Mechanical practice in dentistry.

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MECHANICAL PRACTICE IN DENTISTRY

BY

W. BOOTH PEARSALL

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IN

DENTISTRY.

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MECHANICAL PRACTICE

IN

DENTISTRY.

BY

WILLIAM BOOTH PEARSALL,

FELLOW OF THE ROYAL COLLEGE OF SURGEONS IN IRELAND;
FELLOW OF THE ROYAL ACADEMY OF MEDICINE IN IRELAND;
HONORARY MEMBER OF THE ROYAL HIBERNIAN ACADEMY OF PAINTING, SCULPTURE AND ARCHITECTURE.

WITH A LARGE NUMBER OF ILLUSTRATIONS

DESIGNED BY THE AUTHOR AND DRAWN BY

J. M. KAVANAGH, R.H.A., AND CHARLES RUSSELL, R.H.A.

AND

MANY OTHER ENGRAVINGS FROM NEW AND ORIGINAL SOURCES.

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To

JAMES SMITH TURNER,

M.R.C.S., L.D.S. Eng.,

CONSULTING DENTAL SURGEON MIDDLESEX HOSPITAL AND
DENTAL HOSPITAL OF LONDON,

This Book is respectfully dedicated

AS A

SLIGHT ACKNOWLEDGMENT OF MUCH HELP AND
ENCOURAGEMENT,

AND OF

MANY YEARS OF PERSONAL KINDNESS.

'FABER FABRICANDO FIT.'

PREFACE.

The progress of Mechanical Dentistry, a subject which has occupied much of my time for many years, cannot, in my opinion, be advanced without the aid of accurate training under the instruction of a competent teacher, a first-rate workroom equipment, and much practice in the workroom and at the chair side.

It is admitted on both sides of the Atlantic that practical instruction of the best kind is a necessity for dental students, and that systematic training in mechanics is the best foundation on which to rely for operative and inventive progress.

In the following pages I have endeavoured to bring the workroom and the chair into the close relationship which exists between them in daily practice,—a relationship which, strange to say, is not much dwelt upon in the books.

I have described the experiences of others with an open mind, and my own with an honest one.

If some subjects are not found to be included within the compass of this book, they are omitted because they have been dealt with already by other writers.

I have taken at first hand all original matter at which I have not worked myself,—and for this I make grateful acknowledgment.

In placing this book in the hands of my brother dentists I have ventured to break a silence in Dental Literature which has prevailed in my native island for ninety-six years, and I am proud to finish my task in a year the most memorable in the history of the British Empire.

Many illustrations in the text will be found to be new, and these I have designed with considerable pains in order to avoid as much as possible long and wordy descriptions. For the sake of clearness I have used diagrammatic rather than highly-shaded representations,—and, whenever it was possible, I have used a facsimile size rather than the unnecessary reductions to which we have been too much accustomed in dental illustrations. My ideas have been faithfully expressed by Mr. J. M. Kavanagh and Mr. Charles Russell, who have prepared my illustrations for publication.

I have to thank my kind friend, Mr. James Smith Turner, M.R.C.S., for the great care which he has taken in reading my MS., and for many valuable suggestions.

My grateful acknowledgments are due to Mr. J. A. Biggs, Mr. J. Charters Birch, Mr. George Brunton, Mr. Walter Campbell, Mr. J. A. Fothergill, Mr. Edwin Goodman, Mr. W. E. Harding, Mr. W. R. Humby, Mr. W. A. Hunt, Mr. Alexander Kirby, Mr. Wm. Penfold, Mr. J. Smith Turner, and Dr. W. H. Williamson,—for the loan of plans of their workrooms.

My hearty thanks are also due to Mr. J. Charters Birch, Daniel Corbett, jun., F.R.C.S.I. (formerly my fellow-lecturer on Mechanical Dentistry), Mr. J. H. Gartrell, Mr. Wm. Heylar, Mr. Amos Kirby, Mr. Alexander Kirby, Mr. Ladmore, Mr. R. P. Lennox, and Mr. Charles Manton,—for the loan of tools, apparatus, illustrations and much valuable information.

In lending me apparatus and illustrations I have further to acknowledge many courtesies from Messrs. Bailey & Co., Manchester; Messrs. Crossley Brothers, Manchester; Messrs. Cuttriss & Co., Leeds; the Dental Manufacturing Co., Lexington Street, London; Messrs. Fletcher, Russell and Co., Warrington; Messrs. Plucknett & Co., Poland Street, London; Messrs. Ramsbottom & Co., Leeds, and other firms.

The Appendix will, I trust, be found of use to those members of my profession who may be far removed from the centres of practice, and who may not find it easy to see the tools which are used in our best workrooms.

I have myself made use of most of the tools which I have figured, and have made personal inspection of the apparatus described, which will, I think, be found equal to any demands made upon them in the stress of modern practice.

To Messrs. Claudius Ash & Sons I have to express my thanks, not only for their liberality in the loan of many illustrations placed at my disposal, but also for the tools which, from time to time, they have, at my request, sent to me for leisurely examination.

A book like this, written during intervals of active practice, cannot be wholly free from blemishes, although I have devoted much time and thought to its preparation. For its shortcomings, be they many or few, I crave the kind indulgence of my readers.

W. BOOTH PEARSALL.

13, Upper Merrion Street,
DUBLIN,
December, 1897.

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MECHANICAL PRACTICE IN DENTISTRY.

CHAPTER I.

INTRODUCTORY—MECHANICAL DENTISTRY.

The general arrangement of the workroom is a subject of some importance to the dental profession, and it is one which has not been exhaustively treated in the text-books.

To the young practitioner it is a matter of deep interest how best to get the maximum accommodation out of the minimum of space. How to spend money in the necessary tools, so that the outlay will be remunerative (so far as the durability of the tools and apparatus under wear can be ascertained beforehand), requires more thought and consideration than is usually given to such an expenditure.

It is evident to some of us that the old-fashioned methods, although well tried in the past, do not readily lend themselves to modern ideas as far as speed of production is concerned. Work that used to be considered well executed in eight or ten days, or even longer, has now often to be constructed and finished within the short space of twenty-four hours.

This increased demand for speed is owing to the popular wish to hurry everything, in order to save time and money—to the natural competition produced by an increasing number of practitioners—to rapidity of communication ; people come quickly and expect to get away quickly ; a day in town is expected to cover a multitude of events ;—to the habits of a numerous class of patients to leave things to the last moment before going on the annual holiday, or on a long voyage to the Colonies—as well as to the increased cost to the practitioner of the mechanical assistant.

The question of the workroom and its position is largely governed by the accommodation available in the house used by the dentist for carrying on his practice. This room is commonly to be found in the basement, and occasionally in the attic. Whenever possible, a room situated on a level with the operating room or rooms should be chosen, in order to permit of easy access. Stairs, whether they lead to the basement or to the attic, prevent rapid access to the workroom.

If noise can be muffled or avoided, a workroom of easy access will prove of greater use and comfort than if it were placed at some considerable distance from the operating room.

Abundance of light, with facilities for rapidly ventilating and freshening the air of the workroom, should be a *sine quâ non*. Without good light and fresh air, the health of those who have to spend many hours in the workroom is apt to suffer, even if the workroom conveniences are otherwise of the very best quality.

A suitable room having been selected, or built, the next important question is how to utilize the space at command, so that, when periods of active practice set in, mechanical work can be as well carried out as in more leisurely times.

A good work-bench is the first great want to be provided for, and opinion is very much divided as to the details to be embodied in its design and construction. The ordinary type of bench is that of a flat table-like surface, with a place or places cut out of it to accommodate one or more workers. This type of bench survives from the practice of carving ivory dentures, with or without natural or mineral teeth inserted in the ivory.

By putting together the hints I have gathered from a somewhat *limited* knowledge of the methods and designs of other practitioners, and by the many experiments I have personally made during the past thirty years, I have come to the conclusion that the most useful type of bench permits of both the standing and seated positions, with great comfort to the workman, and without any loss of efficiency in the character of the work done.

A narrow room, of from eight to twelve feet wide, by twenty-four feet long, is one of the best types for a workroom, if the windows are on one of the long sides and facing north. A narrow bench can be fitted round the walls, so as to make it possible to carry out certain details of the processes employed in constructing artificial dentures with ease and precision where the tools have been arranged for such purposes, without having to sweep away a lot of small tools employed on other work before beginning the task in hand.

Such a bench need only be narrow, and can be made to rest on brackets fastened to the walls. This plan permits of the bench being firmly and solidly secured to the wall without needing any support from legs, which are an inconvenience when sweeping or cleaning the floor, or when tools or other articles are dropped and have to be picked up. The tools employed by the dentist should all be placed within easy reach and in full view of the workman, so that he can take up any tool without disturbing or knocking down a number of others.

The usual habit of leaving a disorderly pile of tools on each side of the work-place is so ingrained in the routine of the ordinary workroom, that I fear that any evidence that time can be saved, and greater precision gained, in carrying out the necessary details, will be received with incredulity.

A more tidy and well-tried arrangement can be designed, such as I propose to describe at greater length in these pages. The work-benches should be carefully planned for the skilful and deliberate execution of metal work, soldering, wax modelling, plaster casting, vulcanite work, grinding and fitting mineral teeth, polishing metal and vulcanite, moulding in sand, melting and casting precious metals as well as the baser ones, such as zinc, lead, etc.

Some dentists also include gas furnaces, for making porcelain crowns and continuous-gum dentures, in their equipment.

In the hands of the skilful dentist the processes already mentioned lend themselves to many methods of work.

A well-considered plan of arrangement in benches and tools is, therefore, of the greatest importance to every workman.

In a complete workroom it is necessary to have a good floor. It has been recommended to cover it with sheet zinc or galvanized iron, so that the surface can be kept clean, and the sweepings, which are valuable, kept from falling into the seams of the boards.

I have used concrete for flooring for many years, but consider it a very dusty material, subject to abrasion, and am inclined to cover it over with wood.

CHAPTER II.

THE WORKROOM.

BUSY practitioners absorbed in the daily stress of practice can hardly be expected to realise the advantage of a well equipped and carefully arranged workroom.

That loss of time is entailed by faulty equipment I have had opportunities of knowing, from the experience of many years spent in the discharge of the duties of the workroom.

I am in a position to recommend many details of arrangement, not likely to be familiar to the profession, which are the outcome of the teaching of necessity and of many experiments.

These details have been thoroughly tested, and many members of the profession who have not seen them have applied them to their workrooms from hearsay, with advantage to themselves and their assistants in all such matters as speed, efficiency, order, comfort and health.

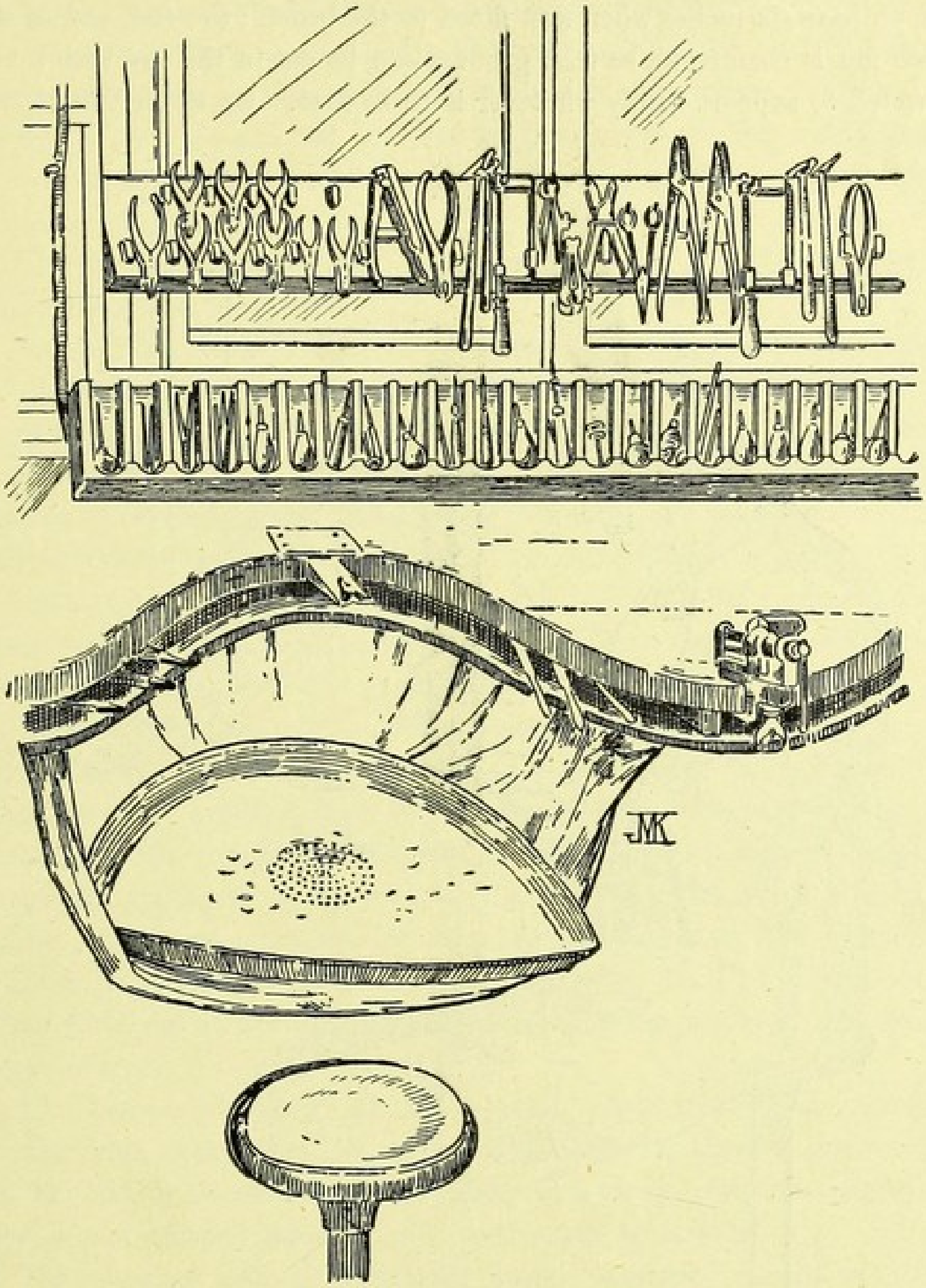
The usual height of a work-bench is that of the household table—thirty inches from the floor.

By raising this height to that of forty-one inches, a level will be found that is convenient for working at either in the erect or in the seated position.

The dental work-bench is best made of beech or other hard wood of a suitable substance from 12 to 15 inches wide. For greater convenience a semi-lunar space, opposite which the workman sits, is sawn out of the outer side of the bench about 19 inches wide.

An arm and shoulder piece can be added to the bench by attaching a piece of curved wood to the front at each side where the sawn curve ends. Much comfort is given to the workman by thus enlarging the surface of the bench in convenient positions, on which to lay the elbow, or against which to lean the shoulder in some kinds of work, in order to get greater steadiness of hand.

FIG. 1.

