one hundred and eighty pounds pressure, with pound dots near the outer circle of the dial. A pointer indicates the force which moves it.

" This size is better than a smaller one, because the spring inside not being crowded to its utmost capacity in vulcanizing, will, of course, retain its working integrity longer; in fact, as long as any dentist now living will be personally interested in the matter. The price of such a gauge, at this time, is $18; and, though more expensive ones can unquestionably be made, they are no more reliable, the difference consisting in mere 'outward show and adorning.' They can be used with all vulcanizers generating steam, connecting by means of three or four feet, or as much more as may be convenient, of small pipe having a U-shaped bend, or a single coil near and under the gauge to receive the condensed steam, as water alone should enter that instrument.

" The following table exhibits a range of pressure sufficient for vulcanizing purposes, with the temperature necessary to produce the same.

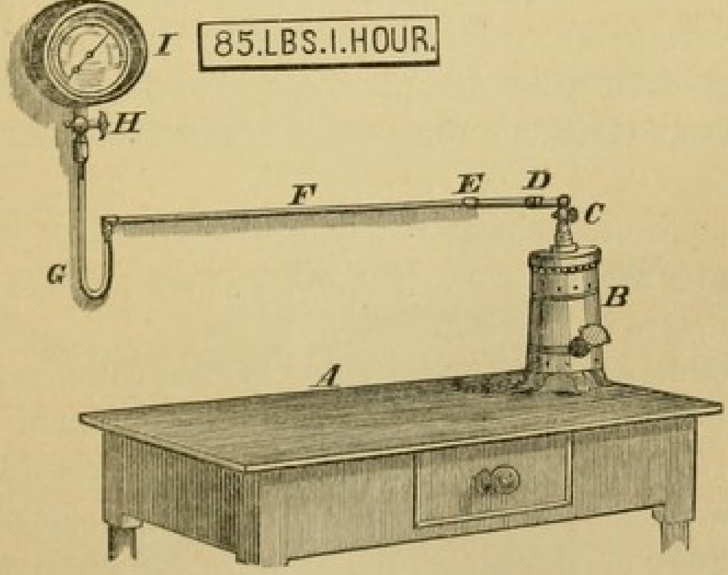
Pressure in lbs.	Temperature.	Pressure in lbs.	Temperature.	Pressure in lbs.	Temperature.	Pressure in lbs.	Temperature.
60	295°	69	305°	78	314°	95	328°
61	296°	70	306°	79	314°	100	332°
62	298°	71	307°	80	315°	105	335°
63	299°	72	308°	81	316°	110	339°
64	300°	73	309°	82	317°	115	342°
65	301°	74	310°	83	318°	120	345°
66	302°	75	311°	84	319°	125	349°
67	303°	76	312°	85	320°	130	352°
68	304°	77	313°	90	324°		

"It will readily be seen by the above, that a pressure of sixty pounds requires a temperature of two hundred and ninety-five degrees by Fahrenheit's scale to produce it, and eighty-five pounds three hundred and twenty degrees, at which latter pressure I vulcanize, running one hour, and with the most satisfactory results.

"The manner of putting up and using the gauge is very simple. All that is required is to secure it, by screws passing through the flange on the back, in some conspicuous and convenient place, attach a pipe and carry it down ten or twelve inches, give it a bend or curve upward about half its length, or five or six inches, thence at right angles or otherwise, and in any convenient length not less than three feet, to the vulcanizer.

"The annexed cut is from a photograph of a Whitney vulcanizer with the gauge attached, but is by no means the only

FIG. 145.



arrangement which can be made, as, in some cases, convenience may require more pipe, or a different distribution.

"A, table or work-bench; B, vulcanizer; C, side outlet pendant cock screwed on in place of the thermometer scale; D, coupling joint; E, angle in the pipe; F, iron pipe, three-sixteenths inside; G, U-shaped curve, five or six inches in depth; H, cock to the gauge; I, gauge.

"The fitting, putting up and arranging the entire apparatus can be done in an hour's time by any gasfitter, or, to those residing away from cities or towns where such mechanics are employed, can be furnished to order by them, or by the parties furnishing the gauge.

"All the joints, from the vulcanizer to the gauge, except the coupling, should be 'leaded' with very thick lead paint, and screw together steam tight.

"In using the apparatus, the cocks C and H must be turned straight with the pipe, for if shut off at either point, the gauge cannot be acted upon by the steam. I generally heat the water in the vulcanizer nearly or quite to the boiling-point, and let off the heated air by turning, or allowing to remain open, the cock C, then connect at the coupling D, turning the nut tight (not too tight) with a wrench.

"So soon as steam begins to form, it is condensed by contact with the cold part of the pipe, and falls into and fills the curve or coil with water, which is then forced into the gauge with a power indicated by the pointer on the dial. The pipe should descend a trifle from the angle E to the commencement of the curve, to facilitate the passage of the condensed steam to that point.

"Although vulcanizing one hour at eighty-five pounds affords results satisfactory to me, others may prefer a different time with more or less heat.

"The table will be found a guide in such cases.

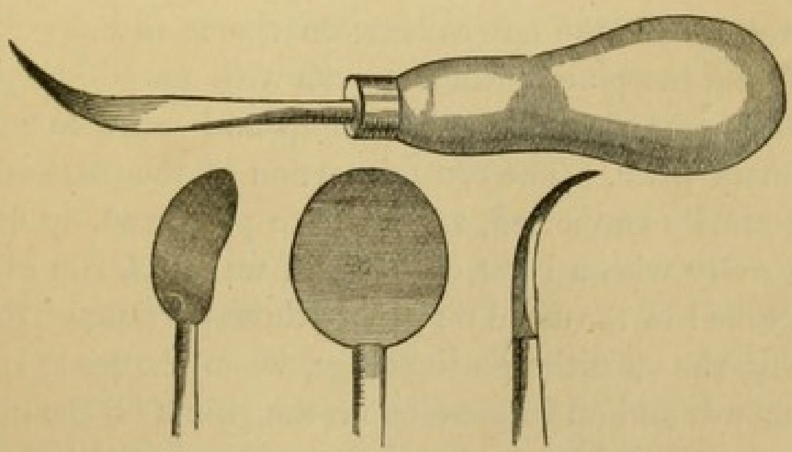
"When the time is up, discontinue the fire, and shut off the steam by turning the cock C. Turn the cock H in the same manner, to prevent a too sudden reverse movement of the machinery of the gauge, the pressure on which should be gradually relieved at any convenient time.

"Now disconnect by unscrewing the coupling and dispose of the steam in the vulcanizer by blowing off, or any other means preferred. Further remarks would seem unnecessary to a full understanding of the subject. Having used the gauge almost every day for about six months, I am fully satisfied that it is a decided improvement in vulcanizing, and am so de-lighted with it that no reasonable sum would induce me to substitute the thermometer."

When the process of vulcanizing has been conducted a sufficient length of time, the flame is turned off and the steam discharged through the safety-valve, if the vulcanizer is provided with one; or the lower half of the boiler may be placed in cold water until the contents are cooled down to about 200°. When time will permit, however, it is better to let the vulcanizer cool gradually. The top is then taken off and the flasks removed. The latter should always be allowed to cool gradually, as the immersion of the flask, while hot, in cold water will endanger the porcelain teeth by a too sudden change of temperature. Neither should the flask be opened while hot, for the plate being pliable when heated, would be liable to suffer some change of form in forcing the sections of the flask apart, or in removing the piece after separation of the flask. When the plate is removed from the flask, detach carefully all adhering plaster with a pointed knife, and cleanse well by washing with a stiff brush.

Finishing.—The rougher and more redundant portions of the indurated material are first removed with coarse files or

FIG. 146.



rasps, following with those of a finer cut until all parts of the piece accessible to such instruments are reduced to nearly the thickness required. The excess of material on the lingual side of the plate and other points not admitting of the use of the file, is removed with scrapers of various forms, some of which are shown in Fig. 146. After nearly the desired thickness is thus obtained, and the surface rendered somewhat smooth and uniform, a still further reduction is obtained with the use of sandpaper, using first the coarser and finishing with the finer kinds. The final polish is then given to the surface, first with the use of finely pulverized pumicestone, and afterwards with either prepared chalk or whiting. The best method of applying the pumice is with flat circular pieces of cork of various sizes, which may be readily formed by attaching them to the lathe and reducing them to the proper size and shape with a file while revolving. The chalk or whiting may be applied upon a cotton or ordinary brush wheel. In the use of the polishing materials, the latter should be kept constantly and freely saturated with cold water throughout the operation.

Partial Dentures Constructed in a Base of Rubber.—The foregoing description of the method of forming entire dentures in a base of indurated gums, together with a knowledge of the manner of constructing parts of sets of teeth mounted on metallic plates, will render any extended description of the former process, as it relates to partial pieces, unnecessary. A gutta-percha plate of the required thickness and dimensions is accurately moulded to a model of the parts, the narrower portions passing into the spaces between the teeth being stiffened by doubling the plate at these points with an additional strip of gutta-percha warmed at the lamp and made to adhere to the primary plate. The central portion of the plate may also be temporarily supported, and its form preserved, by filling in the concavity with a layer of stiffened wax. A rim of wax is then attached in the usual manner to those portions of the plate occupying the vacuities on the ridge, when the plate is placed in the mouth and an impression of the points of the opposing teeth secured; it is then removed, reapplied to the model and the heel of the latter extended posteriorly to form an articulating surface for the remaining portion of the antagonizing model,—the latter being formed in the ordinary way. The teeth are then fitted to the vacuities in precisely the same manner as when metallic plates are used, and the wax trimmed to the required fulness. The plate, with the teeth attached, is then placed in the mouth and any necessary corrections made in the arrangement of the teeth; after which it is removed and readjusted.

In constructing partial sets of vulcanite, it is of the first importance, when forming the mould, that the relation of the porcelain teeth to the model of the mouth should be accurately maintained, the reasons for which are fully set forth when treating of the formation of the mould or matrix for full sets. To secure this result with certainty the following method should be adopted. Having adjusted the plate and teeth upon the model, with the wax trimmed and carved to the required fulness, place the model in the lower section of the flask and fill in with plaster, extending it up to the points of the teeth, binding them to the model, and making the line of separation of the sections of the flask at that point. The ends of the plaster teeth should be cut away sufficiently to allow of a ready separation of the sections. Plaster is then poured in for the upper section of the mould, and, when hard, the flask is parted and the wax removed from the model and teeth, the latter being retained in the lower instead of the upper section as in full cases.

Metallic Clasps attached to Rubber Plates.—Although atmospheric pressure should be made available in all practicable cases as a means of retaining parts of sets of teeth in the mouth, yet cases occasionally present themselves necessitating the employment of clasps. These may be of rubber, but those formed of gold, or gold alloyed with platina, are more reliable, and better adapted to those cases where the spaces between the teeth are contracted. The following description of the method of constructing them is given by Professor Wildman.*

"First bend the clasp to fit the tooth accurately; then make the attachment by which it is to be held to the rubber (this may be done by soldering a thin plate of gold or platina

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* Instructions in Vulcanite, p. 36.

to the clasp in such a position that it will be inclosed in the rubber); then perforate the plate with numerons small holes, which should be countersunk on both sides (Fig. 147). This plate entering the base, the rubber filling the holes forms pins which rivet the clasp securely to the rubber plate.

"Or the attachment may be made in this manner: On the parts of the clasp that can be covered with rubber, drill one, two, or three holes, as the space may admit; insert gold or platina wire, solder with gold solder, then cut off at proper length, and head them (Fig. 148); these act in retaining the clasp in the same manner as the double-headed pins in securing the tooth to the base, and offer the advantage over the perforated plate of being more easily manipulated, and less liable to become displaced in packing the mould. The clasp is to be

FIG. 147.

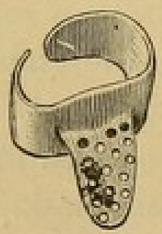
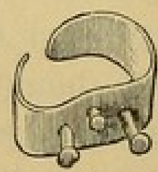


FIG. 148.



attached to the model plate, and will remain secured in the mould when it is opened."

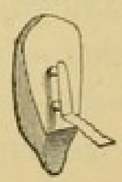
A metallic clasp may also be very securely attached to the rubber by drilling a number of holes in that part of the clasp which lies in contact with the rubber, and countersinking them well on the inside of the clasp.

Substitution of Plate for Rubber Teeth.—An ordinary plate tooth, such as is commonly used in connection with a metallic plate base, can be readily rendered suitable for a rubber base. This is done by soldering a narrow strip of gold plate to the ends of the platina pins, forming a loop or staple (Fig. 149), and which imbedded in the rubber, renders the attachment very secure. A narrow arm of rubber extending to a single tooth may be materially strengthened by permitting the gold strip, perforated with holes or roughened on its edges, to pass some distance into the rubber as seen in Fig. 150.

Instead of forming a loop or staple as mentioned, it will be preferable in many cases to solder to the tooth a somewhat wider strip than that represented, in the same manner as ordinarily practiced in backing for gold work, the strip being strengthened by flowing solder at the angle of divergence from the heel of the tooth, and extending thence into the body of the rubber, perforated or roughened on the edges as before recommended. The rubber in this case may be cut away, when finishing, to the angle, leaving nothing but the strip of gold and sub-lining of rubber at the base of the tooth. This method may be resorted to with signal advantage in those cases where,

FIG. 149.

FIG. 150.



on closure of the jaws, the points of the opposing teeth encroach unduly upon the space to be filled, extending nearly to the gum, requiring the tooth of replacement as thinly formed throughout its length as possible.

Repairing.—If a tooth or block has been broken, or any change is to be made in the position of either, the teeth or fragments thereof, are removed and an irregularly shaped groove or dove-tail formed in the base occupying the space to be supplied; into this space the tooth or teeth are properly arranged and supported with wax; the dovetail is then filled in with wax, giving some additional fulness to compensate for waste in finishing. All portions of the piece except the lingual face of the plate and teeth are then imbedded in plaster in the lower section of the flask. The upper section of the mould is obtained in the usual way. When separated and all traces of wax removed, the gum is packed into the cavity around the tooth or teeth. Grooves are then cut extending out from the mould; the two sections heated and forced together, and the process of vulcanizing conducted in the usual manner, the same time and degrees of heat being required as in the first instance. The renewed heat employed renders the surface of the material previously vulcanized somewhat darker, to remove which it is recommended to moisten the surface with dilute nitric acid for a short time, after which the piece is thoroughly washed and then placed for a few minutes in an alkaline solution to remove any remaining traces of acid. It is also recommended to immerse the case in alcohol for five or six hours, and then expose it to the rays of the sun for a like period of time.

Refitting Gold or Rubber Plates with Rubber Lining.—Gold or rubber plates, whose adaptation to the mouth has become impaired, in a greater or less degree, by subsequent absorption of the alveolar ridge, may be easily refitted and the adaptation restored by either of the following methods:

First Method.—Take, for example, a full upper set on either gold or vulcanite. Secure, in the first place, an accurate impression of the mouth, in its changed condition, in plaster, and from this a plaster model in the manner usually practiced. Perforate the palatal portion of the plate with from eight to twelve holes at different points, and also the external borders, from heel to heel of the plate, at intervals of from one-eighth to half an inch apart, and near the edges. These holes may be enlarged to the dimensions of a medium-sized knitting-needle; or if the piece is of vulcanite, to twice or three times that size. On the lingual and buccal surfaces the holes are well countersunk with a burr drill. The plaster model, with the central portion raised to form a chamber (and which should be made to correspond, as nearly as possible, in position, form, and thickness, with the chamber in the plate, if one exists), is next heated throughout by placing it over a spirit-flame, or in the baking furnace of an ordinary cooking stove, or the muffle of a furnace, and when of a temperature that will barely admit of being taken in the hand, remove and cover the face of it with a sheet of india-rubber or gutta-percha as prepared for vulcanite work, and press it down upon the face of the model with the fingers. Apply the perforated plate to the model, being careful to secure a proper relation of the two; then press the former down firmly upon the model. To render the vulcanite material still more plastic and compressible, the whole may now be returned to the furnace, and subjected to a uniform heat throughout, when it may be removed, and firm and steady pressure made upon the plate and teeth, until forced, as nearly as practicable, into contact with the face of the model. Portions of gum will be forced through the apertures and out at the borders of the plate; these should be well packed into the countersinks and under the edges of the plate, when the model, with the rubber and plate adherent, may be placed in a vulcanizing flask and incased bodily in plaster. It is then placed in a heater and vulcanized. If all the steps in the process have been carefully conducted, the fit of the plate will be perfectly restored, with no material change in the antagonism, or none, at least, that is not susceptible of ready correction. The union between the vulcanite lining and the plate will be strong and lasting, and altogether impermeable to the fluids of the mouth.

In the case of lower pieces, the holes should be made along the external and internal borders of the plate near the margins. In all other respects the manipulations are the same as those described above.

It is scarcely necessary to observe that, in the use of gold plates, the method is inapplicable whenever it is designed to re-swage the same plate for the permanent piece.

Second Method.—Perforate the plate, whether of gold, silver, or vulcanite, as before directed; and employing this as a cup or holder, take an impression of the mouth in plaster, pressing the plate up closely to the parts. The plaster forced through the holes, and filling the countersinks on the opposite side of the plate, will serve to bind the plaster to the plate, and prevent, with cautious manipulation, the two from separating as they are being detached from the mouth. When removed, the plaster impression lining the plate is trimmed even with the borders of the latter, and then varnished and oiled. The lower section of a vulcanizing flask is now filled with a batter of plaster on a level with its upper surface, and the impression, filled with the same, is turned over and placed in the centre of the flask, with the edges of the plate touching the surface of the plaster. The plate and adhering plaster are now carefully separated from the model. After cutting out the plaster from the holes and countersinks in the plate, the plaster forming the impression is detached from the plate, and the holes and countersinks filled with wax. The plate is then readjusted over the model, and (the surrounding surface of the plaster in the flask having been varnished and oiled) plaster is poured in upon the upper surface of the plate and teeth, filling the upper ring. When the plaster is sufficiently hard, the two sections of the flask are separated, and grooves formed, running out from the matrix to the margins of the flask. A sufficient quantity of vulcanizable rubber is now either placed upon the model or packed in upon the palatal surface of the plate—before doing which, however, the wax filling the holes and countersinks in the plate (and which was placed there to prevent portions of plaster last poured, in forming the matrix, from running in and filling them up) should be worked out with a small instrument. The whole being sufficiently heated, the two sections of the flask are forced together, expelling redundant material. The piece is then vulcanized as in the former case.