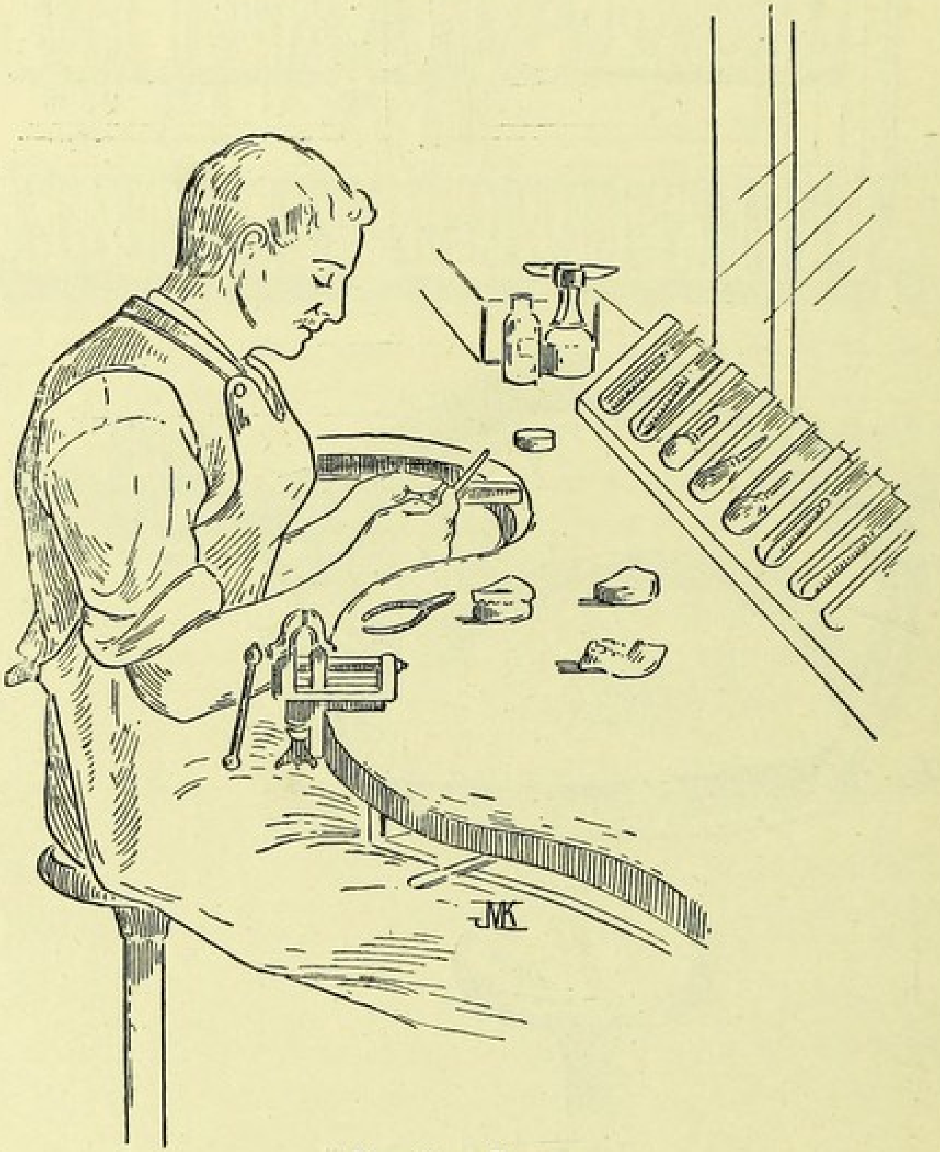


DETAILS OF GOLD BENCH.

A plate of iron or brass, which is seen in the drawing (Fig. 1), is let in flush with the surface of the bench in the middle of the semi-circle. This metal plate covers the mortice into which the bench-pin is fitted.

The bench pin is two inches wide by three quarters of an inch thick, and projects six inches when first fitted to the bench ; the free end of the bench pin is chamfered, so that grooves can be cut in the end with a file, in which to support firmly whatever is to be filed. On the left hand side

Fig. 2.



The Gold Bench.

of the bench pin a few pits or hollows are made half an inch apart, in which to rest the pin of the spindle, when using the drill and bow.

It is a convenience to have a curved shelf placed below the bench inside the skin which holds the gold tray in position below the bench pin, to receive the filings, and to which the skin can be tacked beforehand, a few stout screws securing shelf and skin to the lower surface of the bench. On this narrow shelf can be laid a favourite pair of pliers and a straight pair of shears for cutting plate or solder, with the beaks pointing outwards. From this position they can be grasped by the finger and thumb and swung or dropped into the palm of the hand in the position in which they are used.

The gold files, with their points or handles pointing outwards, are conveniently disposed here.

In the illustration (Fig. 1) will be seen the leather skin, for supporting the zinc tray in which gold filings are caught. In the middle of the tray is a perforated patch, through which the filings can be swept into a metal box soldered to the lower surface of the tray, with a movable cover or bottom. The filings can be removed from this box from time to time, and the risk of loss from an accidental overturn of the whole tray is not so great as with trays unprovided with this box. At the right hand side of the work-place it is well to attach to the bench a small vice of any good pattern, whether parallel or spring locking.

This vice is useful for holding objects too large to be held by the fingers, while they are correctly shaped at the bench pin. Punches on which to rivet small articles can be firmly held in the vice, and the workman, with judicious care, will be able to pull springs or other telescoped appliances apart without damage, if small strips of lead or leather be placed between the vice jaws, to protect the surface of polished or squarely shaped objects. Along the back of this bench is a tool rack, set at an angle of 45 degrees, having a series of compartments (Fig. 2).

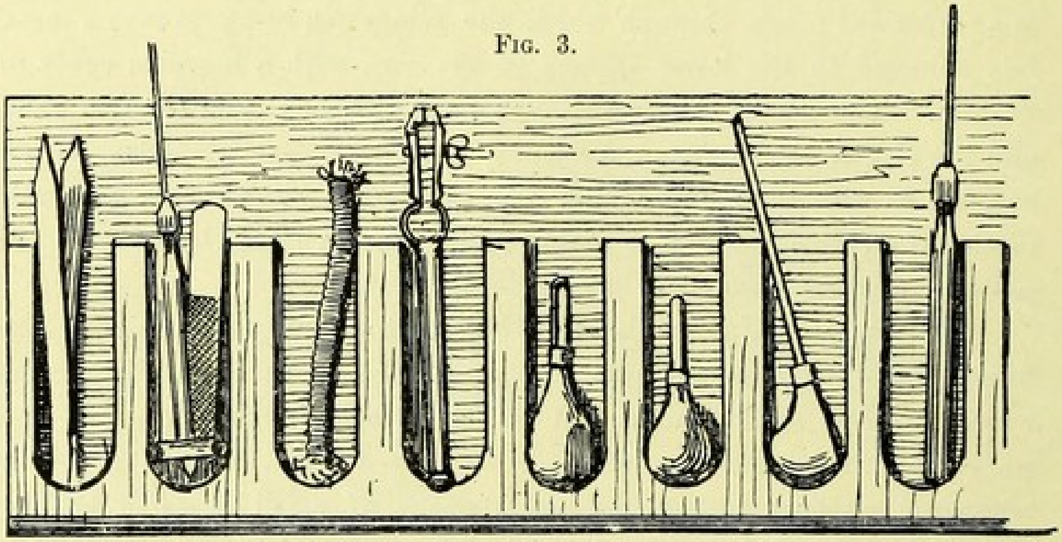
The compartments are about one and a-half inches wide, and are divided from each other by strips of wood. In these compartments can be laid drills, broaches, tube files, corn tongs, sculptors, engravers, three-square scraper, punches and other small tools (Fig. 3).

The common method of putting away "scorpers" (sculptors) on a work bench is to drop the steel blade out of sight in a hole bored in a strip of wood in which the sculptor hangs by its handle. Sculptor handles are globular or pear-shaped in form, and are readily mistaken for each other even when marked with a workroom mnemonic.

In the tool rack now under notice, the steel part of the tool as well as the handle is in sight. Time is saved by not having to pull up a row of handles before the right kind of cutting edge on the end of the steel tool is found.

The illustrations show with clearness many little details which it would be tedious to the reader to dwell upon, yet which give great comfort and facilitate work. On the left or right hand side of the gold bench, as may suit the habits of the workman, should be placed the soldering lamp (see Fig. 4). Next to this soldering lamp should be placed the plate dryer and heater with fire-clay dome designed by Mr. Fletcher, of Warrington, with which to heat to redness plate work which has been invested in sand and plaster, before soldering teeth or

Fig. 3.



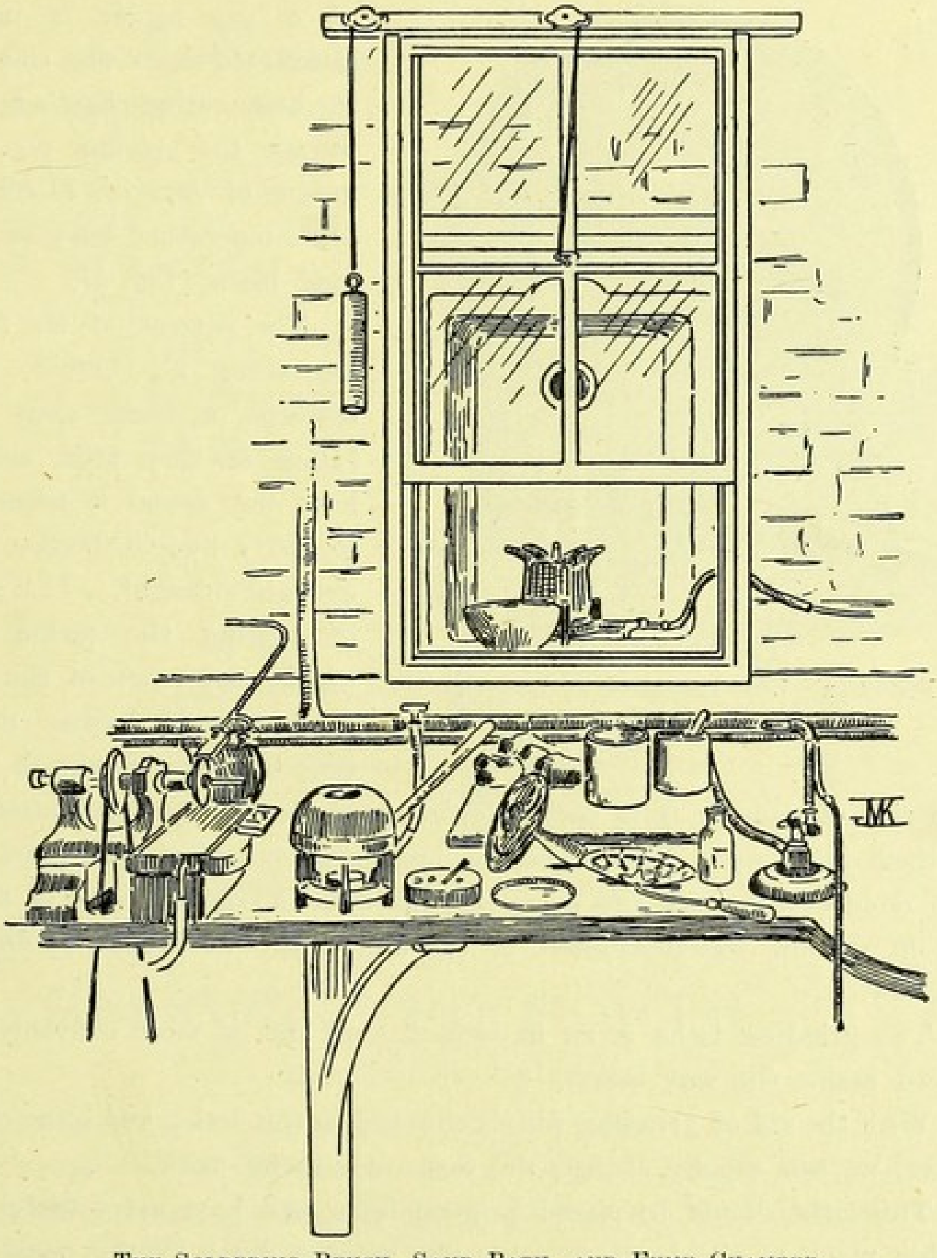
Tool Rack on Gold Bench.

fastenings held in position by means of the investment; a small crock or tea cup holding moist sand, another holding clean water, a small bottle with a cork having a groove cut in the side of it, filled with a solution of borax and water; a slate or marble slab, or a surface of ground glass, on which to grind, with the aid of the above-mentioned solution, some crystallised borax (?) into a paste, and furnished with a suitable camel-hair pencil and a corn tongs or soldering tweezers. Some pieces of willow charcoal, a soldering boss of iron wire or asbestos fibre, and a blow-pipe complete the equipment of this part of the bench.

It is a very great convenience to contrive in the wall opposite or close to the soldering lamp, and within easy reach of the hand, a recess containing an evaporating chamber communicating with the external air.

The evaporating chamber in my workroom is made by cutting a hole in the wall, and cementing in it a household sink of white glazed

Fig. 4.

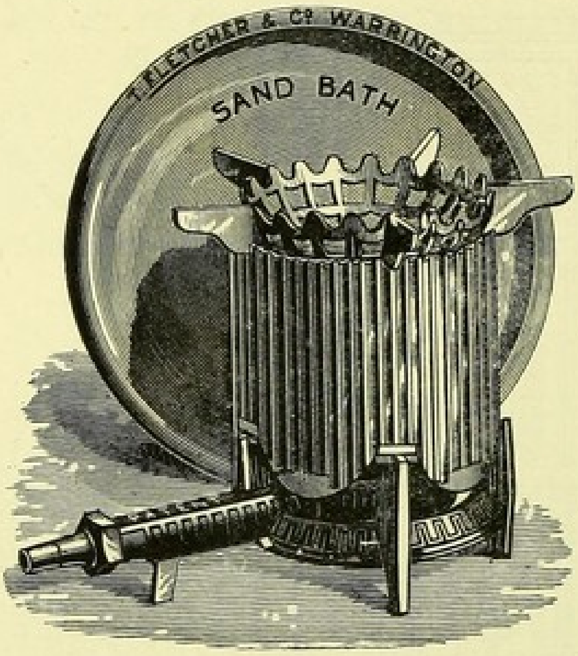


The Soldering Bench, Sand Bath, and Fume Chamber.

earthenware. It measures twenty inches long by fifteen inches wide, and the orifice in the bottom, intended for connecting with a waste pipe, is placed uppermost, the under surface of the sink being left flush with the external surface of the wall.

A small sash, eighteen inches wide by twenty-six inches high, which can be raised at will by the aid of a weight and pulleys, slides up and down the wall between the chamber and the workroom.

Fig. 5.



Fletcher's Low Temperature Burner and Sand Bath.

A gas supply is introduced through the side of the evaporating chamber, and warms the pickle pot by means of one of Fletcher's low temperature burners and sand baths (Fig. 5).

The current of air flowing along the outside wall extracts or sucks away the fumes as they arise, and I have not found it necessary to add a flue to increase the outward draught. This plan of placing the pickle pot within easy reach of the soldering bench saves much time to a busy workman, and also risk of damage from carelessly dropping plates with teeth attached to them into pickle jars, placed in low or inconvenient positions. It also removes the mess and corrosion, the usual accompaniment of acids left in shallow vessels exposed to the air of the workroom or in its chimney.

The grinding lathe is an important tool, and is most conveniently placed beside the wax bench.

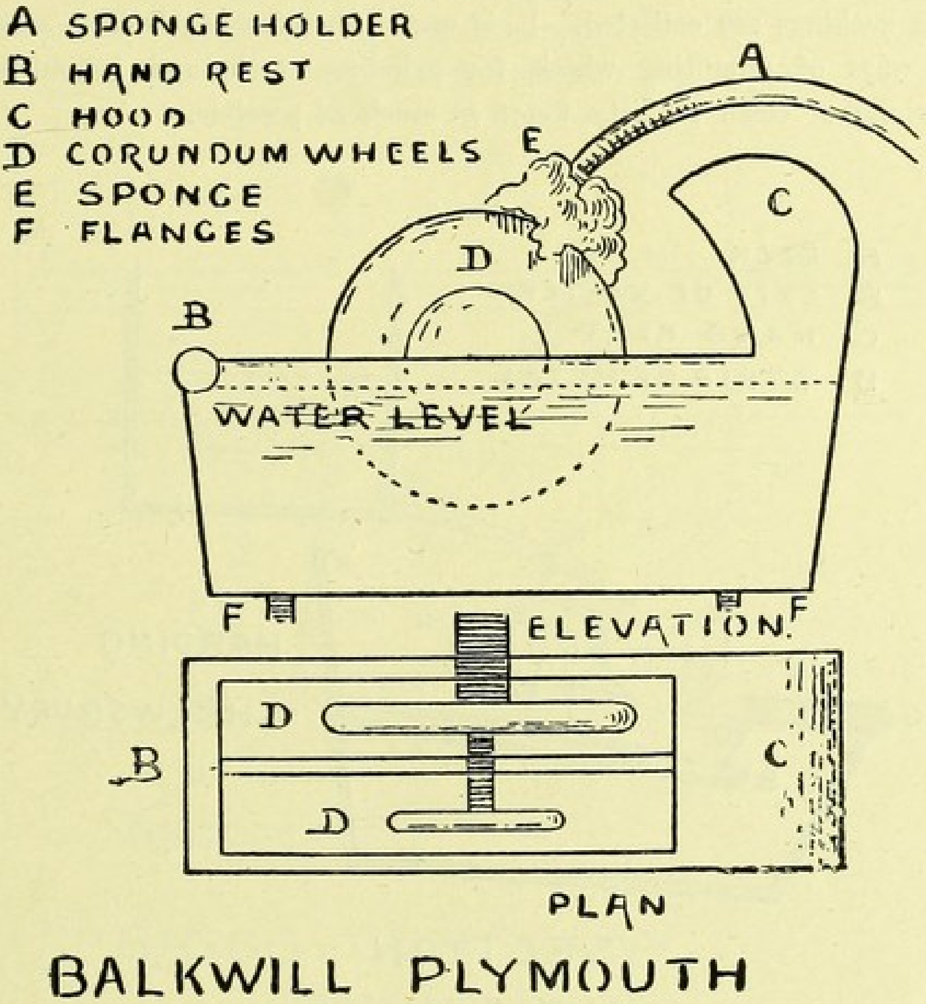
With the aid of grinding wheels chucked in this lathe, and some clean water, we can rapidly change the form of mineral teeth.

This lathe should be placed in good light, and have every useful aid within reach of the hand, to carry out without delay all the details of fitting and mounting porcelain teeth.

The lathe-head should be of a good pattern, and adapted to carry "chucks," on which are mounted grinding wheels. The chucks should be well fitted so as to save time, and give little trouble when changing a large wheel for a smaller one, as the exigencies of the fitting may require.

The lathe-head should be driven by a heavy, but easily moved fly wheel, with the crank and treadle set so as to ensure the lathe moving in the right direction, from the moment the foot presses the treadle.

Fig. 6.



Grinding Lathe Head, etc.

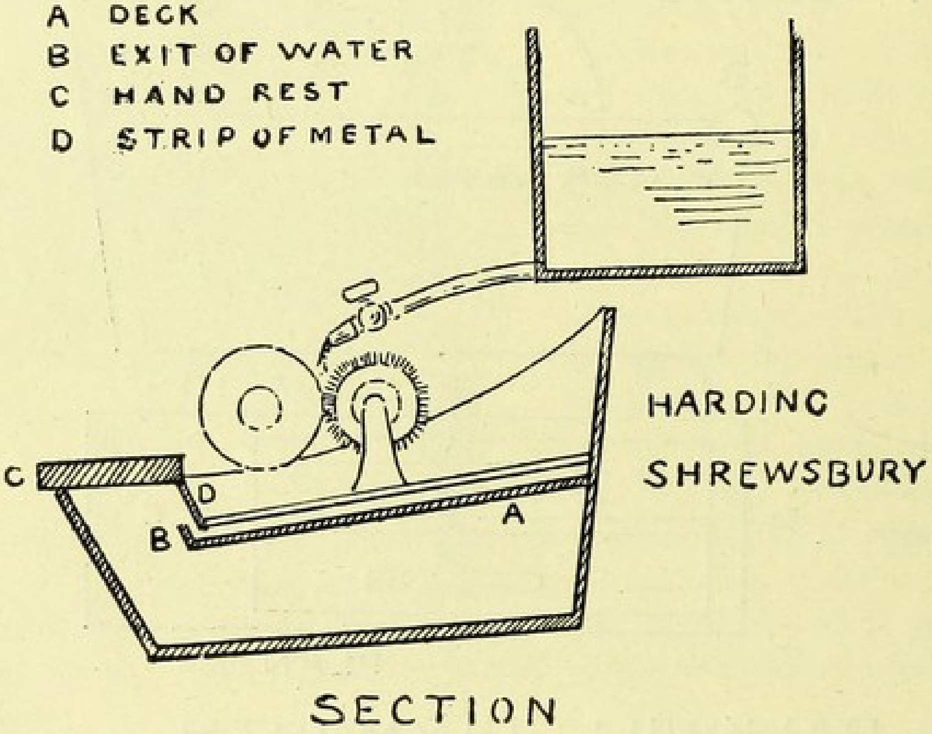
A supply of clean fresh water is a *sine quâ non* in the equipment of the grinding lathe, as all grinding wheels cut best when they are kept free from detritus by the use of water.

It saves time when grinding teeth to have the grinding wheels washed with clean water as the work proceeds.

The rapidly rotating grinding wheel throws off from its periphery, by centrifugal force, drops or splashes supplied by the water. This water becomes heavily charged with detritus, which leaves a white patch when it drops on clothing, and is not very readily brushed out of the texture of cloth.

Water may also be conveyed by a pipe having a fine nozzle direct to the wheel. The waste water can be collected in a tank placed below the bench, or conveyed away by a pipe into a tank in which all the hand-washings are collected. It is useful, therefore, to look at some of the ways of mounting wheels for grinding teeth, and avoiding the splashing of clean or dirty water as much as possible.

Fig. 7.



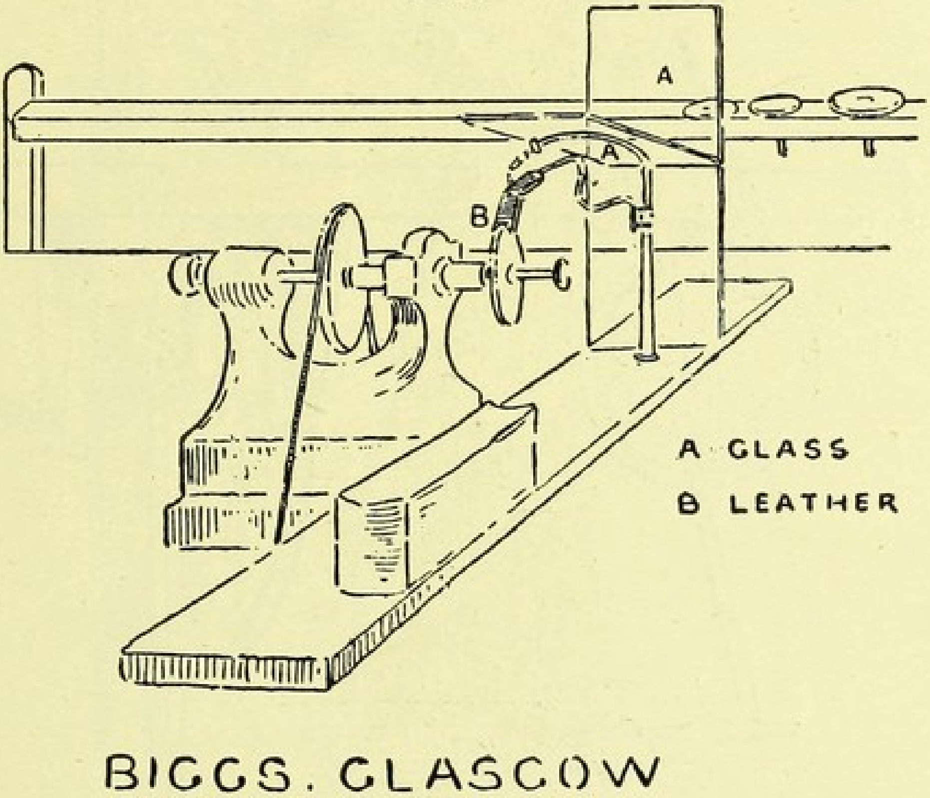
Grinding Lathe Head, etc.

The illustration (Fig. 6) shows the way in which my friend Mr. Balkwill, of Plymouth, mounts his grinding wheels, which are driven from the floor.

A copper trough is made of such a depth that it can be placed below the grinding wheel, so that a great part of the surface of the latter is immersed in water. The excess of water taken up by the rapidly-revolving wheel is rubbed off by the small bit of sponge attached to a holder, which is slightly pressed upon the wheel.

A rounded surface at *B* forms a hand-rest, and *C* is a hood to catch the splashes carried up from the surface of the water as the wheel revolves overhand *towards* the workman. This grinding lathe carries two wheels, a large and a small one, as can be seen in the plan. There is only one disadvantage in this arrangement, namely, the ease with which a tooth can be knocked out of the fingers and immersed in the water tank, from which position it is not easily removed without loss of time.

Fig. 8.



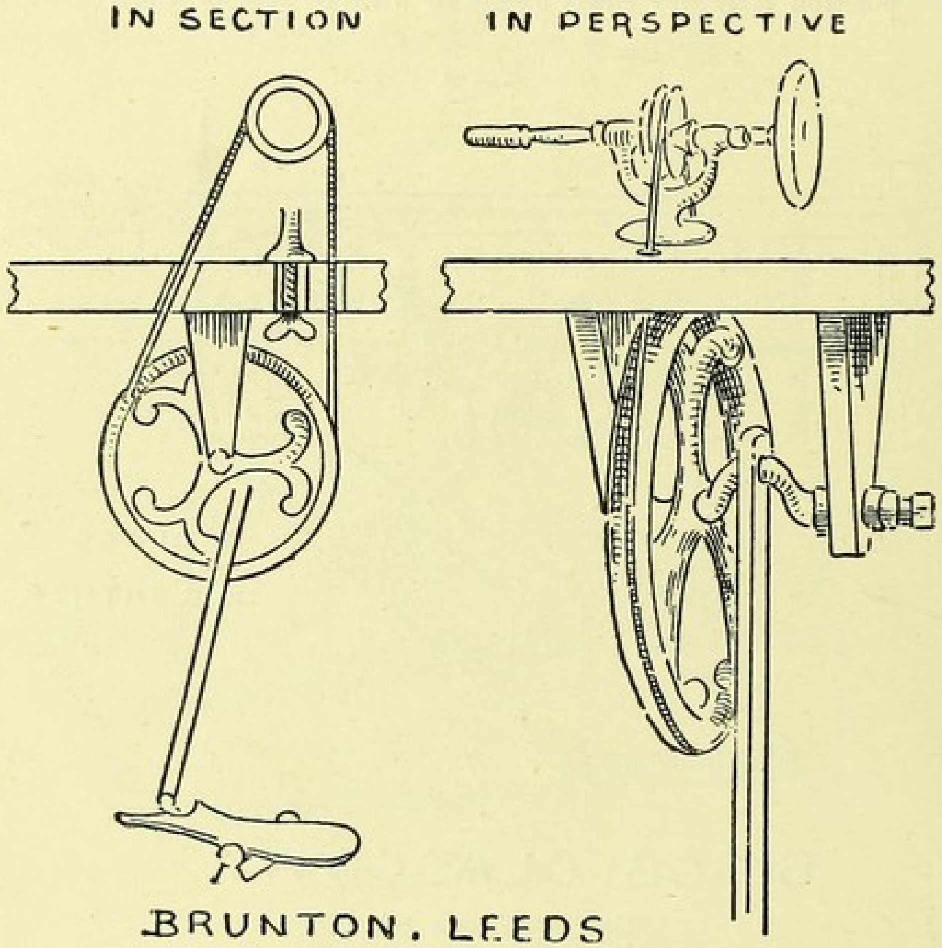
Grinding Lathe Head, etc.

Mr. Harding, of Shrewsbury, has another method, which commends itself to many (Fig. 7).

On a sloping surface called a "deck," and figured *A* in the illustration, is erected a pair of metal supports to carry revolving on a pin a worn polishing brush. As the grinding wheel revolves, the brush revolves in the opposite direction, while the water supply drops where the wheels touch.

The fly wheel of this lathe is secured to the floor. This method of mounting grinding wheels is certainly free from splashing, but is somewhat noisy. The deck enables the surplus water to drain away below it into a tank, and a tooth dropped from the fingers can be instantly recovered. The illustration supplies in section the details of this way of washing a grinding wheel with water.