The above method, though somewhat more complicated than the former, is quite simple in its details, and will occupy but little more time, and is, withal, more certain in its results.

Manner of Duplicating Sets of Teeth Mounted on Rubber.—When from accident, or other causes, a rubber set becomes broken, or its integrity otherwise impaired, necessitating an entirely new plate with an exact reproduction of the arrangement and articulation of the teeth, the following method, described by Professor Wildman, may be pursued with an absolute certainty of success. "Roughen the palatal surface of the rubber, to cause the plaster to adhere to it; then use it as an impression-cup to take a plaster impression, being careful when it is in the mouth to preserve the articulation. In this impression, cast the model, trim, cut keys or conical holes at several points in its outer face. Now, before separating the impression from the model, make a cast of the face of the teeth in two or three perpendicular sections, extending to the base of the model, using a solution of soap or other parting substance on the plaster mould. Remove this mould of the face of the teeth, which indicates their true position relative to the model; then take the impression from the model. By the aid of heat sufficient to soften the rubber, remove the teeth from it. Next make a model plate with prepared *gutta-percha*. Now secure the section of the mould of the face of the teeth to the model (their place will be indicated by the keys); adjust the teeth to their proper positions in the plaster mould of them, and build up with gutta-percha or wax to the proper form of the model set. This being done, test its accuracy of contour and articulation by placing it in the mouth. Then, using the model, proceed as for making a new set."

It will be observed that the above process contemplates the necessity of the patient's presence to secure, in the first instance, an impression of the mouth, and again for a trial of the teeth in the mouth to test the accuracy of arrangement, etc. This procedure is rendered necessary in all cases of faulty adaptation of the primary plate, but where the adaptation is satisfactory, and it is desired to construct a duplicate set in all respects precisely like the original, the following method, in the main the same as the one just described, may be adopted in the absence of the patient. Oil, or coat with a solution of soap, the palatal surface of the plate to be duplicated; into this pour plaster for the model; trim to the edges of the plate, and give the usual form to the body of the model; form conical holes in the same and secure sectional moulds of the outer faces of the teeth in the manner described by Professor Wildman. When hard, remove these sections and detach the model from the plate. Many cases will admit of a ready separation; in others it will be found impossible to force them apart without fracturing the model. To avoid such an accident, the model may be cast in sections, the latter being bound together afterwards in their proper relation to each other. But a better plan is to heat the model and plate sufficiently to render the rubber soft and pliant enough to be removed without injury to the model. Cases not admitting of the successful application of either of these expedients must be treated in the manner described by Professor Wildman, that is, by securing an impression of the mouth. After the separation of the model and plate, the manner of conducting the subsequent steps of the operation is precisely the same as that described in the preceding method. The author has adopted the above process in a number of instances with the most gratifying success in cases of defects or accidents to the original plate, and where the presence of the patient could not be conveniently commanded.

CHAPTER XV.

Celluloid Base.

The employment of celluloid in prosthetic dentistry, though of recent date, and notwithstanding the very general failure which attended its first introduction into practice, is rapidly acquiring very general professional favor as a cheap, convenient, and serviceable base for artificial dentures. With the more recent improvements in the manufacture and seasoning of blanks, more perfectly adapted appliances for moulding, and a more extended acquaintance with the peculiar and distinctive characteristics of this material, it promises, in the near future, to supersede in a great measure all other known plastic substances for the purpose indicated.

That celluloid possesses many important qualities which commend its employment as a base in preference to rubber can hardly be questioned. It is more in harmony with the soft tissues of the mouth, more cohesive in texture, approximates more nearly the natural gum color, contains far less vermilion pigment in its composition, and is less objectionable by reason of the comparative cleanliness accompanying its manipulation.

Fig. 151.

The chief objection urged against celluloid as a base is its low power of transmitting caloric, but it is believed to be less objectionable in this respect than rubber. Both are poor conductors, and the soft tissues of the mouth in contact with either suffer, in some degree, as a consequence of this property. To obviate, to some extent at least, this objectionable feature of both rubber and celluloid, Dr. S. C. Carter has devised and recommended what is termed "palate coolers," consisting of a central plate of either gold, platinum, or aluminum, dove-tailed into the rubber or celluloid, and represented in Fig. 151.

Celluloid, as at present produced, and when properly manipulated, does not, in any appreciable degree, undergo change of form after moulding by warping either in or out of the mouth, as was formerly the case, nor, it is believed, does it absorb the oral secretions. It loses somewhat the freshness and clearness of its original pink color after having been in use for some time, but not in any very marked degree.

Though not bearing so perfect a resemblance to the complexion of the healthy gum tissue as the porcelain imitations, yet the near approximation of celluloid to the desired color makes the use of single plain teeth admissible for permanent dentures, and this is unquestionably its crowning merit, and makes it the most desirable of all the so-called "cheap bases." The indiscriminate and almost universal employment of block or sectional gum teeth in connection with rubber has, it may be safely affirmed, done more to degrade the prosthetic department of dental practice than all other causes combined. The optional arrangement of each individual tooth to meet the requirements of special cases in respect to expression, articulation, and antagonism is one of the absolute and indispensable requirements of a perfect artificial denture. A more general recognition of this important fact must, sooner or later, lead to the entire abandonment of rubber in connection with "ready-made" sectional gum teeth. "Taking into view all its qualities," says a well-known writer, "and leaving out the question of freedom from monopolies, the conclusion is that celluloid has the potentialities which should dethrone rubber, and establish itself as the best of the cheap bases."

Composition and Manufacture.—The following is the substance of Professor Charles J. Essig's account of the composition and manufacture of celluloid :

Celluloid is derived from cellulose, a woody fibre, constituting the framework or foundation of plants.

Linen, cotton-wool, hemp, etc., are examples of cellulose. For the manufacture of celluloid, the cellulose is first converted into paper; hemp is the form of cellulose employed for this purpose, because it has been found to make the strongest paper, and the stronger the paper the better the celluloid.

The hemp is first converted into paper in the usual way by paper machines. By this process the form of the material undergoes a physical change only, while chemically it remains the same, viz., nearly pure cellulose, and has a formula of $C_6H_{10}O_5$. The cellulose, now in the form of hemp-paper, is converted into pyroxylin by a process technically known as "conversion," this change being effected by immersing the hemp-paper in a strong mixture of nitric and sulphuric acids for a sufficient length of time, when it is removed from the acids and washed thoroughly.

It is now still in the form of paper, but its weight will be found to have increased about seventy per cent., and to have become highly explosive, taking fire at about 300° F.

Pyroxylin, then, is the chief ingredient in celluloid, and is reduced to a pulp in a machine similar to that used in paper-making; a thorough mixture is then made of

Pyroxylin, ...	100 parts
Camphor, ...	40 "
Oxide of zinc, ...	2 "
Vermilion, ...	0.6 "

Some alcohol is used to soften the camphor. The mass is now put under a hydraulic pressure of two thousand pounds to the square inch. The cylinders in which it is pressed have a small orifice in the side near the bottom, and when pressure is made the celluloid is forced out through this orifice.

The immense pressure is to condense or solidify the celluloid, and as it is forced out it is cut off in pieces of the proper size, and moulded by pressure and heat to the forms in which we receive it. At this point the blanks are still soft, and require to be seasoned; this requires about two months, during which time they are kept in a room at a temperature of 160° F.

Processes Preliminary to Moulding.

While many of the processes entering into the construction of artificial dentures, with celluloid as a base, are essentially the same as those required when rubber is used, yet there are, in many important respects, modifications of practice made necessary by the peculiar nature and behavior of the material employed.

When the distinctive characteristics of celluloid are well understood, and the operator is familiar with the approved methods of working it, no unusual difficulties attend its successful manipulation. To attain uniform and satisfactory results, however, it is absolutely necessary that there should be a faithful compliance with every manipulative detail, however seemingly unimportant, which experience in the use of this substance has demonstrated to be essential.

Plaster Model.—The inferior plasticity of celluloid, compared with vulcanizable rubber, when exposed to the action of heat, and the consequent greater pressure necessary to mould it into any given form, makes it necessary to give to the plaster model the greatest practicable hardness and strength. To secure these important qualities, it is recommended to use the best quality of coarse builder's plaster, which, though it does not set so quickly as the finer and whiter varieties, becomes much harder and more resistant to pressure when thoroughly dried. Increased hardness will be secured by adding to the plaster mixture a small quantity of clean white river or lake sand or marble dust.

A smoother face will be given to the model by first coating the surface of the impression with a moderately thin mixture of fine plaster, and, as this begins to set, fill in with the coarser variety for the body of the model.

The plaster for the model should be mixed as thick as can be well poured, taking care, as it is slowly introduced, to expel air-bubbles by tapping or shaking the impression-tray as the plaster flows in.

In cases where there is any considerable anterior projection of the alveolar ridge in front, above or below, the corresponding portion of the plaster model is liable to be crushed under the pressure necessary to mould celluloid. To prevent such accident, it has been recommended, in addition to the expedient to be mentioned hereafter, to place in the front part of the impression a curved piece of brass plate punched full of holes, one-half or three-fourths of an inch wide, which, when the impression is filled, will be imbedded in the central portion of the plaster ridge, and extend some distance into the body of the model.

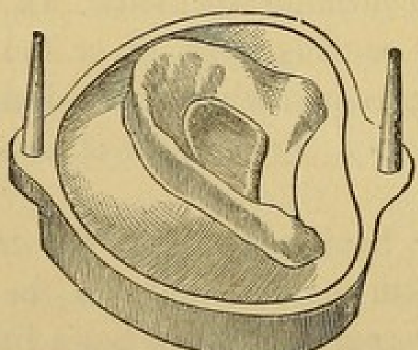
In extreme cases, where the ridge is very thin and the projection spoken of excessive, it may be necessary to substitute metal for plaster in forming the model. In this case the latter may be obtained by pouring block-tin or Babbitt metal directly into the plaster impression, which should first be thoroughly dried, and the cavity for the air-chamber formed before pouring.

Waxing.—After having arranged the teeth for any given case, place them with the trial plate on the model, and build out with wax to the required form, but a little in excess of the fulness necessary in the finished piece. Care should be taken that the palatal portion should be somewhat thinner than the blank to be used. Clean, pure wax should always be used in preparing a case for flasking, as it will be necessary sometimes to free the mould of adhering and inaccessible portions with boiling water, in which case, if there are impurities in the wax, sedimentary particles will be left in the mould and become incorporated with the celluloid in the process of moulding.

Investing.—The piece prepared as above is then placed in a flask especially designed for celluloid, invested in plaster, and the mould or matrix formed in the same manner as practiced when rubber is used. In case the ridge overhangs, to which the term "under-cut" is applied, the model, before being incased in the flask, should be cut across diagonally with the slope towards the heel of the model, thus depressing the latter posteriorly, as exhibited in Fig. 152. By this means the projecting portion of the ridge will be brought more directly in a line with the pressure in closing the flask.

It is quite as important that the incasing plaster forming the matrix should be as hard and resistant to pressure as that entering into the composition of the plaster model. If this condition is not secured there will be great danger, not only of fracture of the model for the want of adequate lateral support, but of displacement of the teeth by being forced into the plaster. So important is the right condition and manipulation of plaster in the use of celluloid that the author feels war-

Fig. 152.



ranted in adding, to what has already been said in this connection, the following judicious comments contained in a pamphlet issued by the manufacturers of celluloid:

"Plaster should always be mixed *as thick as possible*, and, if convenient, allowed to set over night, with the flask open, and dried in a warm place, as it is thereby rendered much harder. Simple as the operation is, comparatively few understand how to mix plaster so as to get the greatest strength and resistance to pressure. The proper way to mix plaster for both models and filling flasks is as follows: First, stir up some plaster as thick as can be well poured, taking care that there is no excess of water; pour some of this into the flask or impression to be filled, and shake down well. Then, into what remains in the bowl, stir more plaster until you have a mass so thick that it can be piled up. With this the flask is filled up and thoroughly shaken down. It is surprising how much plaster can be stirred in after the first is poured out, and also how a thick mass, such as described, will settle down in the flask without bubbles. The thinner plaster first poured in will run and be driven by the thicker afterwards added, into all the crevices, and most of it will escape from the flask, leaving a body of solid, resisting plaster that cannot be obtained by the ordinary method of mixing."

When the piece is incased, and the plaster has sufficiently hardened, the two sections of the flask should be carefully separated, and this can be done with greater safety to the model and other portions of the matrix, and with less liability of loosening and detaching the teeth from the plaster, by first applying just sufficient heat to the flask to soften the wax and trial plate, being careful not to melt the wax by too great or long-continued heat.

When the flask is separated, all portions of wax or other material should be carefully and thoroughly removed from the mould, and if any remain not accessible to instruments, the section or sections of the flask containing remains of wax should be placed in a clean vessel under clean water and well boiled until all is expelled. The thin, frail edges encircling the matrix in both sections of the flask should then be cut away somewhat, and well rounded to prevent fracture and consequent mixing of particles of plaster with the celluloid in moulding. When this is done, put the flask together and see if there is ample room for the "nose" of the model to pass the edge of the matrix.

To permit the escape of surplus material in moulding, either of the following plans may be adopted: 1. Cut two concentric grooves in the plaster of the upper or lower section completely encircling the matrix, the inner one not less than one-fourth or one-sixth of an inch from the margin of the mould, and the other at the border of the flask, the inner side of the latter forming a part of the outer groove. 2. Bevel the plaster around the mould, commencing about one-fourth of an inch from the margins of the latter and extending it to the sides of the flask. 3. Cut cone-shaped cross or radiating grooves from the inner circular gutter to the margins of the flask,—shallow where they connect with the circular groove, and deepening and widening towards the edges of the flask.

In no case should cross grooves be made communicating with the matrix, as these afford too ready an exit for surplus material, and prevent that "back pressure" so essential to a complete and compact filling of the mould. The grooves should be deep and ample enough to receive all surplus, otherwise it will be difficult if not impossible to close the flask perfectly. In the use of gum teeth, holes may be drilled in the matrix inside the teeth, opposite each joint, not over an eighth of an inch in diameter, and as deep as it may be deemed necessary. These act as waste gates, and relieve the blocks from pressure.

Selection and Preparation of the Celluloid Plate or Blank.—The mould having been prepared in the manner described, a suitable blank should be selected, and, as it is important that this should be, as nearly as possible, the size and general form of the mould, a good assortment of plates, for both entire and partial pieces, should be at command from which to select for any given case. Special attention is directed to this important requirement. Celluloid does not, like rubber, flow together and intimately intermix when exposed to heat and pressure. If, therefore, the blank is, in any considerable degree, wider than the model, or its central or palatal portion, fuller and deeper than that of the model, the material, when under pressure, will lap or fold upon itself along the lateral walls of the arch, and, failing to unite, will form grooves or fissures. On the other hand, if it is not wide or deep enough, the material is liable to be stretched and torn. The blank should be just large enough to fill all parts of the mould perfectly, with some slight excess, and the central portion should always be somewhat thicker than the corresponding part of the trial or pattern plate.

As celluloid cannot be depended on to flow from one part of the mould to another, it is important that there should not only be an excess of material, but that this excess should be, as nearly as practicable, distributed throughout all portions of the matrix. A neglect of this precaution will result either in an imperfect filling of the mould in some places, and consequent defect of the plate, or a porous condition of the celluloid will be found wherever the material, though apparently filling the mould, has not been impacted with sufficient force.

The selected blank should be conformed as nearly as possible to the shape of the mould by heating it in boiling water and pressing it with the fingers into the section of the matrix containing the teeth; after which the necessary fulness of the several parts of the blank may be obtained by dressing away redundant portions with files, a small bracket saw, or the knife, first softening the plate in boiling water before using the latter.

Greater exactness in the required amount of celluloid necessary in any given case may be obtained by measurement, the simplest method being by the use of the Starr instrument, illustrated in the chapter on Vulcanite. It must be remembered, however, that this device only determines the aggregate amount of material necessary, and that, while it may be a safe guide in the use of rubber which flows freely, it may lead to failure when celluloid is employed, unless care is taken that all parts of the blank correspond with the capacity of the mould.

A more reliable, though somewhat tedious, method of securing exactness in the quantity and distribution of material necessary, and which acquires special value in cases where there is unusual danger of fracture of the model or teeth, and especially of the latter when gum teeth are used and these are ground very thin, is the following, given by a correspondent of the *Cosmos:* "After preparing the case ready to flask, remove the teeth from the pattern; stop the pin-holes, then remove the pattern and carefully flask it. When the mould is ready, remove all the wax or material of the pattern; place the celluloid 'blank;' apply heat, and cast the same as if for final case. Remove the flask from the heater; place it in the clamp and cool rapidly. When it is entirely cool remove it from the flask, and trim as carefully as for final case until the blank is almost the same as the pattern in thickness (it always comes out thicker). Now you have a blank with but little excess; only what the vacuum and pins displace, or slightly more, and exactly the shape of the pattern, minus the teeth. Now set up the case again, being careful to make the pattern the same size; flask, and when ready remove the pattern; if doubtful as to amount of excess, pare the edges of the mould slightly, which will be all that is needed. Replace the blank; apply heat, when but moderate pressure will be found necessary to bring the flask entirely together. If dry heat is preferred, dip the edges of the blank to come in contact with the pins in spirit of camphor for a few minutes before casting."