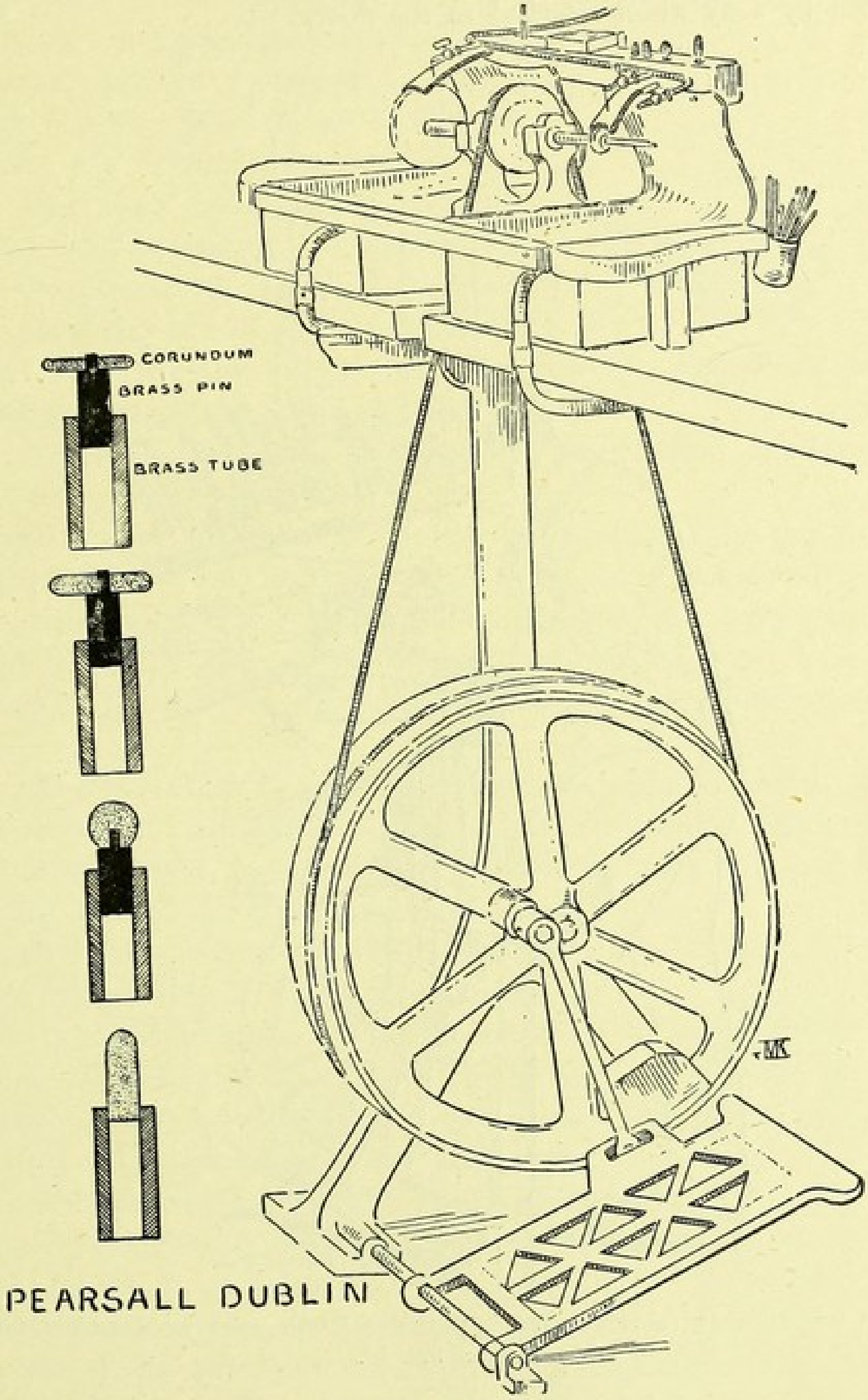
Fig. 9.



Grinding Lathe.

Mr. J. Austin Biggs, of Glasgow, has devised a different way, and conveys the water supply to the grinding wheel by means of a bit of stiff leather (Fig. 8). This strip of leather just touches the periphery of the wheel *B*, and prevents the water thrown off from splashing the workman when the lathe is in motion at working speed. Mr. Biggs uses plate glass as a splash guard; the details of construction can be gathered from the illustration.

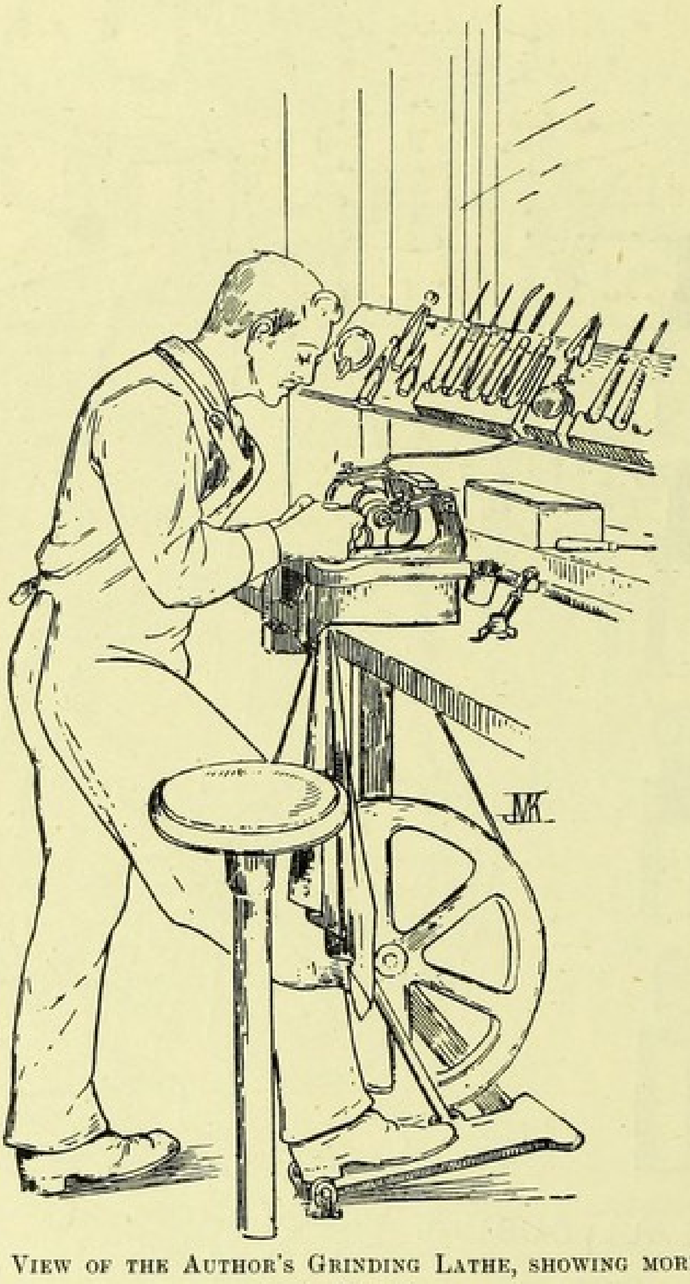
FIG. 10.



GRINDING LATHE.

I regard the use of a strip of leather in this way by Mr. Biggs as a very great advance on the methods commonly used. This grinding lathe is run by a fly wheel attached to the floor.

Fig. 11.

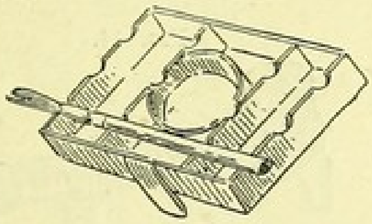


A Second View of the Author's Grinding Lathe, showing more Details than Fig. 10.

Mr. George Brunton, of Leeds, prefers to have the fly wheel of the grinding lathe hung from the under side of the work bench (Fig. 9).

The lathe head can be raised or lowered by means of a screw. Provision is thus made for taking up the slack of the lathe band, as required. The treadle has a long connecting rod working on the crank and is attached to the floor.

Fig. 12.



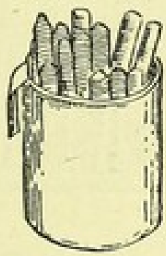
Paint Pot.

The grinding lathe in use in my own workroom has a cast-iron standard, carrying a fly wheel and treadle. The cast-iron standard is Y-shaped, and is strutted between the floor and the bench; it is secured to the floor and to the bench with strong screws. The inner part of the lathe band runs through the bench and over the lathe head. The lathe head is one of Messrs. C. Ash and Sons' patterns, and carries three grinding wheels.

When first I attempted to remedy the splashing from the grinding wheel, I tried conducting the water along pieces of grooved wood, which were hinged in a sloping position from the water supply to the edge of the wheel. This worked tolerably well, but was noisy from the vibration of the wood as it touched the rough surface of the grinding wheel.

In the lathe which I use (Fig. 10) the water drip is received on a leaden surface at a convenient distance beneath the wheel. This surface slopes to one corner, from which the water is led away in a pipe.

Fig. 13.



"Sticking Wax" in Holder.

I find most of the grindings deposit on the lead, and rich gold grindings can be removed day by day, or week by week, as required. A rounded edge, made of hard wood, frames and surrounds the lead pan, on which the right or left hand can rest when grinding a tooth, and is smooth and comfortable to the "heel of the fist." The patterns for this type of fly wheel for the grinding lathe were made, at my suggestion, by Mr. A. J. Watts.

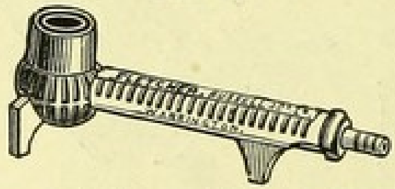
The illustration (Fig. 11) shows very clearly the details of this lathe, with the water supply conducted to the edge of the wheels by the leather strips.

The paint pot (Fig. 12) is seen next the small chucks on the rack on the top of the splash board.

On the end of the hand-rest hangs a cup made of a piece of brass tubing hooked to the wood, which holds a small supply of "sticking wax" ready for use (Fig. 13).

The tubes conducting the discharged water are shown, and are led to the tank in which I allow the detritus to precipitate. It will be observed that a weight has been placed on the fly wheel so as to keep the crank in a position for readily starting the fly wheel into motion. Were there a demand for these lathe standards, they could be turned out at a moderate cost, and would be much more useful in dental schools than the easily damaged grinding lathe so commonly seen there.

Fig. 14.

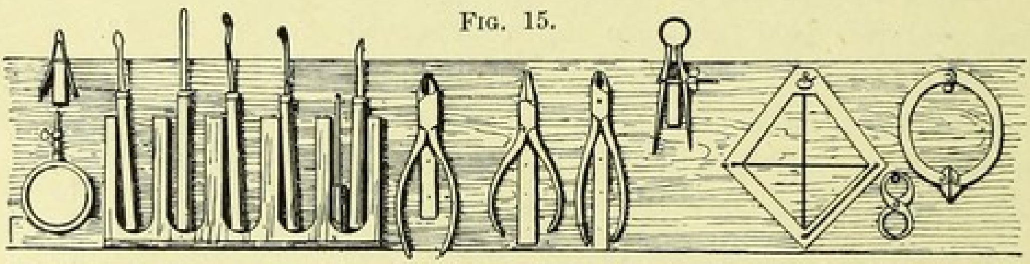


Fletcher's Argand Bunsen Burner.

The wax bench is most usefully placed next to the grinding lathe, and is in fact a continuation of the narrow bench I have already described. Over its surface at a convenient height I use an Argand Bunsen burner of the pattern figured (Fig. 14), made by Fletcher, Russell and Co., of Warrington, and I find it most useful in every way.

Some wax modelling tools, with the metal parts made of copper, which retains heat longer than steel, Kirby's Square, Callipers, Dividers, an old pair of Forceps, a pair of sharp-nosed Pliers, and Lennox's Fusible-metal outfit, complete the list of tools needed for modelling in wax, mounting teeth for vulcanite, and for making fusible metal plates. All the tools here enumerated are shown in Fig. 15.

Fig. 15.

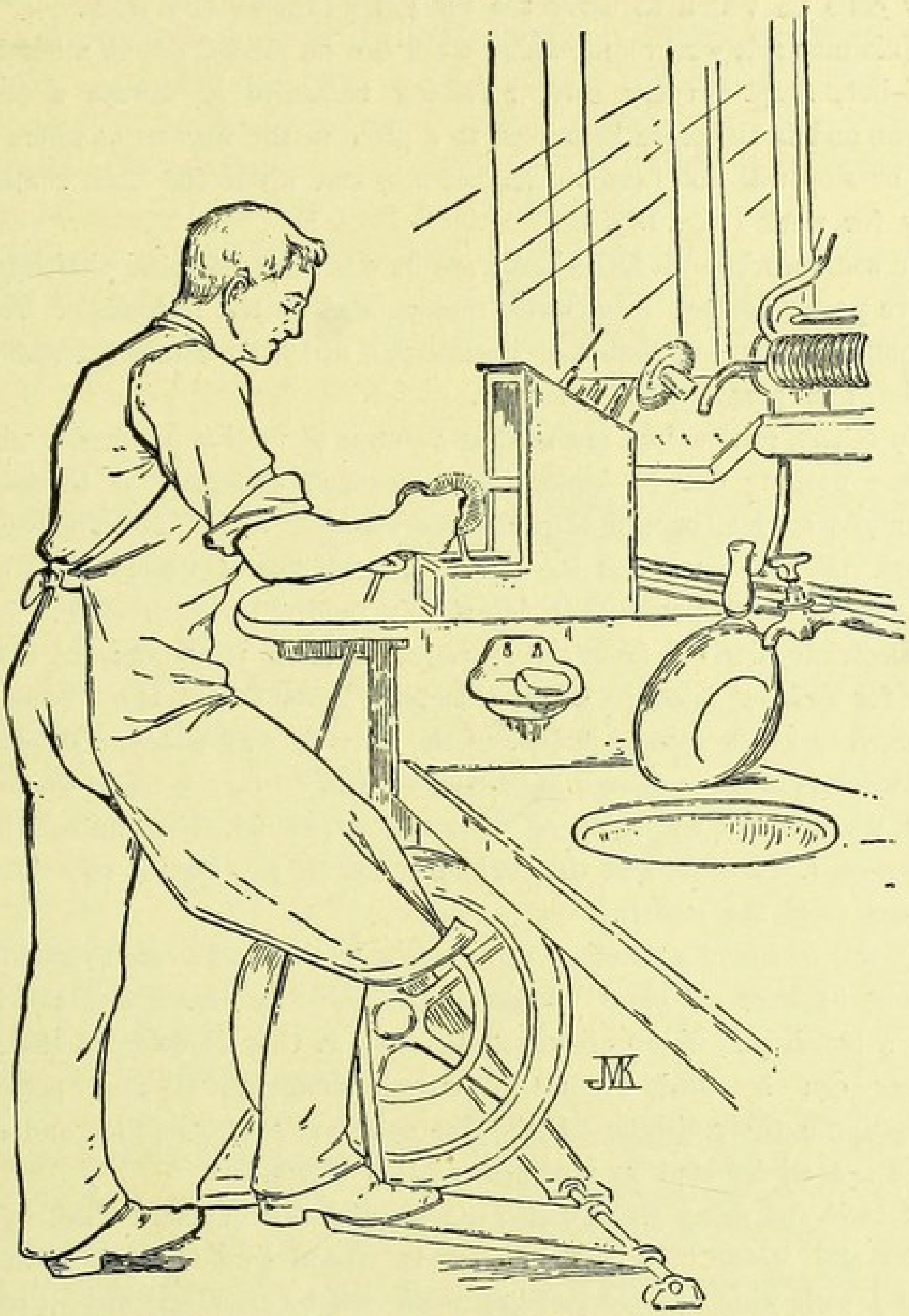


Rack Showing Wax-modelling Tools, etc.

I prefer to use leather bands, as they wear well, are easily repaired, and are not so subject to the weather as "gut."