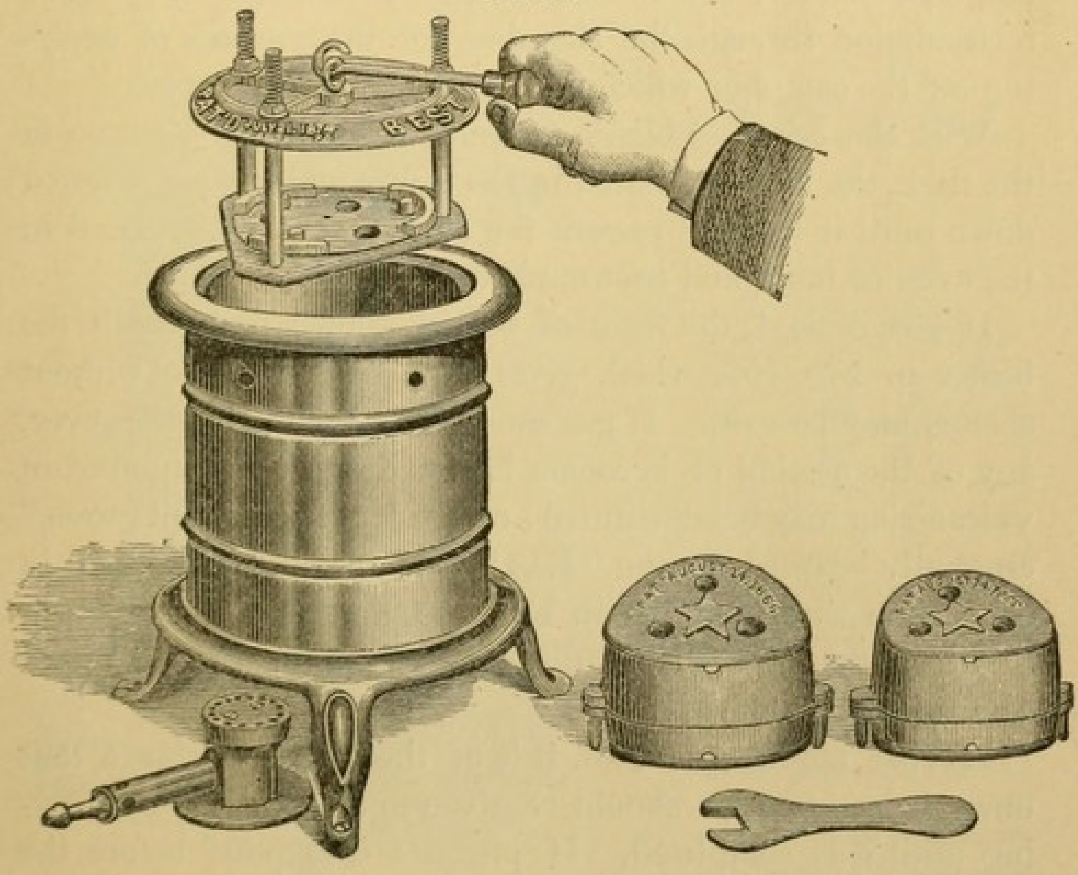
Before the blank is placed in the flask preparatory to moulding, some provision should be made against adhesion of the plaster to the plate. This may be done by oiling the surface of the model, or by coating it and other portions of the matrix with either collodion or liquid silex, or by rubbing the surfaces well with French chalk, or powdered soapstone; or a layer of tin foil may be interposed between the model and blank. The following novel method of coating the surface of the model with tin is recommended by Charles P. Alker, of Bordeaux, France: "Reduce ordinary collodion with about three times its bulk of ether, and add powdered tin until the solution is well impregnated with the metal. The tin is the same that is sometimes used for coating plaster images. When properly mixed and applied with a brush, an even covering of tin is formed upon the model, so dense as to closely resemble tin foil, and so firm as to not be detached by boiling water or heat. The plate is readily cleansed with a coarse brush, and presents the appearance of having been made in a metallic mould."

The case, as thus described, is now ready for moulding.

Moulding.—The various machines or heaters now generally employed in moulding celluloid into dental plates contemplate the use of either hot moist air, glycerin, or steam for the purpose of producing the requisite plasticity of the material subjected to pressure. There is considerable diversity in the form and construction of heaters designed to utilize these several sources of heat, as well as differences in the modes of applying pressure, and while each has doubtless some special points of merit not possessed by others, satisfactory results may, with careful and intelligent manipulation, be attained by the use of any one of the many recommended. The limits of this work will only permit the introduction of such as are believed to be in most general use.

Hot Moist Air (so-called "Dry Heat") *Machines.*—In the use of these heaters, the water with which the plaster is im-

FIG. 153.



pregnated is relied upon to produce the steam necessary to carry off all excess of camphor from the celluloid in the process of moulding. An essential point by this method is to have the plaster in the flask thoroughly wet, and this may be better attained by setting the flask in a vessel of water before placing it in the heater. To provide against insufficiency of moisture in the plaster, a small quantity of water may be introduced into the tank before applying heat.

Fig. 153 represents a moulding or packing machine of the class here spoken of, and is designated as the "Best."* The inside chamber is of cast iron, surrounded by a sheet-iron casing. The lid, of cast iron, forming a part of the clamp, is pierced for the passage of three wrought-iron screw-bolts,—the nuts being on the upper side and easy of access. When these nuts are turned for the purpose of closing the clamp, the bottom portion of the clamp is drawn up by each revolution away from the flame, thus avoiding the danger of overheating the plate, and securing a uniform heat. The bottom of the cast-iron chamber and the lid are pierced with holes, to allow a circulation through the chamber, for the purpose of carrying off the camphor which is disengaged in the process.

With the celluloid blank adjusted to its proper position in the flask, the latter is placed in the clamp and the top screwed down until it slightly presses the flask. It is then placed in the oven or tank, and heat applied.

If gas is used, the form of burner shown underneath the heater in Fig. 153, which gives a pure, blue flame without smoke, may be used. If gas cannot be commanded, however, any of the alcohol or kerosene lamps commonly employed in vulcanizing may be substituted; or, the "Hot Blast Oil Stove," especially adapted to the "Best" machine, and exhibited in connection with the latter in Fig. 154, and its construction in detail shown in sectional diagram, Fig. 155, will be found convenient and efficient.

Having applied the heat, it is of the first importance that unremitting attention should be given to the process of moulding until it is completed. If pressure is applied before the celluloid is rendered somewhat plastic, or too great force is exerted during the earlier stages of the process, and without suf-

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* Among other approved machines, applicable to the so-called "dry heat" process, may be mentioned "Brown's" and "Hays's" celluloid apparatus, provided with screw-bolts similar to the "Best," the Hays heater being used in connection with the Hays or Whitney boiler; the "Hindsman Heater;" a "Celluloid Press" manufactured by Spencer and Crocker, of Cincinnati, and doubtless others with which the author is unacquainted. All of these, except the "Hindsman" Heater, are adapted to either dry heat or glycerin.

ficient intervals of rest, there is danger of crushing or fracturing the model, and of impairing the articulation by displacement of the teeth. On the other hand, the nature of celluloid is such that if it is exposed to a temperature of 270°, without being under pressure, the camphor evaporates, and the material, besides being rendered hard and intractable, is puffed up, exactly as a loaf of bread is raised by yeast, and filled with air-cells, and thus rendered porous.

Celluloid begins to soften at about 225°, and will then yield slightly to pressure, but this should be applied very gently at

FIG. 154.

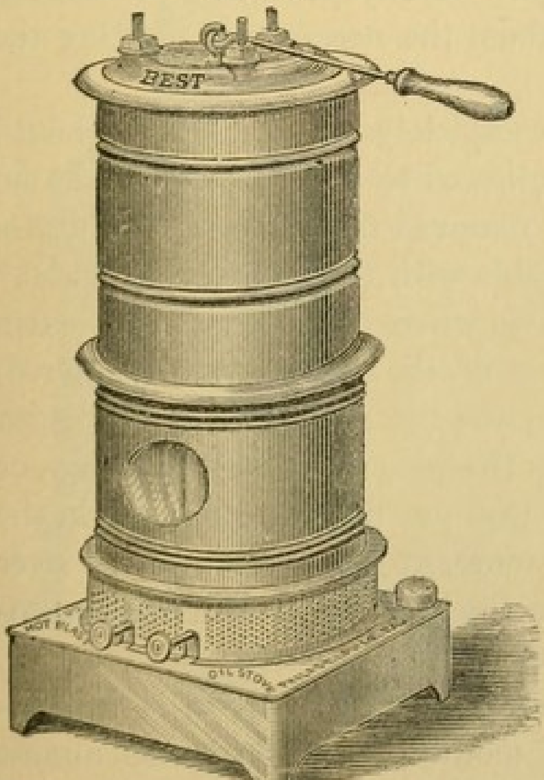
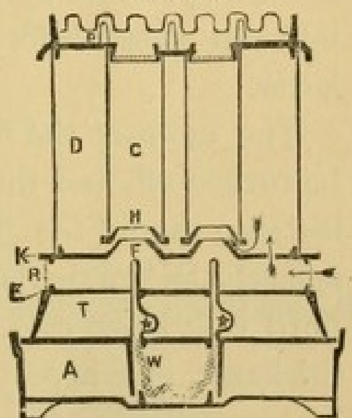


FIG. 155.



A. Reservoir, made of galvanized iron. B. Top of reservoir. C. Chimneys. D. Drum. E. Hanging partition, which keeps the radiated heat from reservoir. F. Principal air deflectors. H. Supplementary air deflectors. T. Tank surrounding wick tube. R. Perforated ring through which all the air that supplies the stove passes. W. Wick chamber. X. Wick tubes.

first, with no more force than can be readily exerted with the thumb and finger. As the heat increases, and the celluloid becomes more and more plastic and yielding, the pressure should be correspondingly increased, but always interruptedly, giving the material time, between each turn of the screw or nuts, to escape from under the pressure. No considerable amount of pressure will be required in any case until near the close of the operation, when the mould is completely impacted, and the excess is being forced into the grooves or gateways as the flask comes together.

At this point, considerable force will be necessary to close the flask perfectly, and somewhat longer intervals of time should occur between each turn of the screw or nuts.

During the progress of the moulding, the flask should be withdrawn occasionally for inspection. If, in the case of central pressure, the flask is found to be closing unevenly, it should be loosened in the clamp and readjusted in such manner as to correct the faulty approximation. No difficulty will be experienced in this respect in the use of clamps provided with screw-bolts, as pressure may be applied at any point, and the flask be made to close uniformly without the necessity of shifting the latter.

The moment the flask is completely closed, the heat should be turned off, and the piece allowed to cool gradually. In no instance should the flask be removed from the clamp (unless securely locked, as is practicable with the "standard" flask),* until it is *stone cold*. In cases where the material is of extra thickness, or where the shape of the blank is totally altered, longer seasoning is advisable, and the flask should be placed near a stove or over a register (keeping it closed by a clamp, or by an instrument or piece of iron put through the holes in the standard) for half a day or more, at a temperature not over 140°. If these directions are observed, no trouble from warping plates will be experienced.

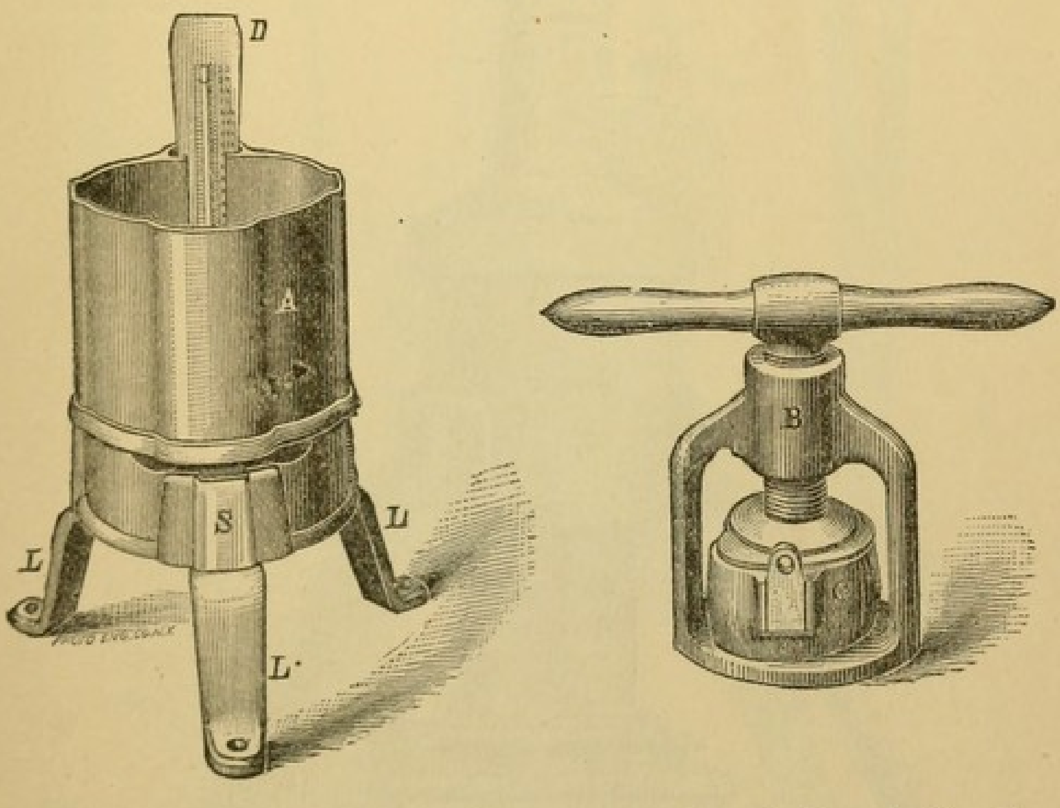
Moulding in Glycerin.—Glycerin, as a medium of imparting heat in the process of moulding celluloid, has almost entirely superseded the use of oil, paraffin, and other allied substances originally employed. It is a favorite method with many leading practitioners, and is recommended by the manufacturers of celluloid as superior to any other. The long and familiar acquaintance of these parties with the composition, nature, behavior, and treatment of the material they produce, entitles their opinions and preferences to more than ordinary consideration.

* Manufactured by the Celluloid Company, and represented in Fig. 156.

The improved glycerin apparatus manufactured by them is exhibited in Fig. 156; consisting of a tank A for containing the glycerin; a stand S with detachable legs L, which slip into slots as shown at S; an alcohol cup shown at K in sectional diagram of steam machine, Fig. 158; a screw clamp B; a flask C; and a thermometer D to indicate the heat.

Either alcohol or gas may be used with this machine. When kerosene is employed, the manufacturers recommend the use of the "leader" oil stove, which will be seen attached to the "steam" apparatus, Fig. 157. When this stove is used, the

Fig. 156.

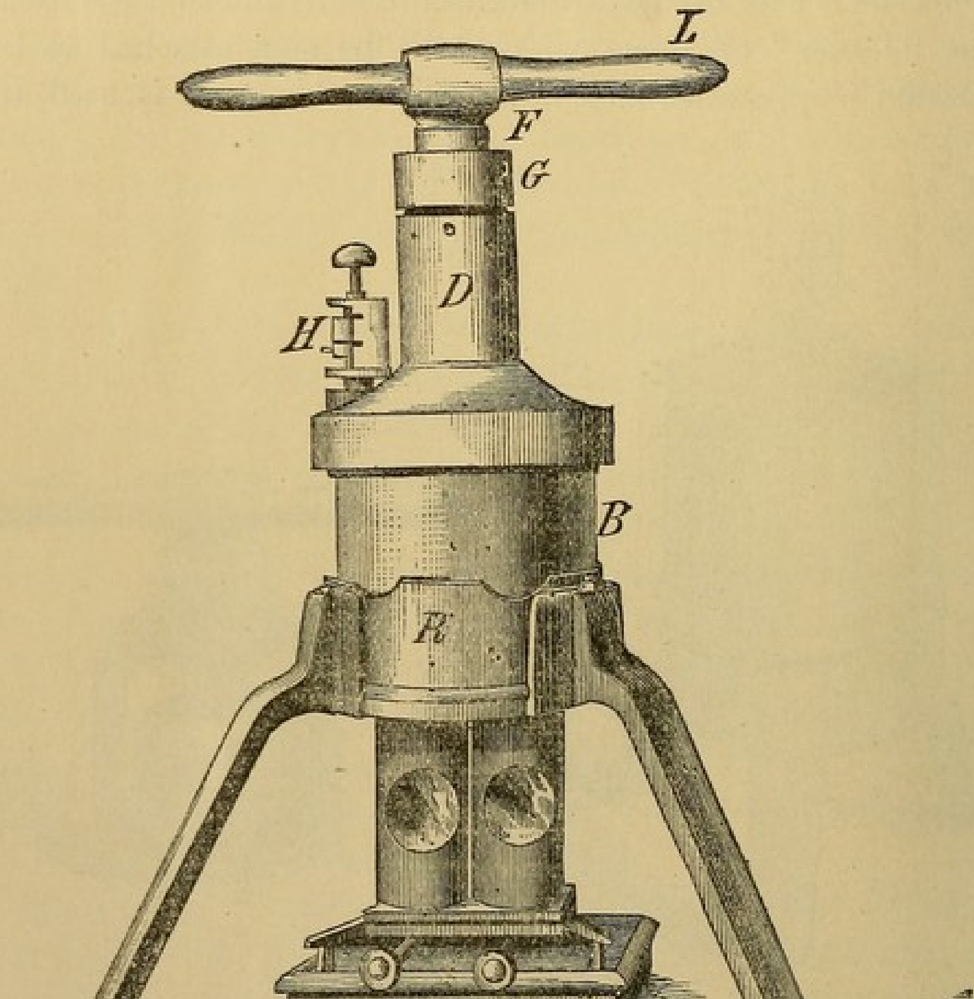


long legs of the steam machine must be substituted for the shorter ones represented in Fig. 156.

Having placed the blank in the flask, put the latter into the screw clamp and turn down the screw until it touches the flask lightly; set the whole into the tank and pour enough glycerin into the latter to come up to about the top of the flask. Apply heat, and proceed with the moulding in the same manner as described in connection with the "dry heat" method. The heat should not be permitted to rise much above 280°. If the flask is not closed when that heat is reached, reduce the flame, and do not hasten the closing. A little practice will enable the operator to graduate the pressure exactly, without reference to the thermometer.