A polishing lathe has next to be provided for, and I certainly prefer to have one always kept ready for this process. The services of the

Fig. 16.



The Polishing Bench with Lathe and Water Supply.

polishing lathe and the grinding lathe are kept in pretty constant use in workrooms belonging to any steady practice—and time, precious to the practitioner, is lost by having to stop grinding or to stop polishing, as the case may be, if both processes are carried on by the use of the same lathe.

Some of the modern grinding lathe-heads are now furnished with a screw cone on which to carry the polishing brushes and buffs.

This may suit workrooms where work can be carried out in a leisurely way—but, despite every care, polishing vulcanite is always a messy process, and is therefore best kept to a place in the workroom where the dust or slop will not cause inconvenience, and where the lathe is always ready for work (Fig. 16).

In some workrooms lathe-heads are driven from overhead shafting by motive power derived from water motors, such as the turbines of Ramsbottom, of Leeds, and Bailey, of Manchester, which are connected with the public or corporation water supply.

In others, gas engines are used as a source of motive power, for which purpose nothing can be better than Crossley's two-man or three-man power gas engine, or the Gardner gas engines, which are supplied by Messrs. Ash and Sons and the Dental Manufacturing Company, as both kinds afford more power than is actually needed for such work.

Electricity derived from a corporation or other public current is also used for driving lathes. When this force is employed, the wheels are arranged to fit the spindle instead of the usual driving pulley. Moreover, the switch is made to form a hand-rest, so that contact is made when the hand, which holds the tooth or other article against the grinding wheel, presses on the switch, and the current is cut off the instant the hand is released from the switch.

It will be found a practical convenience to those who care to go to the trouble, to have a "place" fitted to the polishing bench and provided with a bench pin, where all vulcanite cases as they come from the vulcanizer can be filed, trimmed, scraped, sand-papered, and prepared generally for the polishing lathe. The necessary sculptors, files, and sand paper can all be kept in readiness at this bench.

I have for many years had the polishing bench placed next to the basins and water taps, and have every reason to be pleased with the facility with which partly polished work can be examined, from time to time, without delay, by washing the detritus of polishing away.

With a wooden bench, in which are set two earthenware or enamelled basins covered with lead, and a hot and cold water supply, much good work can be done in the direction of cleanliness, and wax plates can be scalded out of vulcanite flasks.

Vulcanite flasks can be rapidly cooled, and metal and vulcanite plates can be thoroughly washed after they are polished. A couple of towels on "rollers" are hung in convenient places.

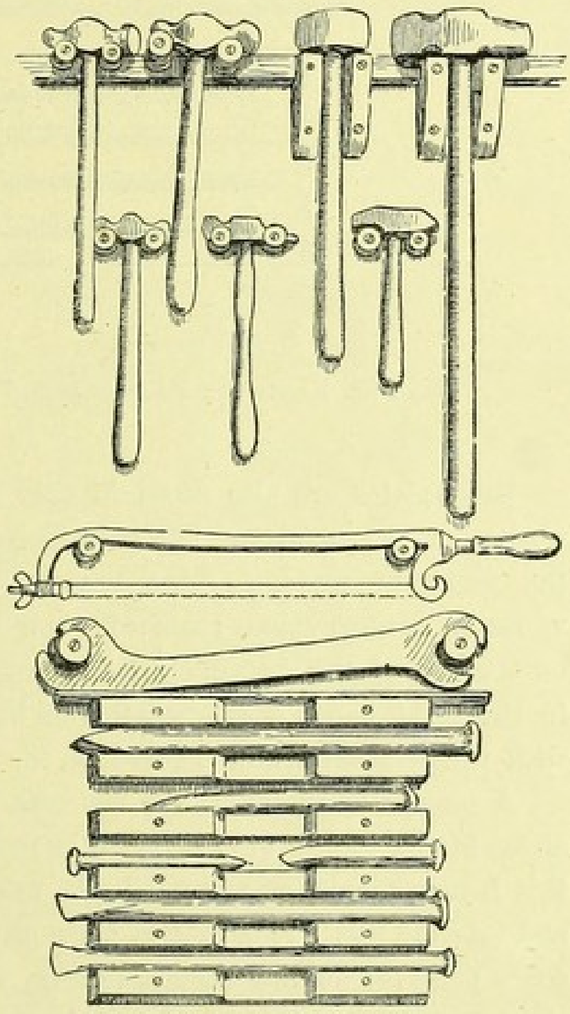
A vice bench is necessary for the workroom. To this bench is fitted a tail vice, *i.e.*, a vice made with an iron rod, the free end of which is sunk into the floor, or into a block of wood screwed to the floor for that purpose. A large vice is of use in holding draw plates and metal casts, or other heavy objects, while they are being trimmed or filed.

The wall at the back of this bench will be found a convenient place on which to arrange the rasps and files used in treating zinc, iron, or brass; also for turnscrews, spanners, hammers, and other useful tools which are in constant use (Figs. 17, 18).

Racks to hold these tools may be readily made by screwing strips of wood an inch square to the wall. A division is placed between the strips to suit the thickness of the tools to be placed in sight ready for use. If the upper surface of these pieces of wood are slightly bevelled *towards* the wall, the tools naturally lie against the wall and cannot easily be dislodged from their places by the shocks of hammering. The tools are pushed into the space with the handles turned towards the right, so that any of them can be removed at will without disturbing the others.

In the case of files, this method of putting them aside after use will be found of advantage, as the tools are all in sight and convenient to

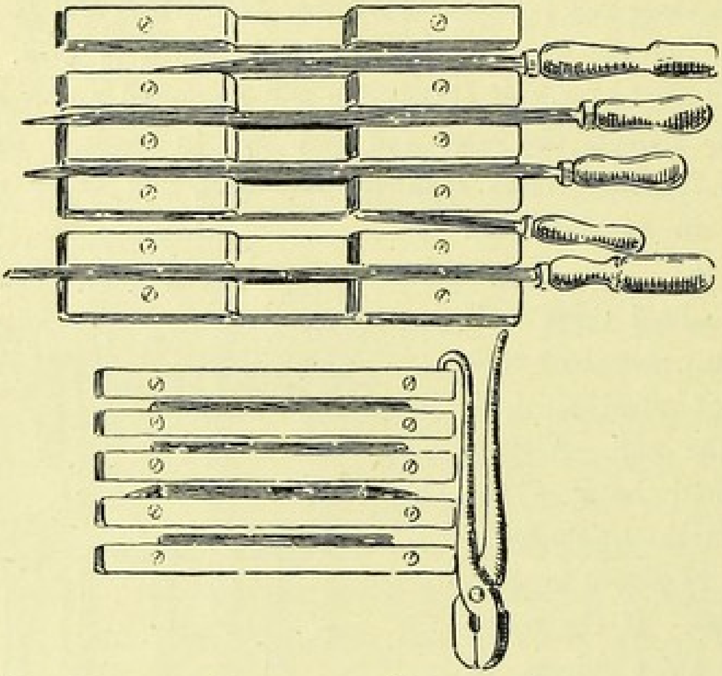
Fig. 17.



Tool Racks.
Author's Method of disposing of Tools on a Wall over Vice Bench.

the hand of the workman. In taking out a file, for instance, the workman cannot scrape it against its neighbour, and injure its teeth. After use the file can be placed in its rack without disturbing the others.

Fig. 18.



Tool Racks for Draw-plates, Files and Screw-drivers.

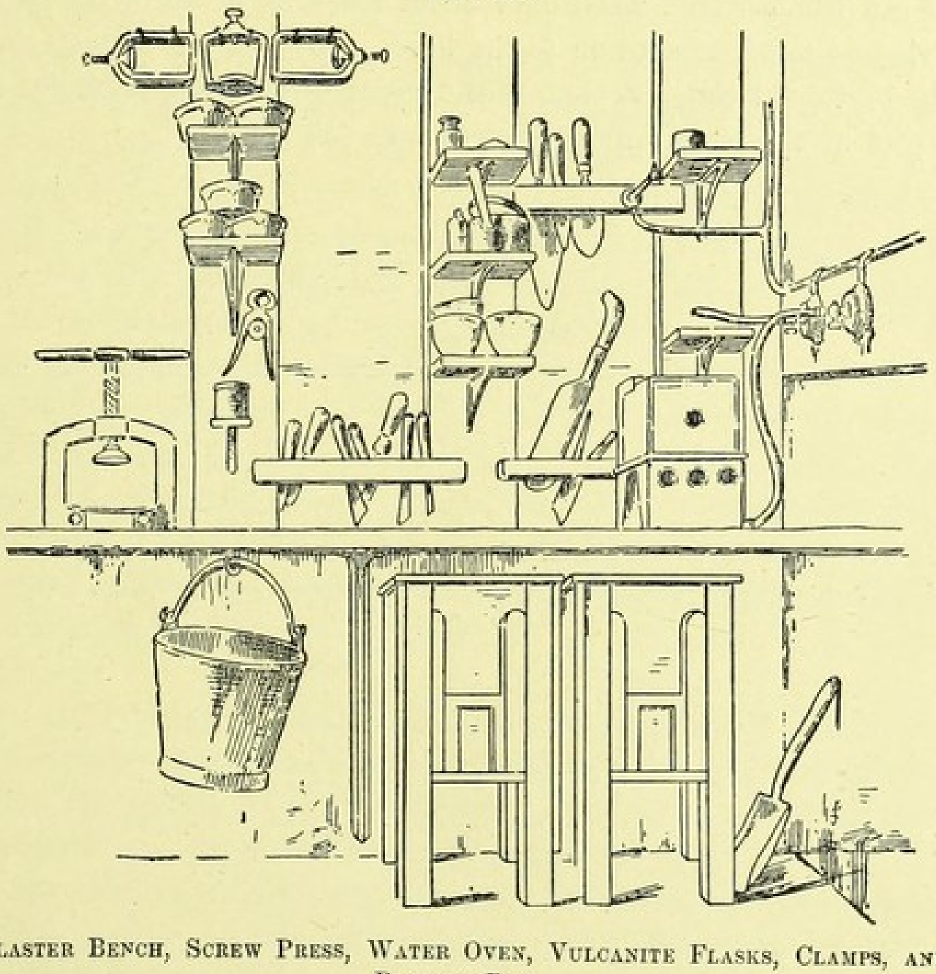
Draw-plates are also fitted in this way, one above the other, in my workroom—a space being left of sufficient width to let them slide between the pieces of wood, so that heavy hammering on the vice bench or vibration cannot shake them off their supports. The draw-tongs hangs on the end of the draw-plate rack, so that, while holding the draw-tongs in the right hand, a draw-plate can be quickly removed from the rack with the left hand and secured in the vice.

A plaster bench (Fig. 19) has next to be thought of, and should be about fifteen inches wide by three or four feet long. On the wall behind this bench should be arranged the vulcanite flasks, clamps, plaster tools and vaseline pot. It is well to place on the left hand end of this bench a screw press for holding flasks together, while the plaster is setting. At the right hand end of this bench can be placed Fletcher's hot-water oven for drying models. A vulcanite packing bench should be in the neighbourhood of the hot-water oven, placed at a convenient height from the floor.

Hanging beneath the plaster bench, on a hook or to a short length of chain, is a common household galvanised bucket. The hook and chain should be fixed in such a position that the bucket can be brought beyond the edge of the bench with the left hand, and parings of waste plaster swept into it with a knife or brush held in the right hand. The bucket can then be allowed to swing into place. In this simple way plaster detritus and parings are easily removed in the bucket from the workroom. Plaster is kept in bins, a sliding door gives access to it, and each bin holds half a barrel of plaster.

A bench to support the vulcanizers, and to which they can be screwed, is a great convenience to the busy dentist, as the vulcanizers can then be opened or closed without the risk of burning the hands, such as exists when they are left loose on a bench. The gas supply is attached to a Bunsen burner below the boiler, and the waste steam can be blown off

Fig. 19.



Plaster Bench, Screw Press, Water Oven, Vulcanite Flasks, Clamps, and Plaster Bins.

into a compo. three-quarter-inch gas pipe leading into the external air,—the discharge of evil-smelling steam into the work-room being thus prevented, and the tools protected from rust.

Provision has to be made for sand-moulding and casting metal dies. This is best effected in the shape of a sand-moulding box—a trough set on casters—see Chapter VII. When in use the box with its supply of damp sand can be wheeled under the light of a window, and when not in use it can be wheeled out of the way under the vulcanite bench, which is higher than the sand box. In the middle of the floor I have placed the anvil block and hammers ready to be used, when stamping metal plates. The anvil is within easy reach of the soldering lamp, the pickle, and the gold bench.

I have also added to this usual equipment a tool known as "a drilling machine vice," set on an iron post which has a socket in the floor. This vice is one of the most useful forms which a dentist can possibly possess, as he can hammer on a metal die without knocking it out of the jaws of the vice, on to his toes, or on to the floor. The vice also swivels round in the horizontal plane, so that, when chasing or punching is carried out, any part of the plate can be brought into full light.

CHAPTER III.

PLANS OF WORKROOMS AND WORK BENCHES.

A COMPARISON of the plans of the workrooms which I have collected for use in this book will, I trust, prove of interest to many, especially to those who are beginning practice. They will be found illustrated at the end of this chapter, arranged in alphabetical order.

To those who have purchased or succeeded to a practice, and who may wish to add to their available resources by providing conveniences for busy times of practice, valuable hints will be gathered by comparing the various plans.

It has long been my conviction that the workroom bench, as commonly seen, is not by any means the best for our purposes. The result of many practical experiments is seen in the drawings, which will, I hope, be accepted in the spirit in which I offer it in these pages, by those who, having practices, are not wedded to inconvenient arrangements, if they can with a little alteration make their workrooms tidier and more comfortable for themselves and their assistants.

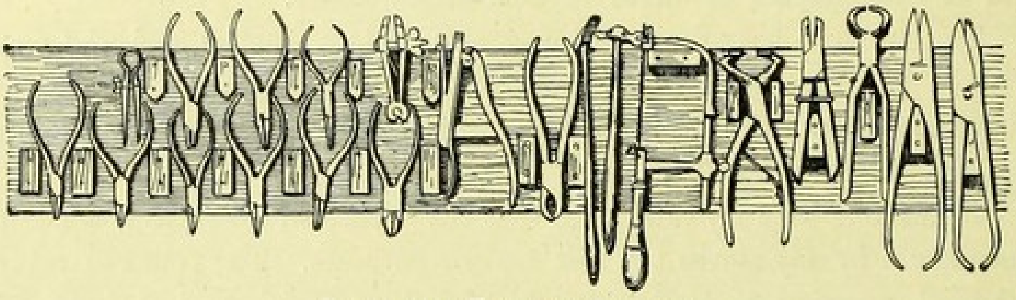
To the beginners in practice my views and recommendations are more likely to prove acceptable, as they do not cost more than the ordinary methods, and can be made by the dentist himself with a little care and patience in moments of leisure, or with the help of a handy man, so that when steady mechanical practice sets in, it will be a pleasure to him to undertake and execute whatever problems he may be entrusted with of a mechanical nature.

In the type of bench which I recommend (Fig. 21), the cutting and shaping of metal, the soldering of metal, the grinding and mounting of teeth, the making of plates in wax or fusible metal, can all be carried out without loss of time or unnecessary complication.

I have combined in one short bench a convenient way of carrying out processes that are so frequently repeated as to fall into what may be termed routine.

This type of bench can be worked at standing or sitting, and can be placed in full or side light, to suit the circumstances of most rooms chosen for workrooms, and will be found amply wide for all purposes. The same type of bench can be repeated where there are several assistants employed, placed parallel one after another on the floor, or placed back to back in a long room which has windows on both sides, while the others may be arranged to face the reverse way, so that the light falls over the left shoulder of the workman or student. Side light when it can be used is the most comfortable of all, but good light, whether facing the window or falling over the left shoulder, is essential on the score of preservation of eyesight as well as health.

Fig. 20.



Rack with Tools in Position.

In some rooms of moderate dimensions with a top light it may be more convenient to have these narrow benches secured to the walls, as it is a very great advantage to have a separate bench and equipment for each workman.

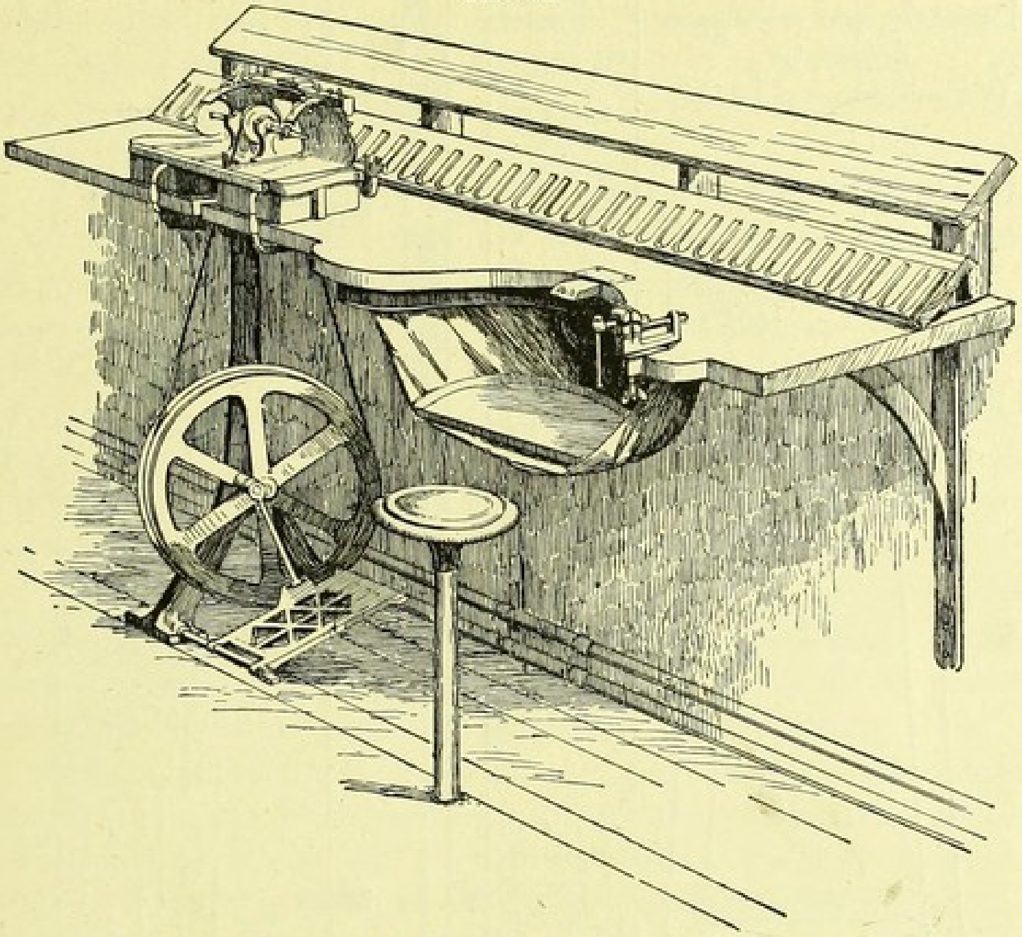
Thus time is saved,—and talking and disagreement while waiting for the use of a lathe, or a soldering lamp, or a pair of pliers or shears, are completely avoided.

The tools are all placed in sight, in a way that will permit of them being lifted, used, and returned to their places without disturbing others (Fig. 20).

Missing tools become "conspicuous by their absence" from the rack, and as there is a place for everything, any tool can be found in the dark by one accustomed to the bench and workroom. In most of the spacious old-fashioned work benches much of the surface is unnecessary, and only tempts the workman to cover it with models, tools only occasionally used, and the litter which an untidy workman inevitably gathers.

The type of bench described above has been a comfort to my assistants and myself for several years. The only one who grumbled and always wanted it lowered was the late Mr. Charles Hunter, who says, in *A Manual of the Dental Laboratory*: "The reader may have observed in a late number of the *Journal of the British Dental Association* some remarks on this subject by one of the members, advising that the height of the bench should be a near approach to that of an office desk at which work is done standing. The motive of the suggestion is excellent, but the idea can hardly be carried into practice."

FIG. 21.



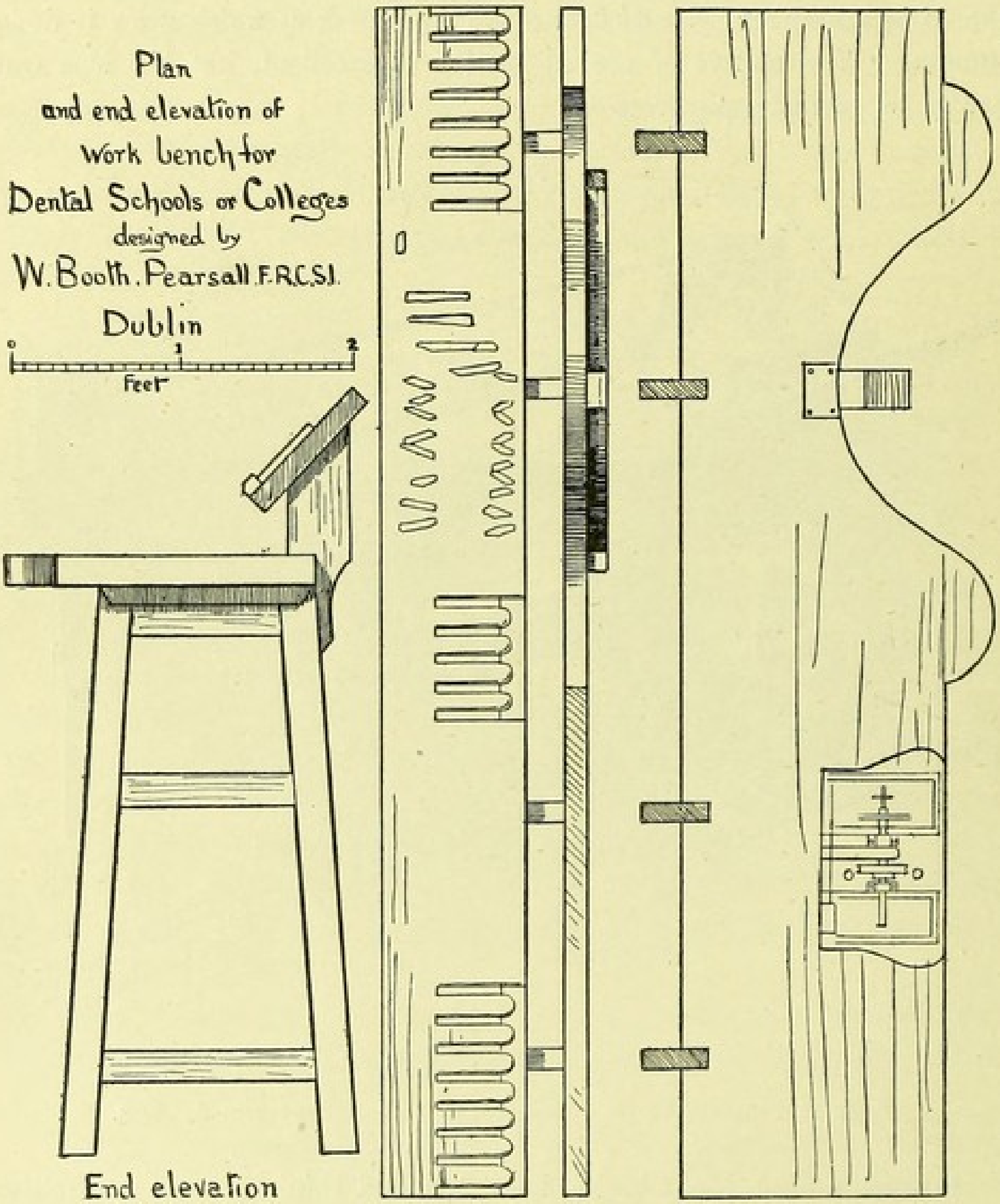
PLAN IN PERSPECTIVE OF WORK BENCH DESIGNED BY THE AUTHOR.

I wonder what Mr. Charles Hunter would think of many novelties which some of us now pretty constantly practise, were he still alive.

I have used this type of bench for some sixteen years and have no wish to return to the lower and more spacious type, which the reader will see figured amongst the plans.

It is my opinion that benches designed on this improved plan, and supplemented within a convenient distance with vulcanizer and packing benches, sand boxes, anvils, drop hammer, plaster benches, and polishing lathes, would save much trouble in the arrangement and administration of public or college workrooms.

FIG. 22.



PLAN AND ELEVATION OF WORK BENCH DESIGNED BY THE AUTHOR.

Each student would be segregated with advantage, and all practical conveniences would be within his reach without much moving about.

The addition of another foot to the length of the bench would supply ample surface for plaster work if it was found necessary.

It may be said that such arrangements would be too expensive, but benches could be added from time to time as they were wanted, and a kind of roster could be kept of the term of occupancy of each bench by the students.

In private workrooms I am convinced that it is more comfortable, if less "chummy," to work in this segregated way, as is the custom in a chemical laboratory or in a technical school.

I have been told that I shall never get men in my profession to accept my ideas, and that I shall never reform the workroom. Well, in reply I can say that what I have done has amply repaid *me* in many ways for any trouble and expense which I have been at in this matter, during the past thirty years.

I have been saved much anxiety, the execution of my work has been more certain and convenient, and the workroom has been a pleasant place to me, in which I have enjoyed much happiness and good health. What more can one wish for? Surely such attractions are worthy of consideration on the part even of men older and more experienced than myself.

In school or college workrooms I should advocate the complete equipment of the benches with all necessary tools as shown in Figs. 22 and 23.

The destruction, accidental loss, or theft of tools could be dealt with as they are in other technical schools and laboratories.

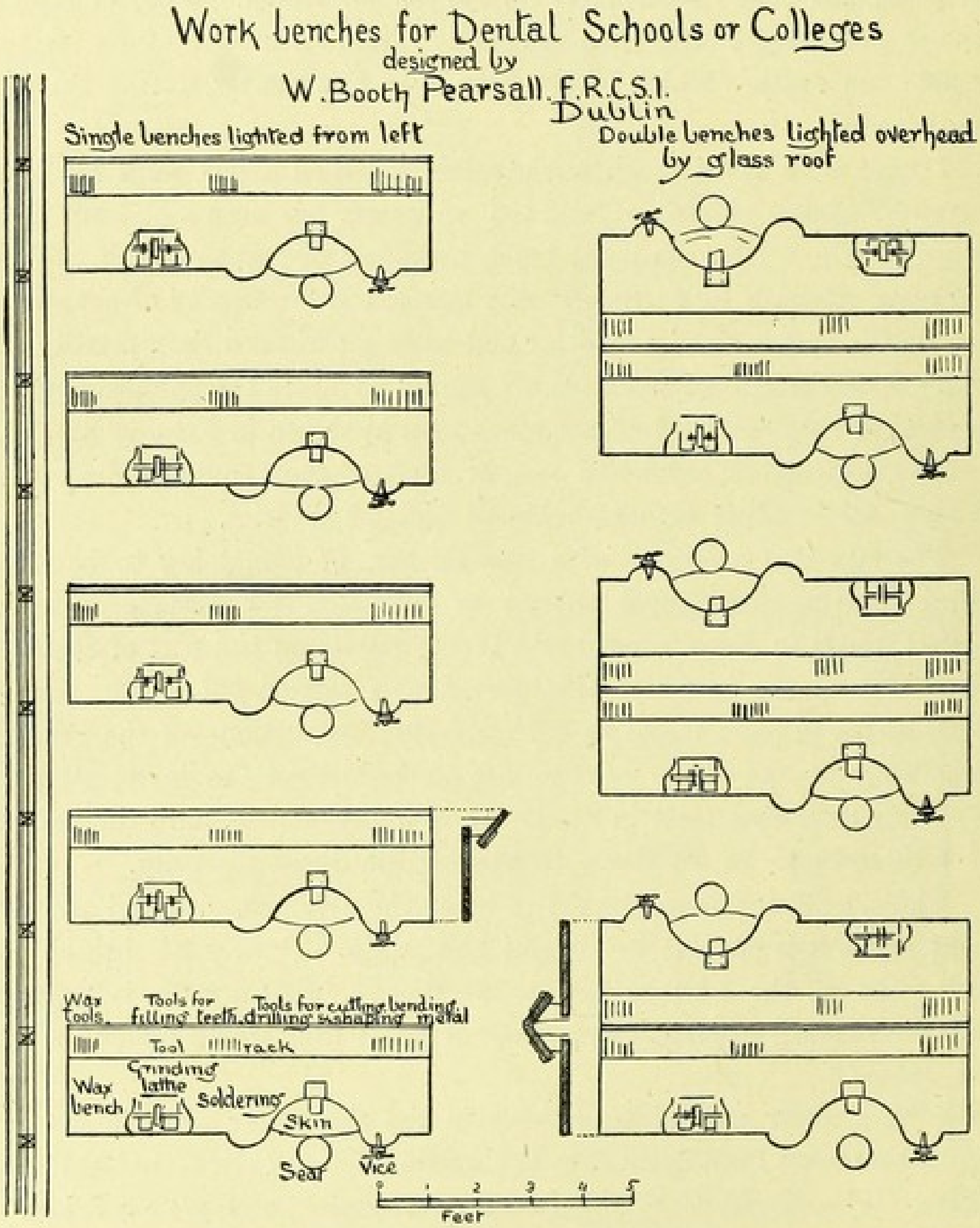
The fact that a deposit of a suitable sum of money has to be made before entering the school, subject to deduction for damage or wilful neglect, tends to foster careful and thrifty habits on the part of students in all the schools in which this provision is carried out.

It seems to me a feeble way of conveying instruction—of the greatest importance to the whole working life of the dentist—to invite students to supply their own tools in a school workroom, and to allow the number of such tools to be cut down to that of the direst necessity.

The school workrooms ought to be of the very best plan and arrangement which it is possible to suggest and equip. If they fall behind the equipment of the average private workrooms, what chance is there of that mechanical progress which some of us at least would wish to see in the future?