Moulding in Steam.—The best adapted apparatus where steam is used in moulding is that manufactured by the Celluloid

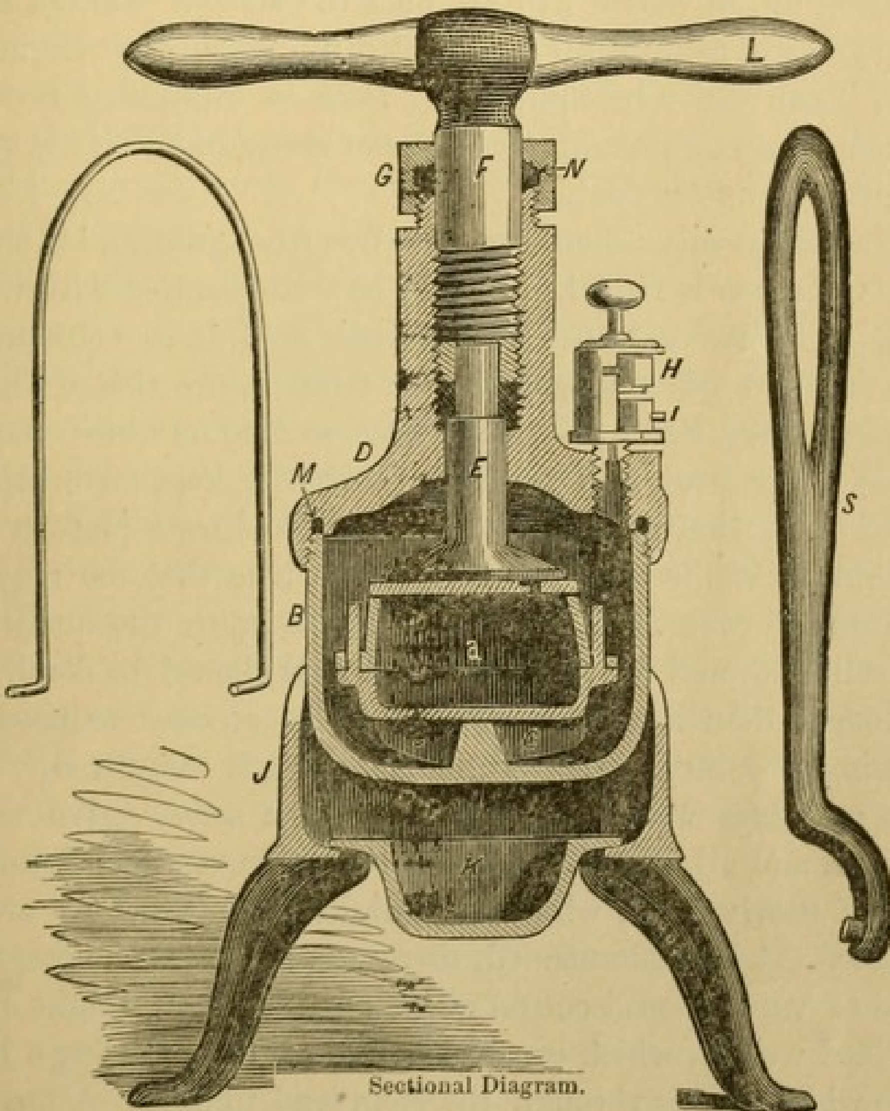
FIG. 15.7



Steam Apparatus, with Improved Stand and Long Legs, adapted to "Leader" Oil Stove

Company, and represented in Fig. 157. A sectional diagram of the same is shown in Fig. 158. It consists of the following parts: (The same letters represent the same parts in both cuts); the base, or standard, J (now made with detachable legs, as in cut of glycerin machine); the boiler B; the cover D, to which is attached the safety valve, H; the plunger, E, and alcohol cup, K (shown only in the sectional diagram below); the screw, F, for closing the flask, operated by the handle, L; the gland or packing ring, G, the object of which is simply to prevent the steam from leaking around the screw; and the wrench or spanner, S.

FIG. 158.



M and N, in the sectional drawing, represent steam packing, to make the boiler tight.

The stand is the same as that for the glycerin machine shown in Fig. 156, and is furnished with short legs, as shown in that cut (for alcohol or gas), or long legs as above, as desired. To use the old steam machine with the "Leader" stove, it is necessary to order only the improved stand with long legs. The company send always the short legs unless otherwise ordered.

In using the steam machine, care should be taken to keep it in good order. The screw should be well oiled with only the best sperm oil, which will not gum, and kept so that it can be easily turned with the thumb and finger. If the machine, when received from the depot, works hard, the screw should be run out, the gland unscrewed, and the rubber packing loosened up, so that it will not bind the screw. Do not turn it down tight again until you heat it up, when, if it begins to leak, it can easily be tightened. Bear in mind that *turning this gland merely prevents the escape of steam, and does not affect the pressure on the flask.*

The safety-valve should be kept free from gum, and if either it or the screw is fouled, it should be well cleansed with kerosene. This valve, in the machine now sold, is so constructed that it blows off at about 275°, a temperature that celluloid will bear very well; and as the heat, *so long as water remains in the boiler*, cannot, if the safety-valve is kept in order, be raised above that point, it is impossible to *burn* a plate in this machine. While this is true, it is also true that *too long* an exposure to even 275° in steam, tends to injure the quality of the celluloid, and for this reason the heat should be continued no longer than necessary, but should be at once reduced by blowing off steam as soon as the moulding is completed. The first machines were constructed with the safety-valve much heavier, and all in one piece, and were adjusted to a temperature of nearly 300°, which was higher than necessary or advisable. It is recommended, therefore, that those having that style of valve should cut off about one-fourth in weight from the lead weight, which can be easily done by removing a little wire which passes through the stem and weight. A modern valve will be furnished when ordered. When moulding, fill the boiler partly full of water. The amount is not material, but there should always be enough to cover the ribs at the bottom. Have the screw well turned back, until the plunger, when placed in position, will rest against the top of the boiler, otherwise the flask may be pressed upon while screwing down the cover, and the cast injured. Turn down the cover snugly; see that the gland is turned back, and the screw works freely.

Many failures have occurred by neglecting this simple matter. If it works hard, it is impossible to tell how much or how little pressure is being exerted; there may be too much, and blocks or cast be broken; or too little, and the plate made porous. In all methods of working celluloid, the *sense of feeling* is the best guide as to when and how hard to turn; but in order to have this there must be perfect freedom of motion of the parts. The *time* elapsing before turning is not reliable, as it varies with the heat employed, the temperature at starting, the amount of water in the boiler, the drafts of air to which the flame may be subjected, etc.

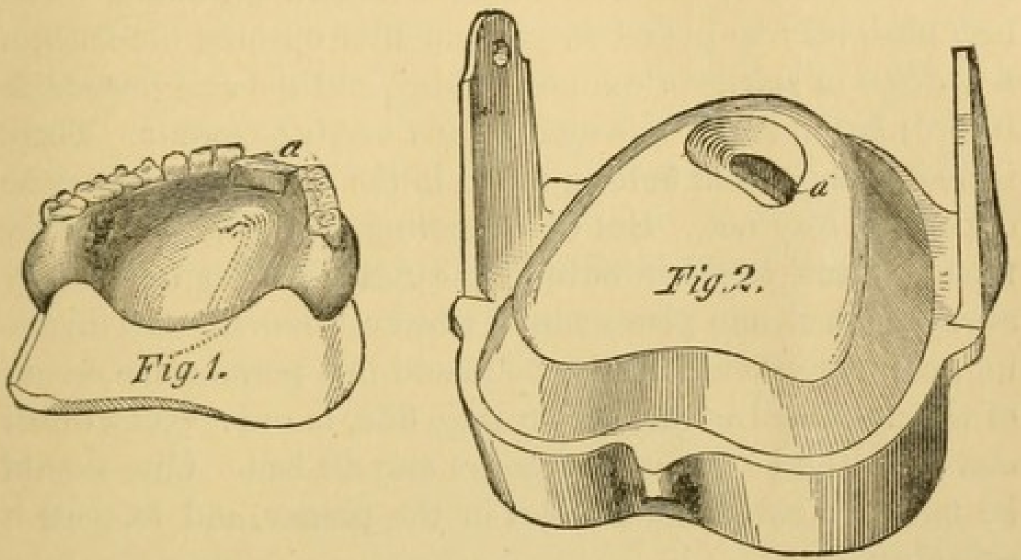
After placing the flask in position, turn down the screw *very gently*, with thumb and finger, until you feel it touch the flask. Fill the cup with alcohol and light it, or light the gas. The safety-valve is made in two parts. The upper portion may be suspended by the pins in the lead weight; the valve will now blow off steam (if in proper order) at a temperature of 225°. Until this occurs, no particular attention is necessary, but from that time the exclusive attention of the operator should be given to the moulding. Many failures occur from the want of this, for the plate may be easily injured from too much heat without proper pressure. But fifteen or twenty minutes, at the most, will be required from this point, with proper heat, and nothing else should be attended to.

At the point when the steam escapes from the valve with the upper portion suspended, the plate will soften, and the screw will be felt to yield to light pressure with thumb and finger. The upper weight should now be dropped down. Turn the screw *very carefully*, stopping when you feel the resistance increase; as soon as it yields again, turn it more, going slowly and carefully at first, but increasing the pressure somewhat as the steam gets up, which you will know by occasionally raising the valve. It is just here that judgment is required, to avoid, on the one hand, too much pressure before the material is sufficiently softened, which would result in fracture of the cast or blocks, disarranging the articulation, or a "flaky" plate; and, on the other, too little pressure after the heat is up, which would result in injuring the quality of the material. The pressure should be followed up as the heat rises and the screw yields, the object being to get the whole of the plate under pressure, in every part of the mould, by the time the steam blows off quite sharply and steadily on raising the safety-valve. After this, the pressure should be increased, but time should always be given between the turns for the slowly flowing celluloid to escape from under the pressure. Toward the close of the process, the pressure should be considerable; in in fact, about all that can be applied with the machine, and should be continued as long as the screw can be turned. If the operation has been properly timed, the steam will blow off at the safety-valve at about the time the moulding is completed, and the alcohol in the cup is consumed. If it should blow off before that, no harm would be done, as the heat cannot become too great if the safety-valve is kept in proper condition. These remarks apply to the use of alcohol in the cup furnished with the machine. If any other heat is used, the flame should be sufficient to complete the process within thirty to forty minutes. If more than this time is consumed in the moulding, the quality of the plate is injured.

Do not allow the water to be all converted into steam, as the steam would then become superheated, and a dangerous condition ensue or the plate be ruined, while the safety-valve would not indicate it. Always have plenty of water in the boiler, and if steam should cease to issue on raising the valve, the heat should be at once withdrawn.

Repairing.—This is very easily and satisfactorily accomplished. Cut away the plate, and fit in the new teeth or block. Dovetails or holes may be made, but they are unnecessary. Always, if possible, *before flasking*, fit a new piece, much larger than the portion cut away, to the plate as closely as possible, and let it come as close as possible to the added teeth; then, having the surfaces clean, cement it fast with spirits of camphor, or a solution of celluloid and camphor. Allow it to dry, after which the new teeth should be waxed into place. Invest the piece in the flask, covering the *whole* *plate and teeth* in the plaster, except the added piece, which should be left at the bottom of a *well* or depression in the plaster.

Fig. 159.



The above cut will show the manner of repairing, and make it as plain as can be done in print. No. 1 shows the first step in the process, the plate being cut away and the new piece (shown at "*a*") fitted and cemented in place. After drying a short time (allowing it to stand a few hours or over night if convenient), fit the new block to its place, leaving as little space as possible between the plate and block; this space is to be waxed up to keep out plaster when investing. Fig. 159 shows the piece invested, the whole plate and teeth, except the new piece "*a*," being covered deep in the plaster, which is trimmed as shown. The upper part of the flask is now put in place, and filled in the usual manner. On opening the flask boil out the wax. Then lay another piece of celluloid, or a ball of tin foil, or moistened blotting-pad—in fact anything that will produce pressure, upon the piece "*a*," and heat up and press as usual. In this way the new piece becomes a *part of the plate* by the cementing process, *before* the pressing is done, and will not scale or separate. If neatly done, the line of junction will be scarcely observable. The sharp edge of the plaster at the bottom of the well or depression should be trimmed out and well rounded, as otherwise these edges are liable to fracture and get into the plate. If the new block or tooth is separated from the plate, so that it has no support, and is liable to be pushed down, it should be supported by crowding a small bit of celluloid under it before beginning. The new piece may be placed in position after opening the flask, a few drops of spirits of camphor added, and the case pressed as before; but union by this means is not nearly as certain. There is no *certainty* about uniting pieces in the machine. It may be done, or it may not. But by cementing well-fitting or freshly filed surfaces together outside the flask, perfect union may always be had, and pieces added wherever desired. In investing, the plate should always be placed in a position the *reverse* of that indicated by the cut on page 382, in order that a direct *downward* and not a *side* pressure may be had. Care should be taken to avoid air-bubbles in the plaster, and to pour it smoothly.

If the plate is of sufficient thickness, the repair may be very nicely made without adding any new material. Fit the new block without cutting away more of the plate than absolutely necessary. Invest the plate, leaving the tongue side exposed, but covering the teeth; on opening the flask, lay over the exposed plate one or more thicknesses of wet thick brown paper, blotting-pad, or unvulcanized rubber, fitting closely to the teeth and having it thickest in the centre, and press as usual. By this means the plate will be *spread* up to the new teeth, which will be firmly united. Loose teeth, if any, on the plate may be tightened by the same means, having been waxed in place, and the wax afterwards thoroughly boiled out. Some dentists attempt to mend in this way, without using anything to produce pressure, depending upon the swelling of the plate to fill the vacancy. This would be *certain* to injure the density of the plate.

To remove teeth, heat the plate in boiling water or glycerin, when they will easily come off.

Rubber plates may be very nicely repaired with celluloid, but as there is no union, dovetailing or drilling holes is necessary.

Finishing.—This is accomplished in one-half the time necessary with rubber. Use files, sandpaper, and scrapers, but do not use too coarse materials. Polish with pumicestone, and finish with a soft brush at high speed, and whiting or Vienna lime. Dr. H. D. Knight, of Lancaster, Pa., recommends a polish obtained by rubbing with an old cloth wet with camphor. This may be valuable between teeth, and in places inaccessible with the brush-wheel. In finishing, care should be taken not to heat the plate by friction, as by so doing the surface may be injured, or the plate sprung out of shape.

CHAPTER XVI.

Attaching Porcelain Teeth to a Metallic Base with Rubber or Celluloid.

The following method of attaching porcelain teeth to a metallic plate by means of rubber or celluloid, though but little practiced heretofore, is attracting more attention than formerly, and is eminently deserving of more favorable consideration and general adoption, by reason of its conspicuous and acknowledged merits, than it has ever yet received. The credit of its first introduction to the notice of the profession is due to Dr. P. G. C. Hunt, of Indianapolis, Ind., who practiced the method as early as 1859, and whose published descriptions of the manner of preparing the plate base, substantially the same as that for which Mr. S. D. Engle, of Hazleton, Pa., obtained letters patent some years later, were given in the first edition of this work.

In commenting on this method, Professor Charles J. Essig very justly remarks that, by the means here indicated, we are "able to produce an artificial denture embracing all that is good in metallic and vulcanite work, at the same time avoiding the great defects of each."

That it possesses marked advantages over the method of attaching teeth to a metallic plate base by soldering is unquestionable. The warping and consequent change in the form of the plate incident to soldering, so inseparable from the older method of attachment by means of stays or backings, is wholly avoided; the strain upon the platina pins is greatly lessened by reason of the perfectly adapted rubber or celluloid socket in which each tooth or block securely rests; the liability to fracture of the teeth from concussion or violence is materially diminished on account of the pliable nature of the attaching material used; a nearer approximation to the natural form of the ridge or gum on the lingual side of the plate is secured; the rubber or celluloid, penetrating all the joints and openings between and underneath the teeth, renders the piece wholly impervious to the oral secretions, making it, in point of cleanliness and purity, equal to continuous gum work; the facility with which injury to the teeth may be repaired; the practicability of remodelling the piece without impairment of the teeth or plate; its susceptibility of receiving a final finish excelled by no other method in point of artistic beauty;—these are among the qualities which commend this method of substitution as one of peculiar merit and excellence.

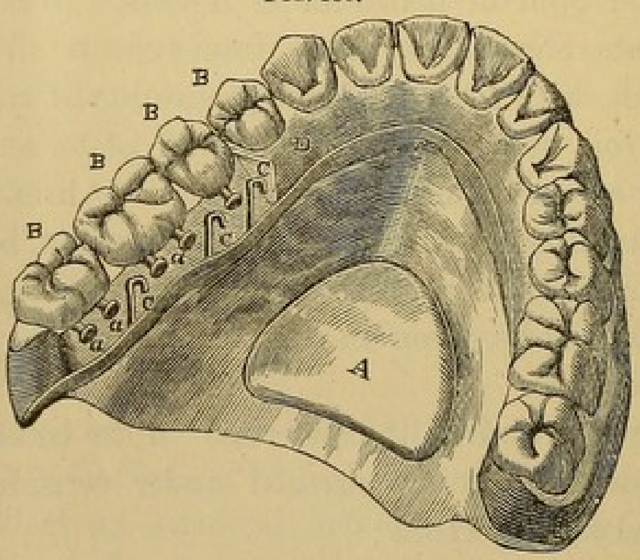
In mounting teeth by this method, preference should be given to either gold or platinum as a base. When silver is used, the plate should be made from refined silver alloyed with platinum, with the additional precaution of interposing a layer of tin foil between the rubber and plate, an expedient not necessary when celluloid is employed. Aluminum has a limited adaptability to this mode of substitution, but requires special treatment in its preparation for the purpose, a description of which will be given in connection with the manner of preparing the plate.

The manipulative details concerned in the construction of an artificial denture by the method under consideration are thus described by Dr. Hunt:

"Take the impression, make metallic dies, and form the plate as for work in the ordinary way. After fitting the plate in the mouth, get the articulation, the fulness and length of the teeth, remove the wax and plate from the mouth and make the plaster articulation. If a full set, after separating the articulation, and before removing the wax from the plate, take a small light pair of dividers, set them say one inch apart, and with one point following the margin of the wax representing the cutting edge of the teeth, and the other point marking permanently the plaster, you have always in the dividers so set a gauge for the length of any particular tooth. A convenient substitute for the dividers may be formed from a piece of wire of convenient length, one-half the diameter of a common excavator, by suitably twisting its middle for a handle, and its ends being sharpened, and pointing in the same direction, one or one and a half inches apart.

"Thus far we proceed as we do for ordinary gold work. We will now suppose the teeth ground and jointed, leaving as much space between the teeth and plate as the plate will admit of. We next mark with a sharp-pointed instrument on the labial surface of the plate each point where it is necessary to place a loop for purposes hereinafter described. Then apply wax to the external or labial parts of the teeth and plate in any manner sufficient to retain the teeth in position, remove the wax

FIG. 160.



from the lingual parts of the teeth and plate, and mark the position on the metal where it is desirable to insert loops, remove the teeth and wax, and with a small bow-drill make holes through the plate at the several points previously determined on for the attachments, about the size of the ordinary plate punch-hole, take a wire, or ordinary gold plate, cut in strips, say from a half to one line in width, being governed by the amount of room there is under the base of the teeth, and with small, round-nosed pliers, bend the strip around, grasp both ends with square-nosed pliers, draw the round-nosed pliers from the loop, still grasping the square-nosed pliers with the left hand, and with a hammer strike the top of the loop a sufficient blow to keep the ends from springing apart. Cut off the ends, and dress down to fit the holes in the plate, after which solder on charcoal or other suitable substance without investment."