I have never met with anything in the shape of a plan, in the few books that have been devoted to the consideration of the technical details of the workroom, its tools, and the many processes which are carried on in it. The plans which I have placed in this chapter are the outcome of such hints as I have been able to gather from brother practitioners concerning their workrooms, the mode of their arrangement, and such other details as could be easily shown without undue complication. It would be unwise, and possibly unkind on my part, were I to criticise in minute detail all the points of interest that will present themselves to the reader when comparing the plans of practitioners, most of whom I know to be more skilful than myself. The plans show many ways of dealing with the

Fig. 23.



Work Benches for Dental Schools or Colleges designed by the Author.

details of arrangement, and they may be divided into three classes: old-fashioned, intermediate, and modern,—without in any way giving umbrage to my kind helpers in this matter. I use the term "old-fashioned" in no unkind or narrow sense, but I may venture to interpret it as showing to some extent the ideas that prevailed when natural teeth and sea-horse blocks were extensively used in the years between 1840 and 1863, or even later. The "intermediate" group shows the recognition of newer methods, such as vulcanite, celluloid, and combination metal work carrying teeth mounted in vulcanite or celluloid. The "modern" group exhibits a full perception of the many-sided nature of modern practice, for which it has been found advantageous to make special benches or places for carrying to completion work which has to undergo many processes before it is finished ready for the patient's use.

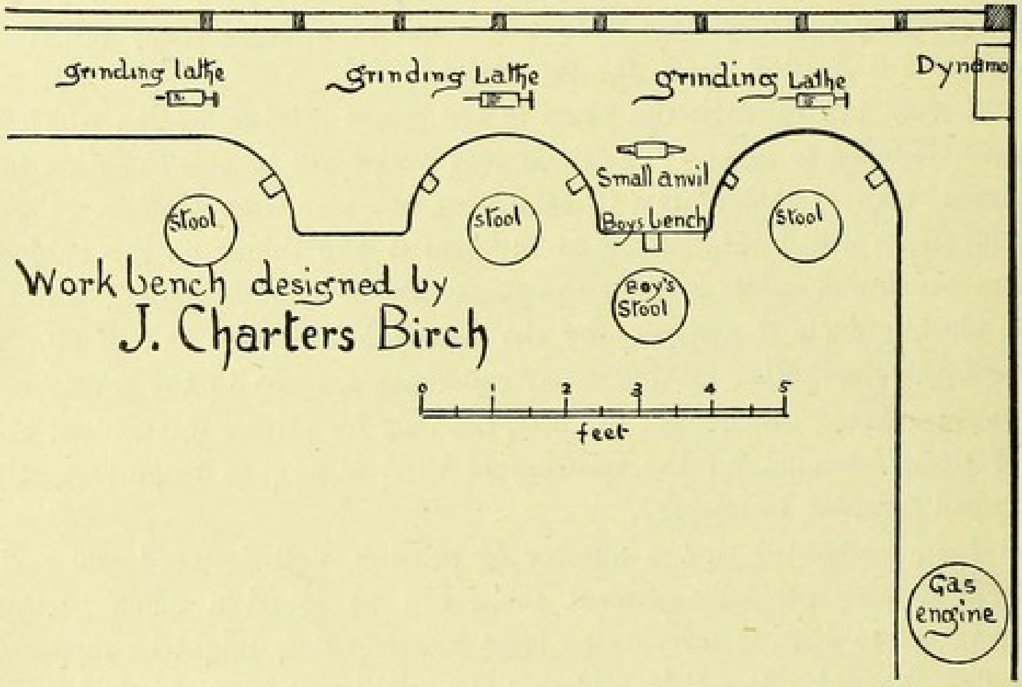
I shall not earmark the plans in the orders of classification which I have ventured to make. The intelligent reader will be able to gather for himself many valuable hints by comparing one plan with another. Close comparison will, I think, show to any dentist who thinks on this subject that benches complete in their equipment and of a simple design, so as to be cheaply made if necessary by the dentist himself, are best of all. I have, therefore, after making many experiments, come to the conclusion that segregated benches are the best, not only for private workrooms, but for those intended for the teaching of what is now so magniloquently termed "dental technology."

I am persuaded that a number of benches, well designed and each supplied with carefully selected tools, will be found a much greater advantage to dentists carrying on large practices than might be supposed at first thought. It will be said that the initial cost is greater in having to purchase so many sets of tools. I have been in very few workrooms, with accommodation for two or three workers, where tools in constant use were not duplicated. I know, from close observation of large works which I have had the good fortune of visiting during the past few years, that the principle of segregating each worker to his own special bench, or lathe, or loom, or dye vat, *is* the rule and not the *exception*. In joinery shops, in the same way, care is taken so to arrange the benches that each workman has ample room at his bench to work out the details of the timber work which it is his duty to prepare.

In the smallest dentist's workroom the rule will be found good that, even if it may not be necessary to duplicate each bench, at least a *definite* *bench or place should be provided for each process that is constantly repeated.* There is a natural conservatism amongst workmen, no doubt, and too many dentists give way on these matters instead of insisting on the cleanliness, economy, order, and discipline that ought to be the rule rather than the exception. Some workrooms are allowed to become the most untidy and dirty room in the house in consequence of this neglect on the part of the owner.

Dr. St. George Elliott had a beautiful workroom when I visited him some years ago in London, and his arrangements for taking power from

FIG. 24.



PLAN OF WORK BENCH DESIGNED BY MR. J. CHARTERS BIRCH.

the gas engine which he had at work were not only ingenious, but thoroughly practical.

With one or two exceptions, I have been in all the workrooms of which I exhibit plans, and the plans have been supplied to me by friends who are interested in the subject. I do not claim that any one plan is *ideal*, but it is found to suit the needs of its owner.

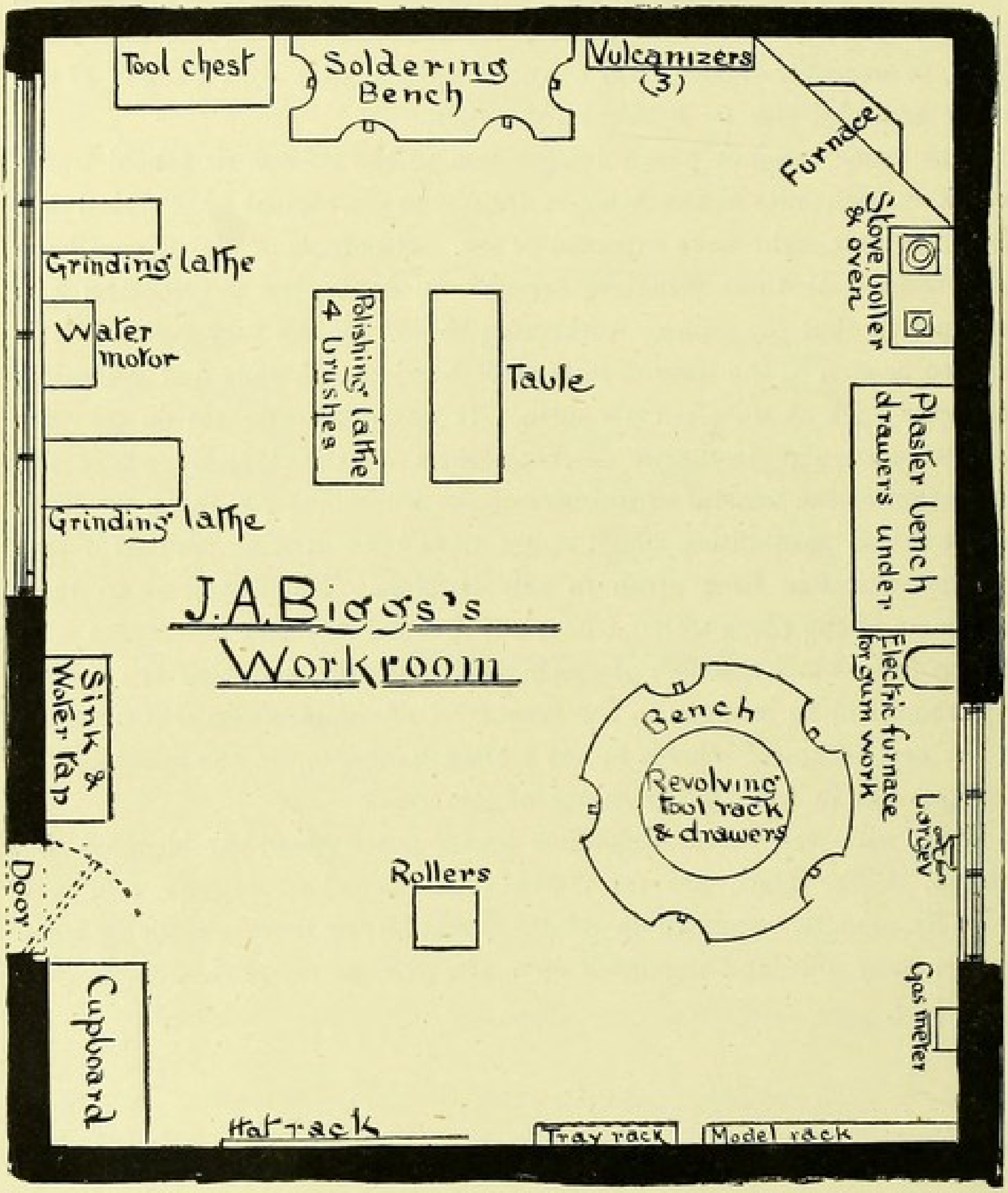
Mr. J. Charters Birch, of Leeds, has kindly favoured me with the plan of a new work bench which he has just made of a type that is new to me (Fig. 24). The details are cleverly arranged for those who like to work in the seated position.

A revolving seat is used in each workplace, so that the workman can use the grinding lathe placed in front of him or turn to either side to file vulcanite or metal, as the case may be. A workplace with two bench pins is a novelty, and will recommend itself to those whose workrooms are confined in area and light. The tools, I am informed, are placed on a revolving stand resembling three truncated cones placed one above the other, so smoothly balanced on a central spindle that with a touch of the finger any tool can be brought into view.

The work benches which I have seen in the college or school workrooms on both sides of the Atlantic are not as convenient or practical as I should at first sight have expected to see. Hundreds of clever men have been trained at these primitive benches, no doubt, but nevertheless it is my opinion that the college workrooms should be the very best of their kind to be seen in the district instead of being of the rude and makeshift character such as we often see them. It would be invidious on my part to cite particular instances on both sides of the Atlantic where the realisation of the natural capabilities of the workroom has fallen far short of the actual possibilities, which might have been existing realities if due consideration had been given to this problem. May I venture to hope that some of the plans which I here put forward may find acceptance with the professors and teachers of mechanical dentistry, and that the college workroom will be brought to the same level of completeness which we see in the best technical schools in the United Kingdom, on the continent of Europe, and in the United States of America?

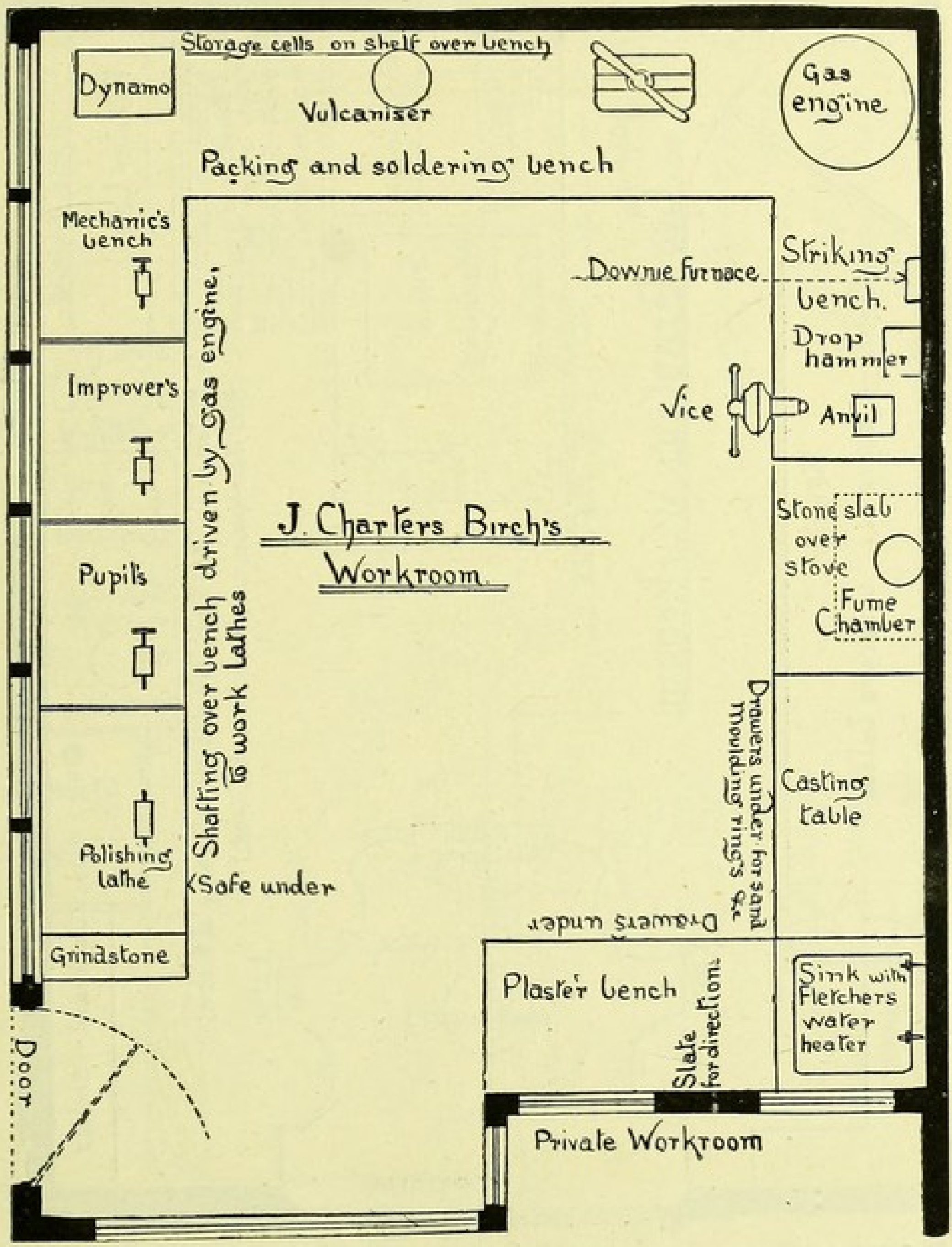
It is with very great diffidence that I put forward my ideas on this subject. The plans are no doubt crude in some respects, and will probably soon be surpassed in several directions by designs made by some of the many able and ingenious men who practise my profession all over the world.

Fig. 25.