By reference to Fig. 160, which illustrates Mr. Engle's method of providing attachment for the rubber to the plate by means of bent or hooked wires soldered to the base, the substantial identity of Dr. Hunt's mode of forming loops for the same purpose will be apparent.

With this digression we return to Dr. Hunt's instructions:

"Pickle, dress, and polish that portion of the plate to be exposed to view. Bend and flatten the pins, arrange the teeth according to the articulation, waxing so as to cover up the loops if practicable; the loops should be placed as near the base of the teeth as possible, the rubber forming when finished a part of that general concave shape which is desirable in upper dentures, and which it is not possible to obtain with the ordinary soldered work. Then with silicate of soda paint the joints, to keep the rubber from forcing in where it would show after vulcanizing. Flask, vulcanize, and finish up as usual. The advantages of this style of work are obvious. With this you have work as cleanly as the continuous gum, decidedly more so than the very best single gum or block-work soldered in the usual way; again it is very much stronger, less liable to breakage, both in and out of the mouth, as the rubber gives *a perfect base* and support for the teeth to set upon. By this method *there is no springing of plates*. As your plate fits the mouth when the articulation was taken, so will be the fit when the case is completed.

"On the labial edge of the upper plate the rubber may be allowed to project beyond the edge, if desirable, and it will be found in many cases exceedingly satisfactory to do so, and allow the rubber to be of considerable thickness near the alæ of the nose, where the loss of the cuspidati may leave a want of support to the soft parts adjacent, and which in this manner can be readily corrected. If the rubber extends upwards so far as to irritate the muscular structure, a few minutes will be sufficient to make the necessary alterations. In all such cases where we have control of our patients, we place the denture in the mouth before finally polishing, so as to determine as accurately as possible the limit to which extension upward may be carried.

"The neatest work on this principle is made by carving blocks, giving to the lingual surface that regular concave form which is desirable. In this no platinum pins or loops are necessary, but that half of the matrix on which the blocks are carved, large metallic pins are so arranged as to be hid from view in the tooth body. Different-sized pins may be used, as large as the nature of the case will admit. In short, we make the holes in the block similar to those in pivot teeth, where there is not sufficient room in the block above the tooth (or below if an under) to allow the pins to run into the body of the teeth. After burning, grinding, and fitting, get the position of the holes in the blocks relative to the plate, and drill through the plate as before, and instead of loops, solder gold wire of suitable size and length, say a very little shorter than the depth of the hole in the blocks, and two-thirds the diameter thereof; the wire should have a screw-thread cut on it, or that which is just as good, and more expeditious, barb or cut with a sharp knife. At this point of the manipulation, if it is desired that the rubber should extend beyond the labial or buccal edge of the metallic plate, place as many loops at different points as are sufficient to retain it with firmness, after which polish the plate, wax, and proceed as before described. If you desire no rubber beyond the blocks, the roughness of the holes in the same, and the barbed points on the gold wire when properly packed and vulcanized, will give ample strength and firmness to the case, and if care has been used in the entire manipulation, you will have, when finished, but a thin line of rubber exposed to view.

"In partial cases, if of gold base, solder on loops, as before, for the retention of the teeth, and if there are to be any clasps, make them of rubber, uniting them, as the teeth, with loops.

If the ordinary plate teeth are used, it is frequently necessary to back them, to give better retaining-points for the rubber. If blocks are to be burned, insert loops of platinum plate in the shape of the letter U in place of the platinum wire pins. In consequence of the affinity of the sulphur in the vulcanite for silver, plates of that metal should not be used."

The following method of preparing aluminum plates for the attachment of the rubber, was communicated to the author by Dr. J. W. Hollingsworth, of Greencastle, Indiana, an intelligent practitioner, who has had long and extended practical experience in the various modes of working this metal for dental purposes, and who says of the following mode of procedure, that "it is the most practicable and the most easily manipulated method that I have yet seen."

The following is the manner of preparing the plate as described by Dr. Hollingsworth: "Perforate the ridge of the plate at proper points and intervals; then pass through these perforations, from the inner surface of the plate, headed pins made of aluminum, which, after replacing the plate with the pins back upon the die, we shrink down to permanency with a hollow punch. The punch must be made with the hole not quite equal in depth to the length of the extruding portion of the pins, and slightly bell-mouthed. This riveting process forms seriate studs or pins, which may be bent or flattened with pliers in any way to suit the requirements of the case."

When celluloid is used for purposes of attachment in the case of upper entire dentures, the palatal portion of the blank should be cut or sawed away, leaving only the ridge portion to be used, and this should be trimmed, if necessary, so as to have but little excess of material. The ordinary full blank may be used for lower cases, observing the same precautions in regard to quantity of material. When the blank is thus prepared, the subsequent manipulations are the same as those described in connection with the celluloid base.

It may be observed that, when rubber or celluloid is used, it is better to dispense with the plaster model in forming the mould or matrix, and proceed as follows: When the teeth are arranged, and the required contour and fulness given to the wax drafts, fill the lower section of the flask with plaster, and (having also filled the plate with the same), imbed the plate in it, making the dividing line on the external rim of wax. When the plaster has hardened, and the other section formed, and the two afterwards separated, the metallic plate will remain in the lower section, and the teeth in the upper.

When using celluloid, plain teeth may be advantageously employed, the former representing the gum; this gives perfect freedom in the arrangement of each separate tooth in the denture, an optional disposition the importance of which cannot be over-estimated.

CHAPTER XVII.

Gold Alloy Cast Base.

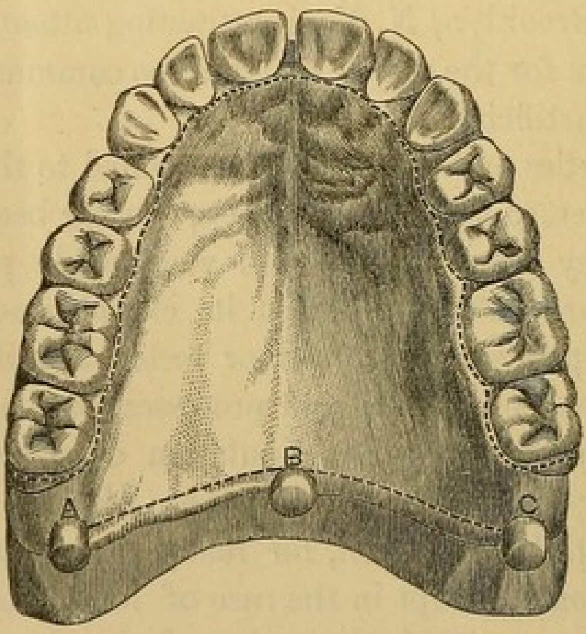
The compound of gold, silver, and tin, in varied proportions, in connection with specific and original methods of casting dental plates, recently devised and patented by Dr. George F. Reese, of Brooklyn, N. Y., is attracting attention as a possible substitute for the plastic materials so commonly employed as a base for artificial dentures.

The properties and capabilities attributed to this alloy, and which are deemed essential in a base, having been practically tested by many representative and responsible practititioners who have unreservedly indorsed its claims upon the confidence of the profession, the author feels warranted in substituting Dr. Reese's materials and processes for the older alloys, appliances, and modes of manipulation described in former editions under the head of "Cheoplastic Method of Mounting Artificial Teeth," and which, for many years past, have been wholly abandoned except in the case of lower dentures where extreme and exceptional absorption of the alveolar processes make greatly increased weight necessary to provide against mobility and displacement of the substitute.

After premising that the methods in common use for casting alloys were not applicable to one having the molecular properties of Reese's compound, the inventor says he was led, after multiplied experiments, to adopt the plan of which the following is a description:

The impression is taken with plaster, to which salt or sulphate of potassa has been added, and the model obtained from this with pure plaster. Upon this the teeth are arranged. For the trial plate, gutta-percha, paraffin, and wax, or modelling compound, may be used. When satisfaction in the occlusion is attained, then the case is returned to the model, and the waxing around the labial and buccal borders of the teeth completed. That portion of the trial plate which covers the palatine surface is now removed, so that the pins of the teeth will be nearly exposed; allowing the wax which is under the gums to remain. That the plate, after casting, shall not be too cumbrous, the trial plate, which has been removed, must be substituted with two thicknesses of French flower wax, cut carefully to the model, and pressed down closely with the finger

FIG. 161.

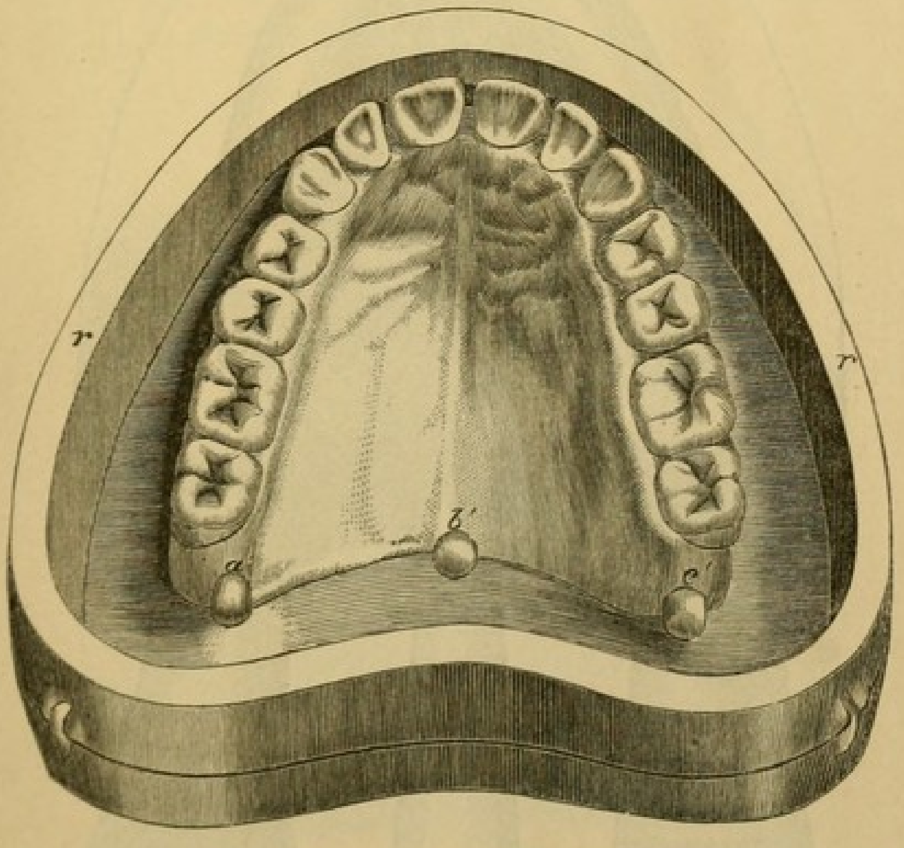


in a manner that no wrinkles will appear to mar the beauty of the work.

Fig. 161 represents a case thus prepared. The dotted lines show the borders of the thin wax. B, A, and C, represent nipples of solid wax, fixed to the posterior border and to the tuberosities; A and C being the places of exit for the molten metal into the waste pockets, and B the place of entrance of the metal from the pouring-gaine.

The case is now transferred to the small brass flask, *r*, Fig. 162, the sections of which having been well oiled, upon the inner surface, to facilitate their removal from the investment. Either section is then placed upon a plate of glass and plaster poured into it until half filled. The model, as prepared, after being well saturated with water, is imbedded in this single section, allowing the teeth and gums to remain uncovered. Set on the counter-part of the flask and add more plaster along the posterior border until the nipples are reached or slightly covered. After this has set, the upper section may be removed and the surface of the plaster covered with a thin solution of shellac, Elliott's parting fluid or vaselin. Return

Fig. 162.

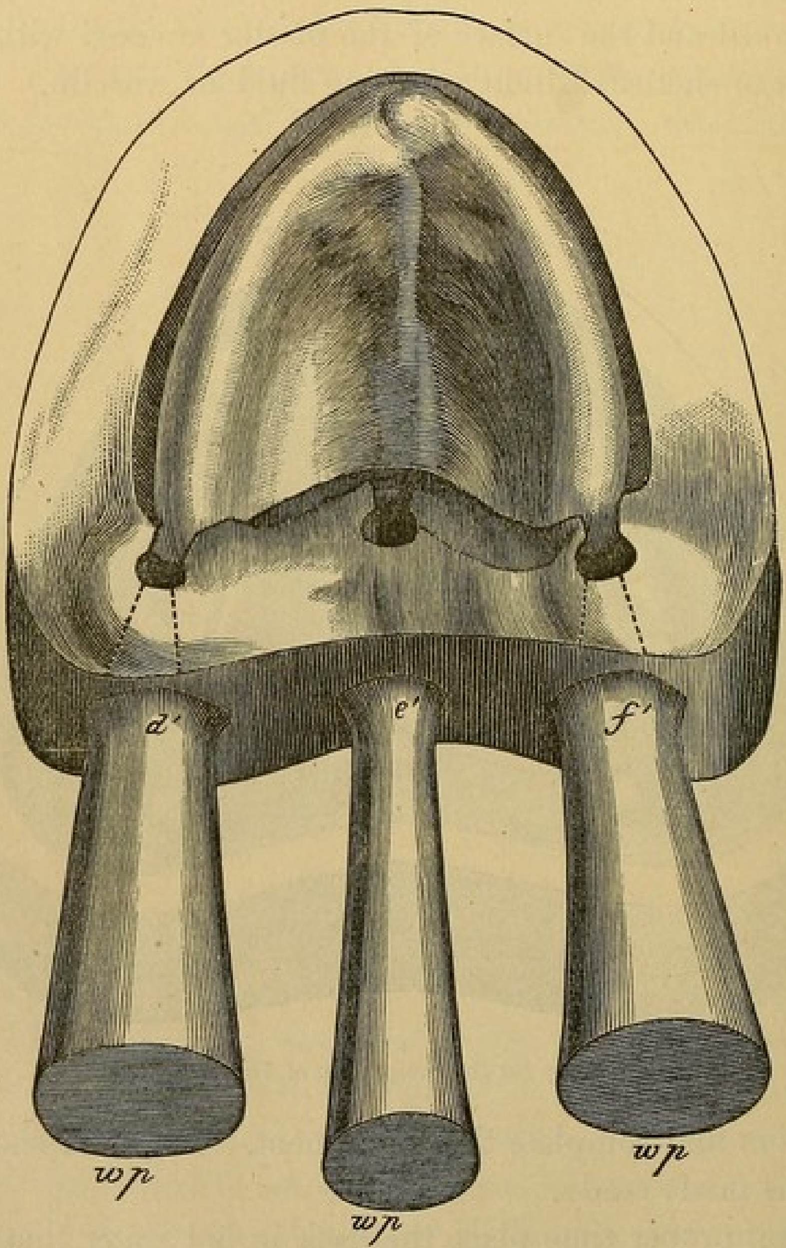


Case ready for the completion of Investment.

the section and complete the investment. Fig. 162 shows the case thus made ready.

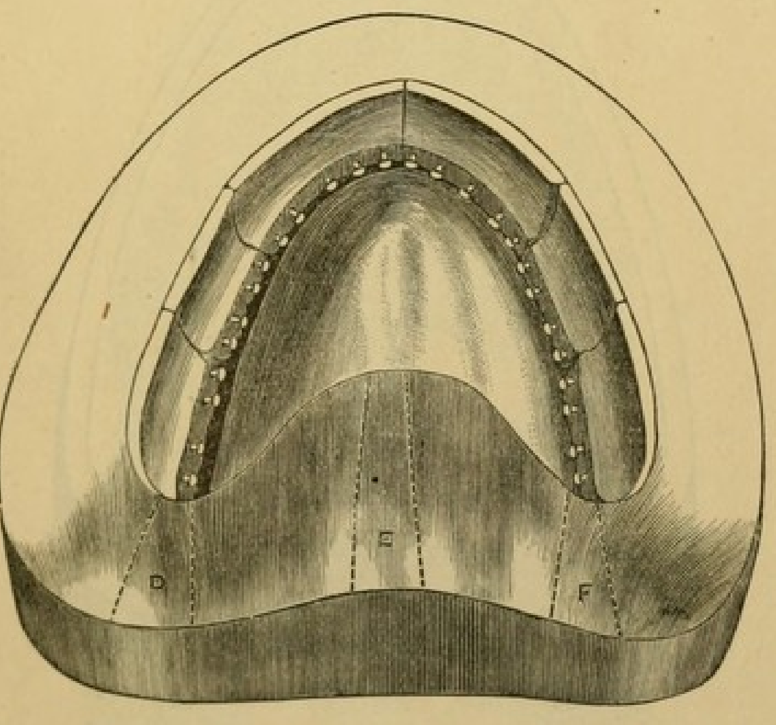
After a proper time place the flask in hot water that it may be separated without injury. When separated, wash away all the wax, and, by means of gentle tapping, remove the flask rings from the investment and set them aside. The depressions formed by the nipples may now be extended through the plaster to the external edge; or, if the circumstances of the case make this impossible, the channels may be made at the line of division between the two sections, as shown by the dotted lines in figures 163 and 164. Externally, the channels, D, E, F, Fig. 164, should be neatly countersunk and varnished with

FIG. 163.



shellac to receive the pockets. The latter are made of the French wax by warming and wrapping the same around a cone-shaped stick, and the base and apex of the cone neatly trimmed of all inequalities. These pockets should be about one and a half inches long, and about half an inch diameter at the base, and an eighth of an inch at the apex. The pouring-gaine is made in the same manner, but should be smaller in diameter at the base, and about two inches long. After removing these wax covers from the moulding-sticks, the larger ends of each should receive a thin wax cover secured to its place, and made water-tight, by flowing hot wax along the line of junction, after the manner of soldering. Trim the covers, then place the smallest ends of the large cones in the counter-sunk channels at the tuberosities and the small cone in the middle hole, and secure them with melted wax. Fig. 163, *d′*, *e′*, *f′*, shows the pockets thus attached.

Fig. 164.

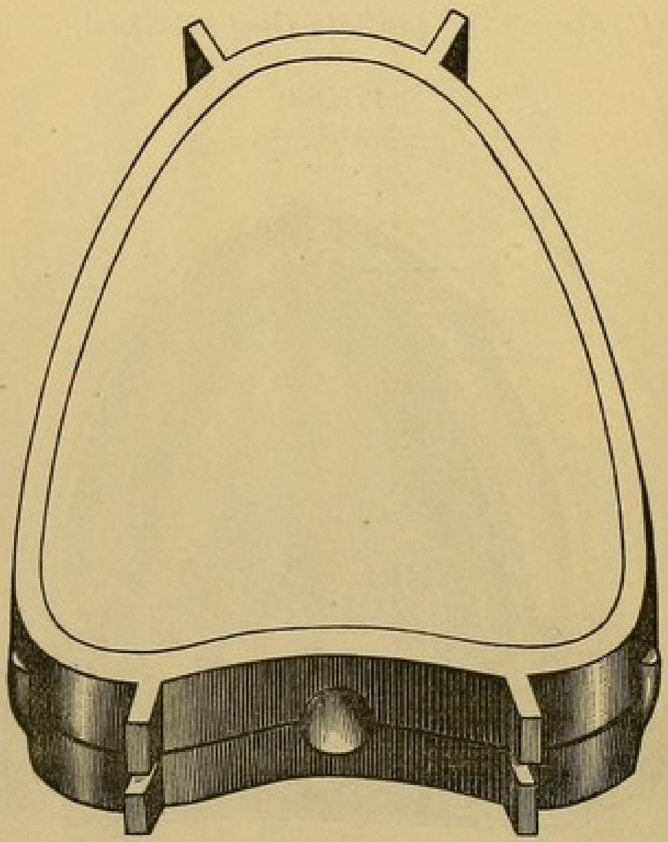


Upper or counter section corresponding to Fig. 163. D, E, F, channels for entrance and exit of metal.

Should the channels have been made through the solid plaster of the lower section, as in Fig. 163, then the upper section, Fig. 164, need not be joined to it until after the pockets are secured to their places. Should, however, the channels have been made upon the line of division, then the sections must be joined before the pockets can be attached.

The case is now ready for a second investment, which is done in a flask sufficiently large to embrace the case as it now presents. Fig. 165 represents the construction of the large flask. One section of the same is placed upon glass and about half filled with plaster. The case, having been well soaked with cold water, is laid carefully upon the plaster, allowing the long cone to rest in the notch at the heel of the flask, and the waste pockets to become imbedded in the plaster. Immediately put the other section of the flask in place and complete the invest-

FIG. 165.



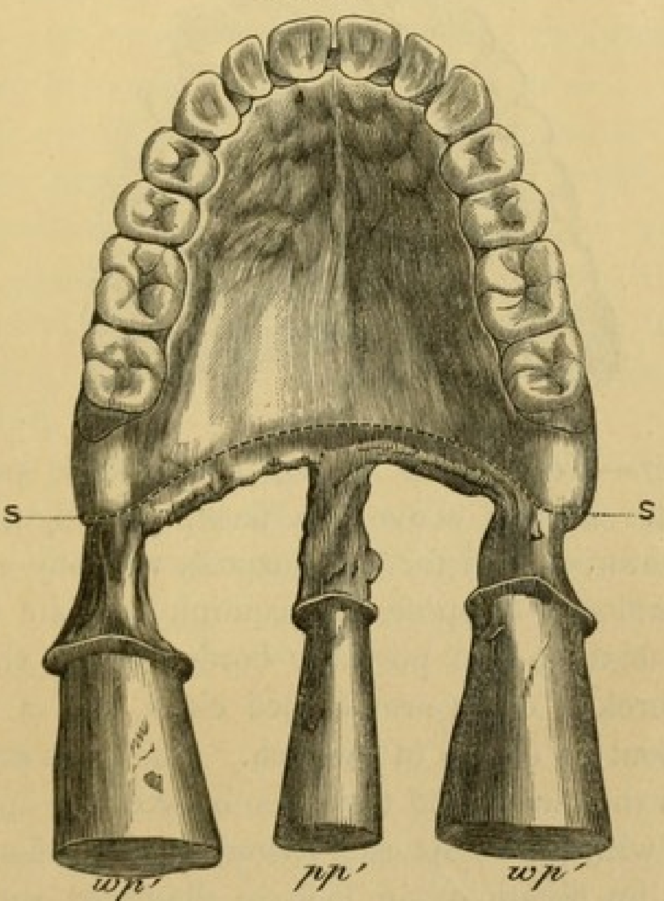
ment by filling with plaster the uppermost section to fulness. Of course there will be no division of the sections as was the case in the former flasking. After solidification, the pouring-gaine must be neatly trimmed and countersunk, and great care must be exercised that no dirt be allowed to enter the channel.

The wax, which is imbedded in the plaster, and which forms the waste pockets, will be entirely absorbed, and no trace of it will be seen upon opening the flask.

All is now ready for drying. This is done in an oven specially prepared for the purpose, but it may be accomplished in any way to be chosen by the manipulator. 'An ice-cold mouth-mirror placed over the opening of the pouring-gaine will detect the slightest moisture which may remain, and until this is entirely dispelled, the casting should not be attempted.

There are several grades of the gold alloy, as compounded by Dr. Reese, which require a heat registering from 600° to

FIG. 166.

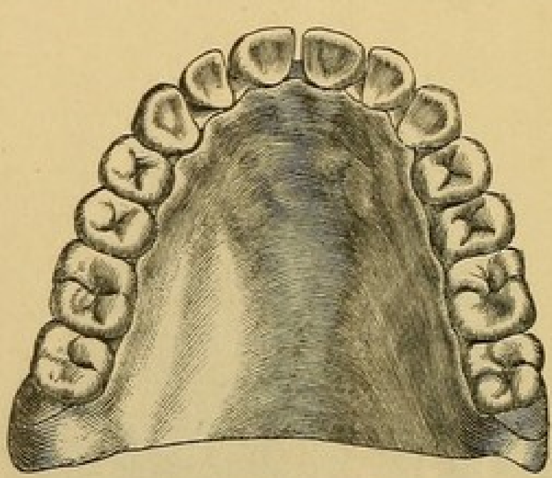


700° Fah. to melt, but a higher temperature than this must be attained before pouring, in order to secure a satisfactory flow. At 900° rapid oxidation takes place. This, of course, should be avoided. The alloy may be melted in an ordinary iron ladle or crucible over a gas or other flame, and should be poured while the mould is hot.

After the lapse of an hour or two, or until the cast is sufficiently cooled to insure the integrity of the teeth, it may be placed in warm water, when the investment can be easily removed.

Fig. 166 represents the cast after removal. The surplus metal may be separated, along the dotted line S, with a ribbon saw, after which the denture is ready for the pumice-wheel and brush. Fig. 167 represents the finished case.

Fig. 167.



Repairing.—The process of repairing broken plates is, in principle, the same as above. A flask, specially constructed by the inventor, is used for this purpose, whereby a single investment suffices. Suppose, for example, a plate is broken, from the labial to the posterior border, along the median line; the broken edges are scraped clean, and a separation made of about an eighth of an inch. The parts are then adjusted upon the model, and the space between the approximate edges filled with wax. At each extremity of the fissure a pencil of wax, an eighth of an inch in diameter, and one and a half inches long, is securely attached, perpendicularly, to the palatine surface, and the whole surrounded with plaster to the depth of one inch. Thus will be constituted two sections, which are separated, and the wax washed out. The external ends of the channels, formed by the pencils, are then countersunk, and into each is inserted a wax cone, the one forming a pouring-gaine, and the other a waste-pocket. The latter should be entirely covered by the plaster. The whole is now invested in the repair flask, and subsequently submitted to the process of drying.

Dr. W. S. Elliott, of New York, has taken advantage of the method above described, to overcome the difficulties attending the construction of continuous-gum work.

To maintain a perfect adaptation of a swaged plate seems often impossible, in consequence of the springing of the plate in the furnace. To avoid this difficulty, the following plan is suggested: The plaster model is first covered with two thicknesses of French flower wax, carefully adjusted. From this a metallic die and counter-die are made, and a very thin (No. 32) platina plate is swaged to fit the waxed model. The labial border need not be returned as in ordinary cases. Upon this the teeth are arranged, and the case is transferred to the furnace for biscuiting and enamelling. After proper annealing, it is replaced upon the model and waxed up, on the labial and buccal borders, over the edge of the plate; then flasked, the wax removed, and the metal cast upon it in the manner heretofore described.

Danger of checking the enamel is associated with the process; but success has attended the effort, and it is hoped that present experiments will insure perfect and uniform results.

CHAPTER XVIII.

Defects of the Palatal Organs, and their Treatment by Artificial Means.

DR. KINGSLEY'S ARTIFICIAL VELUM AND PALATE.*

Palatine Defects.—Defects of the palatine organs may be divided into two classes, viz., accidental and congenital. The first includes all loss of substance in either hard or soft palate by disease or otherwise. Such defects are not uniform in locality or extent, being sometimes but a simple perforation of the palate, and at others involving the destruction of the entire soft palate, a considerable portion of the hard palate, the vomer and turbinated bones, and the loss of the teeth.

The second class includes all malformations, from the simple division of the uvula, to an opening through the velum, palatine, and maxillary bones, and a division of the upper lip, thus uniting throughout their entire extent the nasal passages with the oral cavity.

These malformations are quite similar in character, but not uniform in extent. They may be said to begin with the uvula, and in the uvula and velum *always occupy the median line;* but as the defect progresses anteriorly, it may deflect to one side or the other of the vomer, and follow the nasal passage through the lips, leaving the vomer articulated with the palatine bone on one side; while in other cases the deformity seems to follow the median line, and thus involves both nasal passages, and terminates in a double fissure of the lip.

* The descriptions, with accompanying illustrations, embraced in the above chapter were contributed, at the solicitation of the author, by Professor Norman W. Kingsley, and may therefore be relied upon as an authoritative exposition of the most approved manipulation and appliances involved in the practice of that difficult and important specialty of the Dental Art in which the writer excels.

In both classes (accidental and congenital) the faculty of distinct articulate speech is seriously impaired by defects of any extent. In ordinary cases of congenital deformity, deglutition is not materially interfered with. The patient having never known any other method of swallowing, is not conscious of any difficulty. Accidental lesions, however, coming generally in adult life, produce, in this respect, very great inconvenience. The remedy for these evils must be the closing of the abnormal passage by some means which will restore the functions to the deformed organs. In perforations of the hard palate, unless of extraordinary extent, the method is very simple. In the loss of the soft palate by disease the remedy is more difficult, and in extensive congenital deformity still more complicated appliances will be required.

As we have classified the defects, we shall also classify the appliances used for their remedy.

The term *obturator* will be used for all appliances intended to stop a passage, as all openings in the hard or soft palate which have a complete boundary. Appliances made to supply the loss of the posterior soft palate, whether accidental or congenital, will be called artificial vela or palates.

Obturators.—Any unnatural opening from the oral cavity into the nasal cavity, which will permit the free passage of the breath, will impair articulation. Any appliance which will close such passage, and can be worn without inconvenience, will restore articulation.* Obturators were formerly made of metallic plate, gold or silver being most commonly employed, and many very ingenious pieces of mechanism were the result of such efforts, but latterly vulcanized rubber has almost entirely superseded the use of metals. Vulcanite has been found preferable to metals, being much lighter and much more easily formed and adapted, particularly when of peculiar shape.

* The student will bear in mind that no cognizance is here taken of openings similar to those described in cases of congenital fissure, where the surgeon has united the soft palate, and left an opening through the hard palate, to be covered by an obturator. In such cases, neither the surgeon's operation nor the obturator will prove of any material advantage.

The steps to be taken in the formation of an obturator are not unlike those used in making a base for artificial teeth. It is essential that an accurate model be obtained of the opening, the adjacent palatal surface, and the teeth, if any remain in the jaw. For this purpose an impression in plaster is the only reliable means for such an end. Care must be used that a surplus of plaster is not forced through the opening, thus preventing the withdrawal of the impression by an accumulated and hardened mass larger than the opening through which it passed. To avoid this, beginners or timid operators had better take an impression in the usual manner with wax; if this is forced through, it can be easily removed, without injury to the patient. From this wax impression make a plaster model, and upon this plaster model form an impression-cup of sheet gutta-percha, with a stick, piece of wire, strip of metal, or any other convenient thing for a handle. This extemporized impression-cup must not impinge upon the borders of the opening, neither should it enter to any extent. With a uniform film of soft plaster of from one-sixteenth to one-eighth of an inch in thickness laid over this cup, a correct impression can be made without any surplus to give anxiety. Upon a correct plaster cast, taken from such an impression, make a model of the obturator out of gutta-percha, or any other plastic substance, the subsequent steps being in principle the same as in making any other piece of vulcanite. It is desirable that it should enter the perforation and restore as far as possible the lost portion of the palate, but it must not protrude into or in any way obstruct the nasal passage.

The entire freedom of the nasal passage is essential to the purity of articulation.

That portion of the obturator which occupies the oral cavity should be made as delicate as possible, consistent with its strength and durability.

A clumsy contrivance will interfere with articulation almost as much as it is improved by stopping the opening; therefore if the obturator could be confined entirely to the opening, like a cork in a bottle, it would be all the more desirable, but as it cannot, resort must be had to clasping to the contiguous teeth, if there are any, and if not, the obturator must spread out over the whole jaw, and receive its support in the same manner as would a set of artificial teeth. In fact this is just what it would become in such a case, viz., an upper set of teeth bridging over and filling up an opening in the palate, thus combining an obturator with a set of teeth.

Fig. 168 represents an obturator without teeth and without clasps, for a perforation of the hard palate, being sustained *in situ* by impinging upon the natural teeth with which it comes in contact. Accuracy of adaptation and delicacy in form are

FIG. 168.

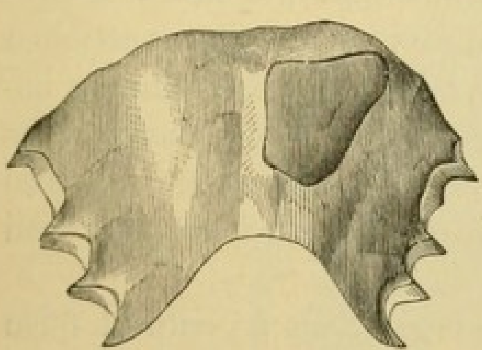
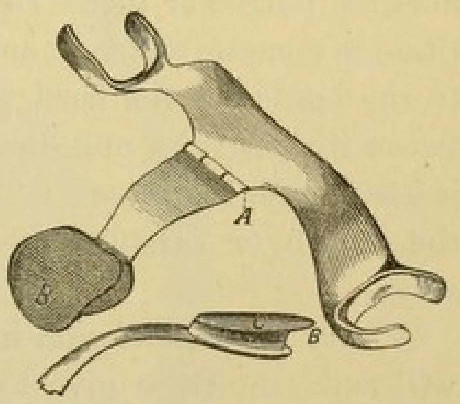


FIG. 169.



all that is essential in such cases, and the restoration of the speech will follow immediately.

Fig. 169 represents a more complicated obturator, adapted to an opening in the soft palate.

The necessity for a variation in the plan will be found in the anatomical fact of the constant muscular action of the soft palate, which would not permit, without irritation, the presence of an immovable fixture.

This is contrived, therefore, with a joint, that will permit the part attached to the teeth to remain stationary, while the obturator proper is carried up or down as moved by the muscles. The joint *A* should occupy the position of the junction of the hard and soft palates. The joint and principal part of the appliance is made of gold, the obturator of vulcanite. The projection *B* lies like a flange upon the superior surface of the palate, and sustains it; otherwise the mobility of the joint would allow it to drop out of the opening. This flange is better seen in the side view marked *C*. It is readily placed in position by entering the obturator first, and carrying the clasps to the teeth subsequently.

Figures 168 and 169 will illustrate the essential principles involved in all obturators. The ingenuity of the dentist will often be taxed in their application, as the cases requiring such appliances all vary in form and magnitude.

Artificial Palates.—Before proceeding to a description of appliances, a brief reference to the anatomical relations and functions of the palate will be necessary. The palate exercises quite as important an office in the articulation of the voice as does the tongue or lips. Being a muscular and movable partition to separate the nasal and oral cavities, one edge is attached to the border of the hard palate, while the other vibrates between the pharynx and the tongue. The voice, therefore, as it issues from the larynx is directed by the palate entirely into the mouth, or through the nose, or permitted to pass both ways.

A very slight deviation in this organ from its natural form will make the voice give a different sound. So will also the presence of anything that clogs the natural passages, either oral or nasal.

Place any obstruction in the nasal passages, paralyze the soft palate, or let it be deficient in size, and the power of distinct articulation is wanting.

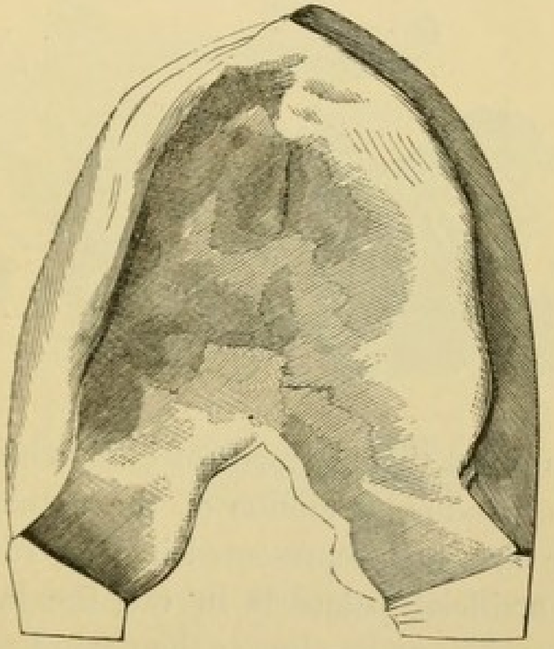
The evidence of this statement is frequently found after the surgeon has successfully performed the operation of staphylorraphy in cases of congenital fissure.

In such instances (with rare exceptions) the newly formed palate is so deficient in length, and so tense, as to be deprived of its function. It cannot be raised so as to meet the pharynx and shut off the nasal passage, but hangs like an immovable septum to divide the column of sound.

Fig. 170 represents a defective palate belonging to the first class; the uvula and a portion of the soft palate contiguous being destroyed by disease. In such a case an obturator would be useless; the constant activity of the surrounding parts would not tolerate it. The material used for a substitute must be soft, flexible, and elastic, and the elastic vulcanite is admirably adapted to this purpose.

By observing the cut (Fig. 170) it will be seen that a portion of the soft palate along the median line remains, and consequently there will be considerable muscular movement which must be provided for, and which may be taken advantage of. It is desirable to make this movement available in using an

FIG. 170.



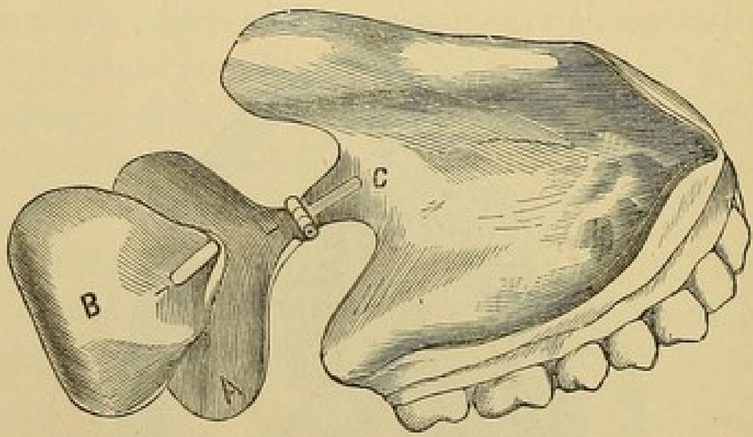
artificial palate, as thereby more delicate sounds are produced than otherwise.

This case presents some extraordinary difficulties, in the fact that all the teeth of the upper jaw have been extracted, and it was necessary, therefore, to adapt a plate which should not only sustain teeth for mastication but bear the additional responsibility of supporting the artificial palate. In the choice of material best adapted for the base for the teeth in such instances, it is preferable to adopt that which will prove the most durable. There are too many interests involved to risk the adoption of anything but the best. In the case under description, the patient desired duplicates, and two sets of teeth were made, one on gold and the other on platina with continuous gum.

The plates were made like other sets of teeth, with the exception of a groove located on the median line at the posterior edge to receive the attachment for the palate (marked C, in Fig. 171).

Fig. 171 will indicate the set of teeth with palate attached. The wings marked letters A and B are made of soft rubber;

FIG. 171.



the frame to support them is made of gold, with a joint to provide for the perpendicular motion of the natural palate, as in the case of the obturator represented in Fig. 169.

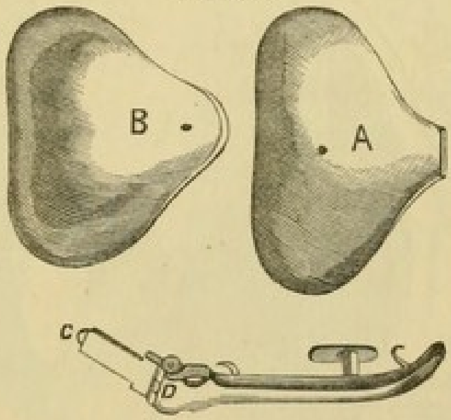
When the artificial palate is in use, the joint and frame immediately contiguous lie close to the roof of the mouth; the rubber wing, letter A, bridges across the opening on the inferior surface or side next the tongue; the wing, letter B, bridges across the opening on the superior or nasal surface, and is also prolonged backward until it nearly touches the muscles of the pharynx when they are in repose.

Both these wings reach beyond the boundary of the opening and rest on the surface of the soft palate for a distance of from one-eighth to one-quarter of an inch, thus embracing the entire free edge of the soft palate. This last provision enables the natural palate to carry the artificial palate up or down, as articulation may require.

When the organs of speech are in repose, there is an opening behind the palate sufficient for respiration through the nares. When these organs are in action, a slight elevation of the palate, or a contraction of the pharynx, will entirely close the nasal passage and direct all the voice through the mouth. The palate thus becomes a valve to open or close the nares, and to be tolerated must be made with thin and delicate edges which will yield upon pressure. An instrument thus made will restore, as far as is possible by mechanism, the functions of the natural organ.

In the case under description the patient was a lady; the defect had existed for seven years before remedy. Articulation

FIG. 172.



was very defective; distinct and perfect articulation followed within one month.

Fig. 172 represents the artificial palate separated into its constituent parts. The frame is bent at the joint, in the engraving, to show a stop, marked D, which prevents the appliance from dropping out of position. Letter C shows the tongue, which enters the groove in the plate of teeth and connects them. Letters A and B are the rubber flaps, which are secured to the frame by the hooks as seen in the engraving.

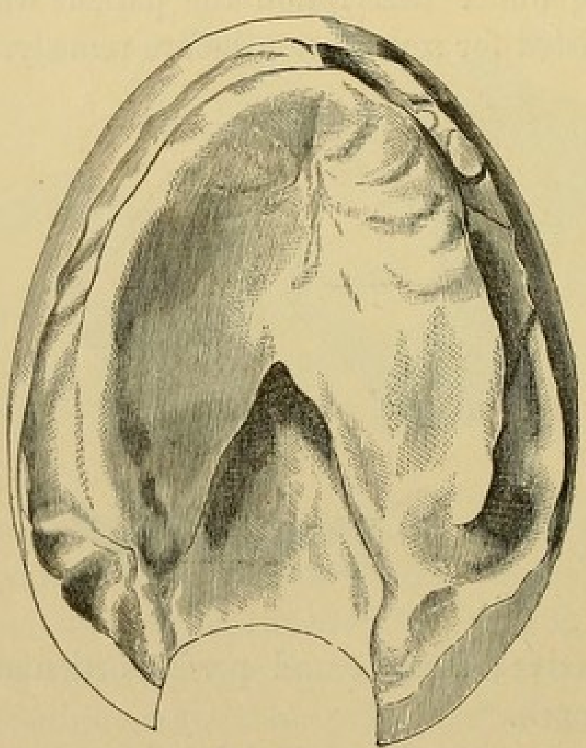
The process for making the rubber wings will be found described on page 429.

Fig. 173 shows a more extensive palatine defect of the first class. In this case the entire soft palate is gone, together with a small portion of the hard palate at the median line.

Although this defect is greater in extent, the means for its remedy are more simple. The muscles of the palate are entirely gone, and consequently no perpendicular movement need be provided for.

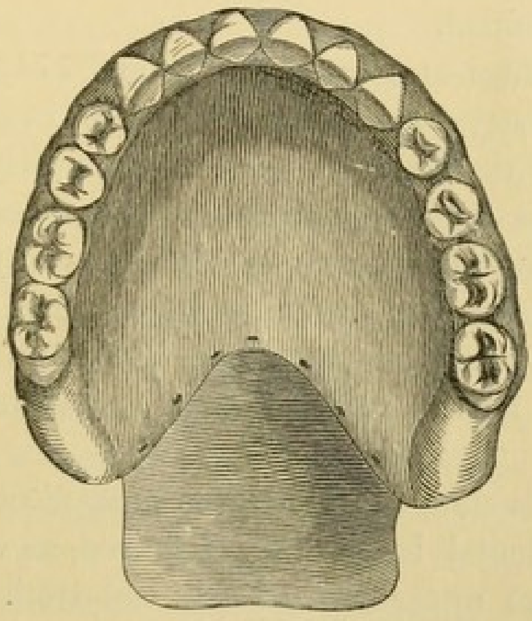
The appliance in this case will resemble an elastic obturator more than the valve-like palate of the preceding one. The principle here adopted will be substantially that recomended by Mr. Sercombe, of London, some ten years since, and con-

FIG. 173.



sists of a plate with a set of teeth in the usual form, and attached to its posterior edge an apron of soft rubber, which shall bridge the opening on its inferior surface, extending nearly to the pharynx. Fig. 174 represents the set of teeth with the palate attached. In Mr. Sercombe's appliance this apron was made of the common sheet rubber in the market, prepared for other uses, and is objectionable for two reasons: 1st, a want of purity in the materials of which it is compounded, in many instances substances being used in its manufacture which would prove deleterious to the health of the patient; and, 2d, its uniformity of thickness. It is far preferable, therefore to make a mould which will produce a palate of pure and harmless materials, and which shall be of sufficient thickness in the central part, and at its anterior edge, to give it stability, and shall have a thin and delicate boundary wherever it comes in contact with movable tissue. Such a palate may be made in a mould by substantially the same process as hereinafter

FIG. 174.



described. (See page 429.) It may be secured to the plate by a variety of simple means. One which will give as little trouble to the patient as any other, is to make a series of small holes along the edge of the plate and stitch it on with silk, or fine platina, gold, or silver wire may be used.

It is desirable to have the plate and palate present a uniform surface on the lingual side. In fitting the plate, therefore, it may be raised along the posterior edge from the sixteenth to the tenth of an inch, according to the thickness of palate desired. The rubber will thus be placed on the palatine surface of the plate and present uniformity on the lingual surface.

A little thought will show that in this case the patient must educate the *muscles of the pharynx alone* to do the work of shutting off the nares, which in the former case was performed by them in conjunction with the muscles of the palate.

Perfection of articulation will therefore depend upon the success of the patient in this new use of these muscles.

In cases of accidental lesions of the palate, such as are under consideration, this education of the muscles to a new work will not be difficult. The patient at some former time has had the power of distinct articulation; his ear has recognized in his own voice the contrast between his present and former condition, the ear will therefore direct and criticise the practice until the result is attained.

In the case illustrated by Figs. 173 and 174, the defect had existed for twenty-eight years, the patient at the time of the introduction of the artificial palate being nearly fifty years of age. The effect upon the speech was instantaneous. Articulation was immediately nearly as distinct as in youth, and this remarkable distinctness can only be accounted for upon the assumption that the pharyngeal muscles had undergone a thorough training in the vain effort to articulate without any palate.*

The two cases chosen to illustrate the application of artificial palates in accidental lesion have required, as will have been perceived, entire upper sets of artificial teeth in connection with the palates. This selection was purposely made because the difficulties to be overcome are much greater. In cases where there are natural teeth remaining in the upper jaw, the palate and its connection with a plate would be substantially the same, and the plate might easily be secured to the teeth by clasps in the same manner as a partial denture.

Artificial Palates for Congenital Fissure.—Congenital fissure of the palate presents far greater difficulties to be overcome than cases of accidental lesion. The opening is commonly more extensive, the appliance more complicated, and the result more problematical. Nevertheless, appliances have been made in a large number of cases, which have enabled the wearer to articulate with entire distinctness, so much so as not in the

* An account of this case appears in the Argus, of Bainbridge, Georgia, August 1st, 1868, written by the patient himself, who is the editor of that paper.

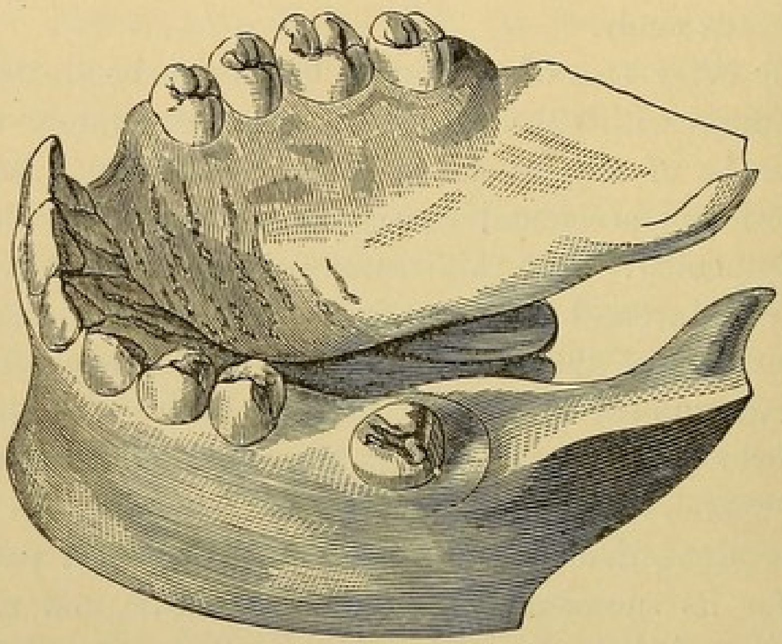
least to betray the defect. The first efforts in this direction were of the character of obturators, simply plugs to close the posterior nares, and the results were far from satisfactory. It was not until it was recognized that the two classes of cases (accidental and congenital) were entirely distinct that much progress was made.

Nearly every case of accidental lesion can be treated with an obturator with considerable success; very rarely will an obturator be of any benefit in congenital fissure, even if the congenital and accidental case present substantially the same form of opening. For this reason so much mystification has been thrown around these appliances within a few years past. The character of the different classes has been confounded, and an instrument admirably adapted to one class has had claimed for it an equal application to the other class. Let it be understood, therefore, as a rule to which there will be but few exceptions, that congenital fissure of the soft palate requires for its successful remedy a soft, elastic, and movable appliance, and that when the most skilfully made and adapted instrument is worn, *articulation must be learned*, like any other accomplishment. Various inventions have been made for this purpose within the last twenty-five years, from the most complicated one of Mr. Stearns, described in the first edition of this work, to the extreme of simplicity of bridging the gap with a simple flap of rubber. The Stearns instrument, with all its complexity, embodied the only true principle, viz., the rendering available the muscles of the natural palate to control the movements of the artificial palate.

The essential requisites of an artificial palate will be, to restore as far as possible the natural form to the defective organs with such material as shall restore their functions. Muscular power, certainly, cannot be given to a piece of mechanism, but the material and form may be such that it will yield to and be under the control of the muscles surrounding it, and thus measurably bestow upon it the function of the organ which it represents.

Fig. 175 represents a model of a fissured palate, complicated with harelip on the left of the mesial line. There is a division also of the maxilla and the alveolar process, the sides being covered with mucous membrane which come in contact with

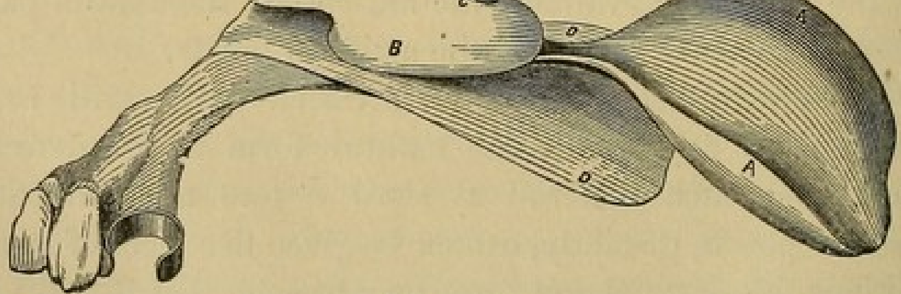
Fig. 175.



each other, but are not united. The left lateral incisor and left canine tooth are not developed.

Fig. 176 represents the artificial velum, as viewed from its superior surface, together with the attachment and two artificial teeth to fill the vacancy.

Fig. 176.



The lettered portion of this appliance is made of elastic vulcanized rubber; its attachment to the teeth of hard vulcanized rubber, to which the velum is connected by a stout gold pin, firmly imbedded at one end in the hard rubber plate. The other end has a head, marked C, which being considerably larger than the pin, and also the corresponding hole in the velum, it is forced through,—the elasticity of the velum permitting,—and the two are securely connected.

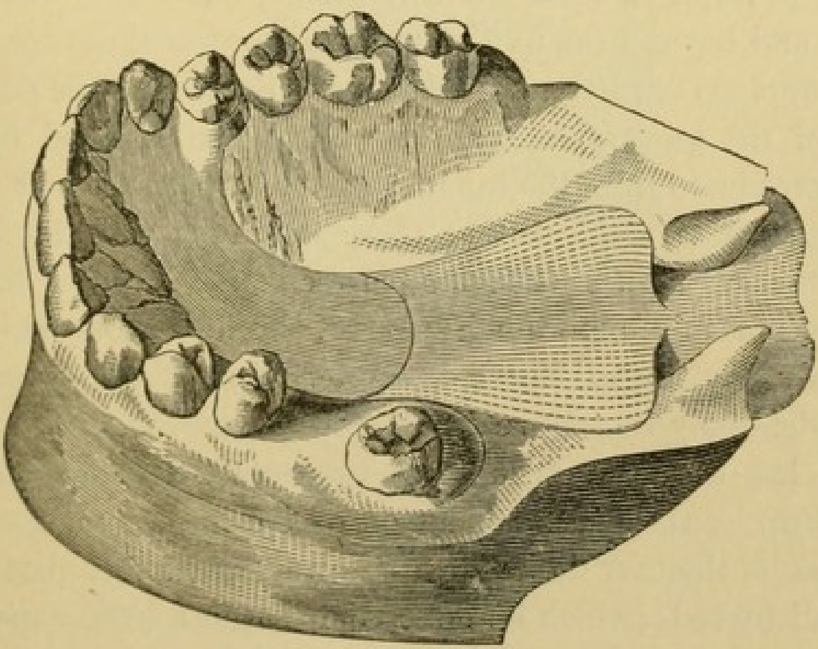
The process, B, laps over the superior surface of the maxilla (the floor of the naris), and effectually prevents all inclination to droop.

The wings A A, reach across the pharynx, at the base of the chamber of the pharynx, behind the remnant of the natural velum.

The wings D D, rest upon the opposite or anterior surface of the soft palate.

Fig. 177 represents a model, the same as Fig. 175, with the appliance, Fig. 176, *in situ*.

FIG. 177.



The wing D D, in Fig. 176, and the posterior end of the artificial velum only in this cut being visible.

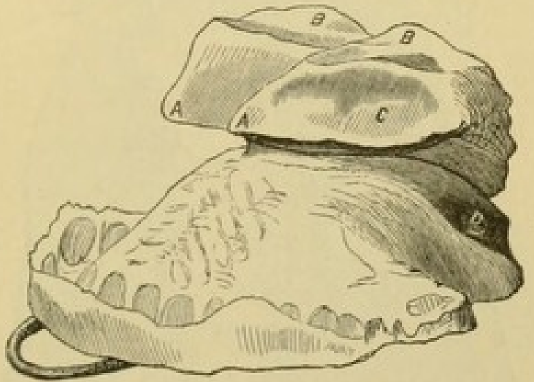
Method of Making an Artificial Palate.—The success of these appliances depends very much upon the accuracy of the model obtained to work by.

It is essential that the entire border of the fissure from the apex to the uvula should be perfectly represented in the model, as the parts are when in repose. It is also necessary that the model show definitely the form of the cavity above, and on either side of the opening through the hard palate, being that part of the cavity which is hidden from the eye. It is desirable, also, that the posterior surface of the remains of the soft palate be shown, but this is not essential; but it is especially important that the anterior or under surface be represented with relaxed muscles and in perfect repose. The impression for such a model must be taken in plaster; it is the only material now in use adapted to the purpose. An ordinary britannia impression-cup may be used, selecting one in size and form corresponding to the general contour of the jaw. This cup will be found too short at the posterior edge to receive the soft palate, but it may be extended by the addition of a piece of sheet gutta-percha, which must be moulded into such form as not to impinge upon the soft palate, but which will reach under and beyond the uvula, and thus protect the throat from the droppings of plaster. Before using the plaster the posterior edge of the gutta-percha extension may be softened by heat and introduced into the mouth; contact with the soft palate will cause it to yield, so that there is no danger of its forcing away the soft tissues when the plaster is used. With the precaution not to use too much plaster, the first effort will be to get only the lingual surface. After trial, if the impression show definitely the entire border of the fissure, and the soft palate has not been pushed up by contact with the cup, nor pulled up by the spasmodic action of the levator muscles, it is all that is thus far desired. If, however, the soft parts have been disturbed (which on close comparison a little experience will decide), it is better to cast a model into the impression, and upon this model extemporize an impression-cup as described on page 418. This temporary cup will have the advantage of the former, insomuch that it will require but a film of plaster to accomplish the result, thus lessening the danger of disturbing the soft tissues. After the removal, if it is seen that any surplus has projected through the fissure and lapped out to the floor of the nares, it may be pared off.

The next step will be to obtain, in conjunction with this impression of the under surface, which we will call the palatal impression, an impression of the upper or nasal surface of the hard palate.

This can be done by filling the cavity above the roof of the mouth with soft plaster down to the border of the fissure, and while yet very soft carrying immediately the palatal impression against it, and retaining it in that position until the plaster is hard, which can easily be ascertained by the remains in the vessel from which it was taken. With the precaution to paint the surface of the palatal impression with a solution of soap, to prevent the two masses from adhering when brought in contact, there will be no difficulty in removing it from the mouth,

FIG. 178.



leaving the mass which forms the nasal portion *in situ*. With a suitable pair of tweezers this mass is easily carried backward and withdrawn from the mouth, and the irregular surface of contact indicates its relation to its fellow when brought together.

Fig. 178 will show such an impression. The portion marked A, B, C, will readily be distinguished as that which entered the nasal cavity. The line of separation from the palatal impression is plainly indicated in the engraving. The groove, marked D, shows clearly the impression made by the delicate uvula in the soft plaster. The nasal portion is relatively large, showing an unusually large nasal cavity.

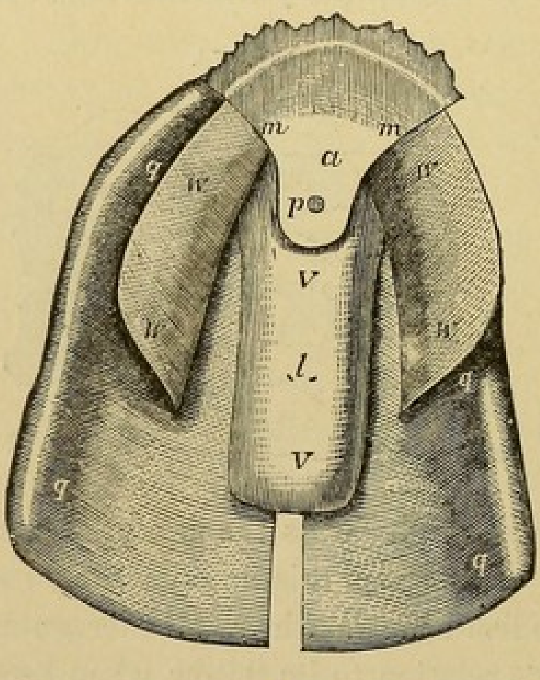
The vomer lies between the projections marked A A; these projections entering the nasal passages. The surfaces marked B B, came in contact with the middle turbinated bones; the surface marked C in contact with the inferior turbinated bone. In many instances these turbinated bones are so large as to nearly fill the nasal passages.

The method of obtaining the model of the jaw from the impression does not require any particular description. The process is similar to the making of a cast into any other mouth impression.

The model represented in Fig. 175 shows a convenient form for such a cast.

When the nasal portion of the impression does not indicate the superior surface of the soft palate, the part may be repre-

FIG. 179.



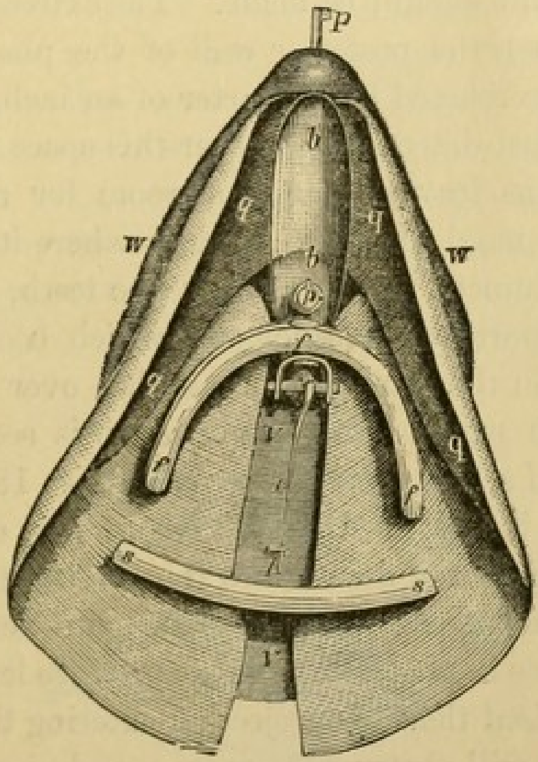
sented in the cast by carving. It is not essential to the success of the instrument to be made that the posterior surface of the soft palate should be represented with the same accuracy that is required of the inferior surface, or of both surfaces of the hard palate. By the aid of a small mirror and a blunt probe, the thickness of the velum and the depth behind the fissure can be ascertained and the model carved accordingly.

The portion of the artificial palate coming in contact with it is so elastic that it easily adapts itself to a slight inequality, rendering absolute accuracy less important.

The next step will be the formation of a model or pattern of the palate. Sheet gutta-percha is preferable for this purpose, although wax, or many other plastic substances, might answer.

The form which should be given it is better indicated by the drawings, Figs. 176 and 183, than a written description would give. The Stearns instrument, of which a cut is here

FIG. 180.



given (Figs. 179, 180), was made to embrace the edges of the fissure, and was slit up through the middle, so that when the edges of the fissure approach each other, as they always do in swallowing, the two halves of the instrument would slide by each other, and a third flap or tongue was made and supported by a gold spring to cover and keep closed this central slit. This complicated provision for the contraction of the fissure is entirely superseded in Figs. 176 and 183, by making the instrument somewhat in the form of two leaves, one to lie on the inferior and the other upon the superior surface of the palate, and joined together along the median line. When the fissure contracts the halves of the divided uvula slide toward each other between these two leaves. The posterior portion, marked A in Fig. 176, is made very thin and delicate on all its edges, as it occupies the chamber of the pharynx, and is subject to constant muscular movement.

The sides are rolled slightly upward while the posterior end is curved downward. The inferior portion marked D D, in Fig. 176, should reach only to the base of the uvula, and bridge directly across the chasm at this point, and no effort to imitate the uvula should be made. The extreme posterior end should not reach the posterior wall of the pharynx when all the muscles are relaxed by a quarter of an inch, although subsequent use must determine whether this space be increased or diminished, thus leaving abundant room for respiration and the passage of nasal sounds. In cases where it is desirable to make the instrument independent of the teeth, as far as possible, in its support, the anterior part which occupies the apex of the fissure in the hard palate may lap over on to the floor of one or both nares. Such a projection is seen in Fig. 176, marked B, and a like process is seen in Fig. 183, but not lettered. Were it not for this process in this case, the palate would drop out of the fissure into the mouth, the single clasp at the extreme anterior end not being sufficient to keep the whole appliance in place throughout its entire length. Caution must be exercised that this projection entering the nares be not too large, or it will obstruct the passage and give a disagreeable nasal tone to the voice.

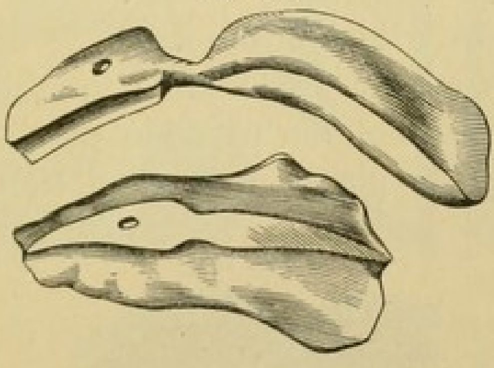
All these described peculiarities must be provided for in the gutta-percha model, which, after having been carefully formed to the cast, may be tried in the mouth to ascertain its length or necessary variations. When its ultimate form has been decided upon, provision must be made to duplicate it in soft rubber.

A parallel process, and one which will be a familiar illustration, is used when a set of teeth is made on vulcanite base. A model or patern form is made of gutta-percha, bearing the teeth, and in all its prominent characteristics is shaped as the completed denture is desired; the rubber duplicate being vulcanized in a plaster mould. In like manner the rubber duplicate of the palate as before described may be made in a plaster mould.

If plaster is used it must be worked with much care so that the surface shall be free from air-bubbles, or the rubber palate will be covered with excrescences that cannot be readily removed. By covering the surface of the mould with collodion or liquid silex, it will be much improved. But ordinarily plaster moulds will be found too troublesome for general use. They may be put to a most excellent use, however, by using one to make a duplicate of the gutta-percha in hard rubber.

This is not necessary with those who have had much experience, but with beginners it will be difficult to work up the gutta-percha as nicely as may be desired; a duplicate of vulcanite will enable the operator to make a more artistic model of the palate, and one which can be handled with greater freedom.

Fig. 181.

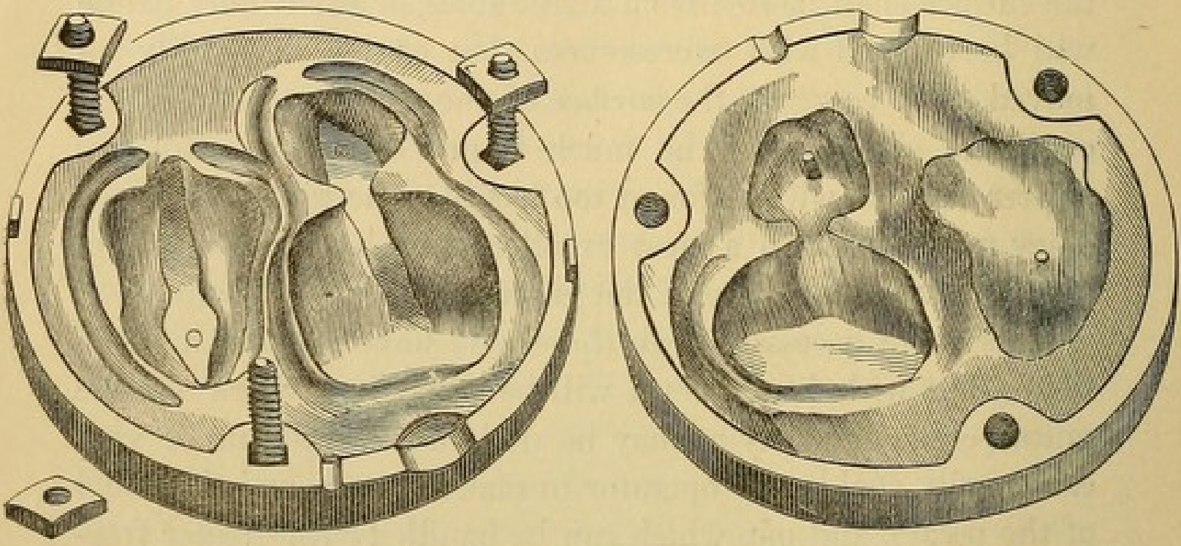


As in the course of a lifetime a considerable number of elastic palates will be required, the mould which produces them should be made of some durable material. The type metal of commerce is admirably adapted to this use. The most complete mould is one made of four pieces, which will produce a palate of one continuous piece. Such a mould requires very nice mechanical skill in fitting all the parts accurately, and unless the operator has had experience in such a direction it is better to simplify the matter. By making the palate in two pieces, to be joined after vulcanizing, the mould may be made in two pieces and with very little trouble.

Fig. 181 shows a palate divided.

Fig. 182 shows the mould or flask in which it is vulcanized. These flasks were made expressly for this purpose, but they are not so unlike the flasks in common use in dentists' labora-

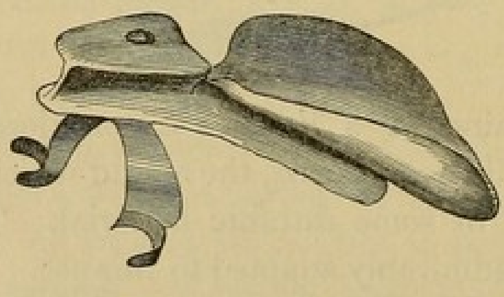
FIG. 182.



tories, that the latter will not answer. The common flask is simply unnecessarily thick or deep.

The mould is readily produced in the following manner: Imbed the two pieces of the palate in plaster, in one-half of the flask; when the plaster is set and trimmed into form,

FIG. 183.

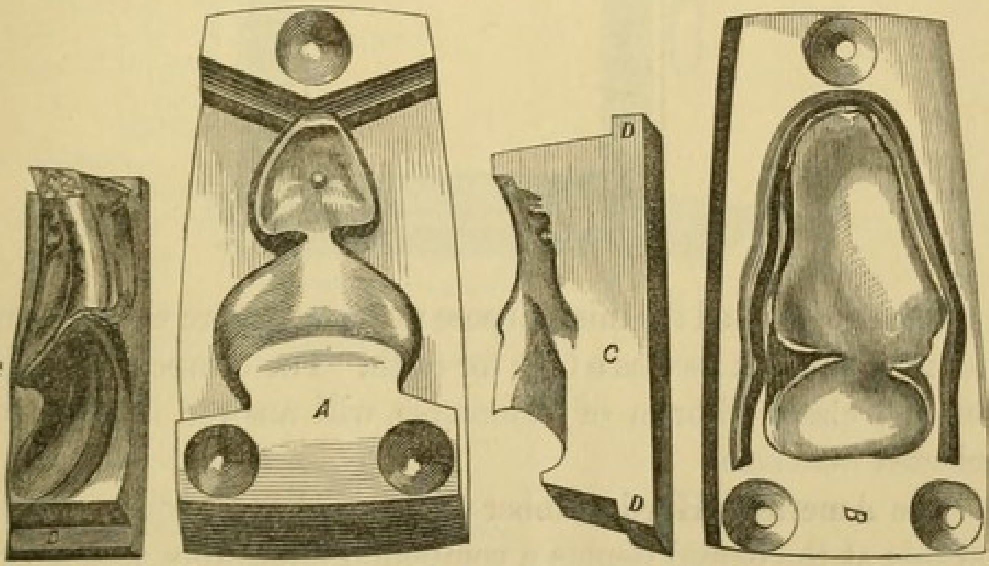


duplicate it in type-metal by removing the palate, varnishing the surface, moulding in sand, and casting. In making the sand mould take a ring of sheet-iron of the same diameter of the flask and three or four inches high; slip it over the flask and pack full of sand. Separate them, remove the plaster, return the flask to the sand mould, and fill with the melted metal through a hole made in the side or bottom of the flask. With one-half thus made, substantially the same process will produce the counterpart.

Fig. 183 shows the palate complete with its attachment to the teeth. The palate is secured to the plate by a pin of gold passing through a hole in the palate of the same size; the head on the pin being larger than the hole is forced through, and thus the two halves of the palate are bound together and joined to the plate.

Fig. 184 shows a mould in four pieces. The blocks C C, are accurately adapted to the body of the mould, marked A,

FIG. 184.

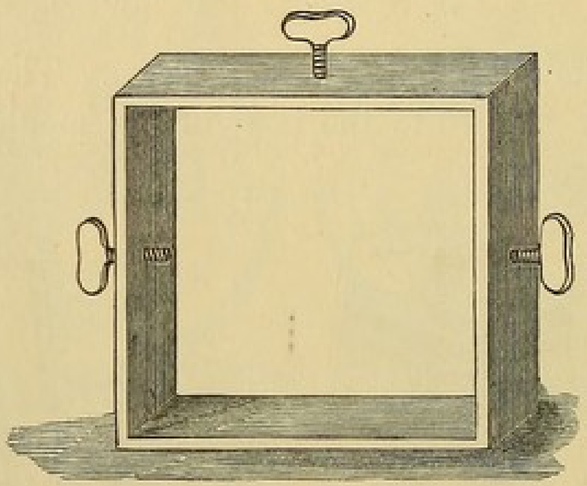


and are prevented from coming improperly in contact with each other by the flanges D D, which overlap the rest upon the sides of the main piece. B shows the top of the mould, and the groove E provides for the surplus rubber in packing.

Such a mould makes the most perfect appliance that can be produced. The palate is one homogeneous and inseparable piece. The cut will sufficiently indicate the forms of the several parts. Each of these pieces is first made in plaster of exactly the form of which the type-metal is desired. They are then moulded in sand and the type-metal cast as in making an ordinary die for swaging. When in use, a clamp similar to Fig. 185 is placed around the mould to keep the several parts firm in their position.

The packing of the mould with rubber will be done in the same manner as when hard rubber is used for teeth bases; with which process it is assumed that the operator is familiar. By washing the surface of the mould with a thick solution of soap previous to packing, the palate will be more easily removed after vulcanizing.

FIG. 185.



The rubber used for this purpose must be a more elastic compound than that used as a base for teeth. The composition used for the elastic fabrics of commerce will answer if made of selected materials.

The American Hard Rubber Company have recently placed on sale at the dental depots a compound admirably adapted to this purpose. The best results are obtained when the process of vulcanizing is carried from a heat of 230° gradually during four or five hours up to and terminating at 270°.

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