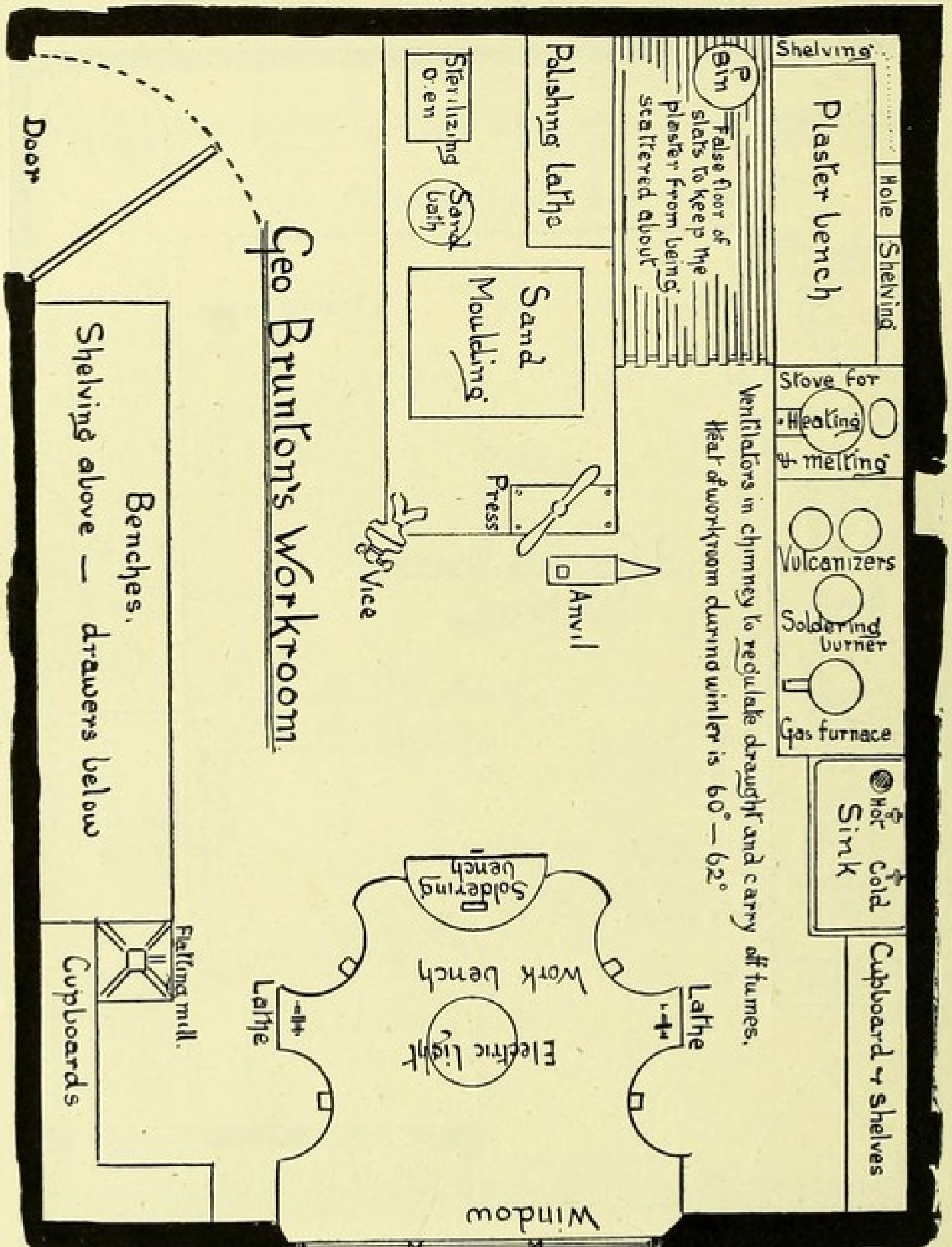
Plan of Mr. J. A. Biggs' Workroom.

FIG. 26.



PLAN OF MR. J. CHARTERS BIRCH'S WORKROOM.

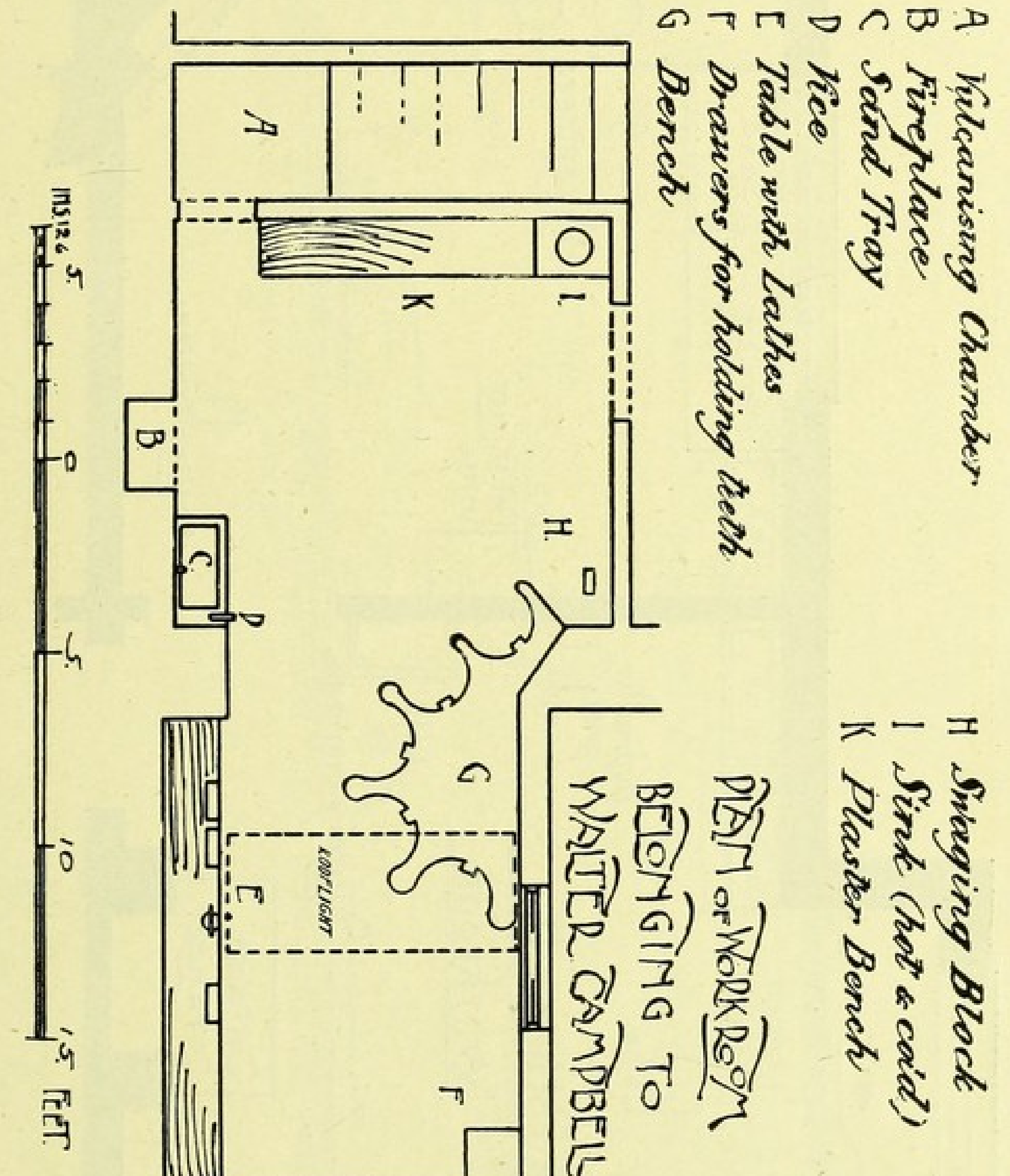
Fig. 27.



Electric light from roof. can be pulled down and shifted where required

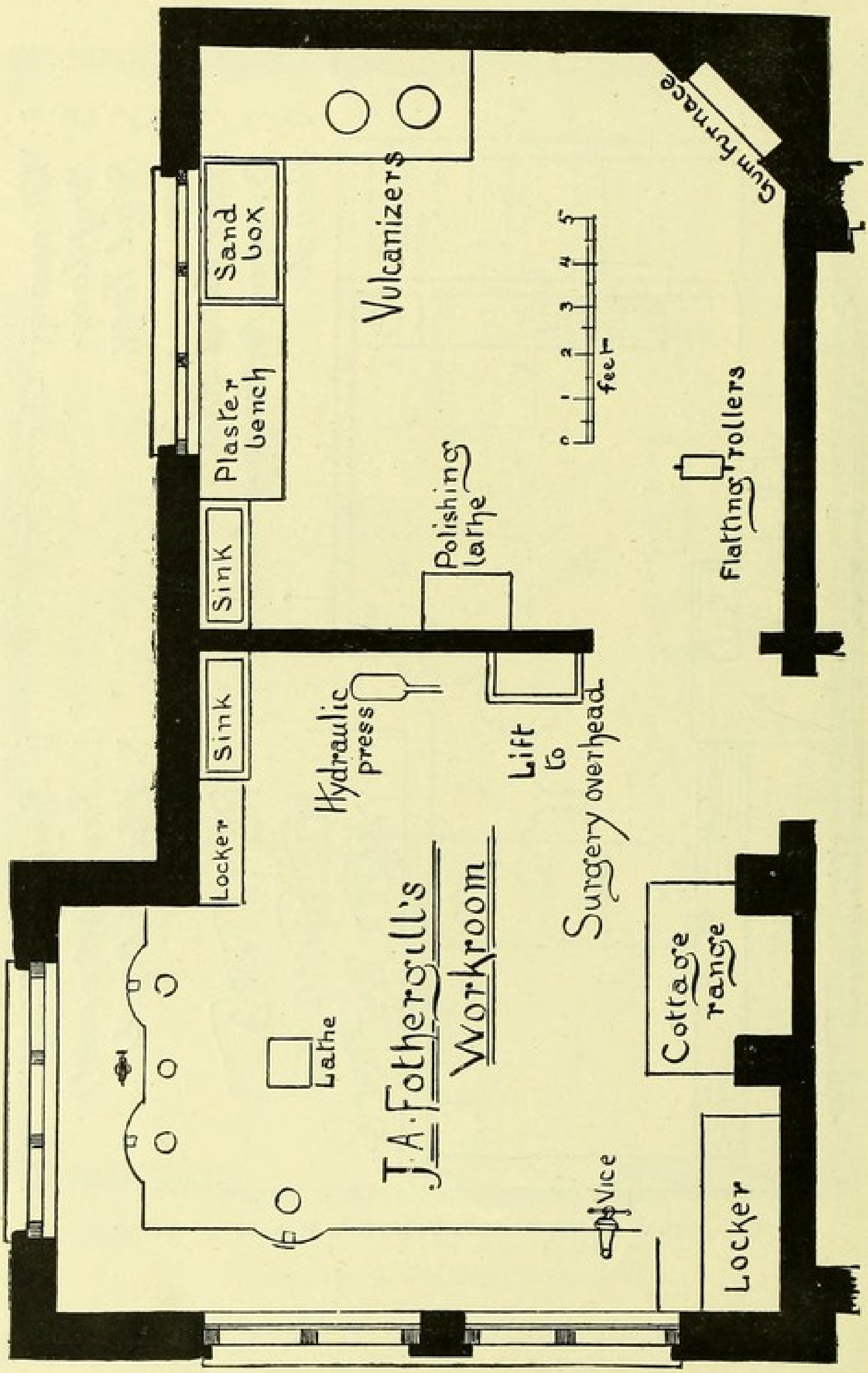
Plan of Mr. G. Brunton's Workroom.

FIG. 28.



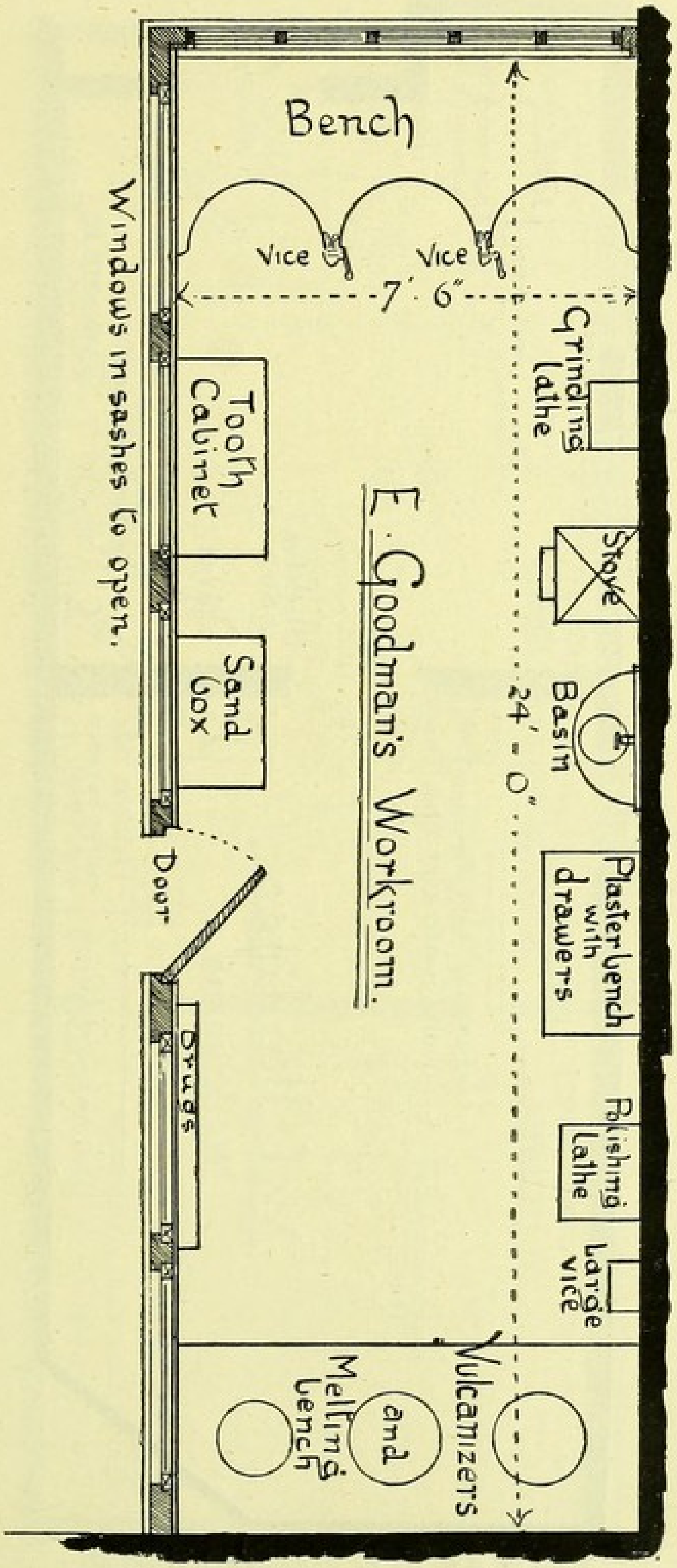
PLAN OF MR. WALTER CAMPBELL'S WORKROOM.

Fig. 29.



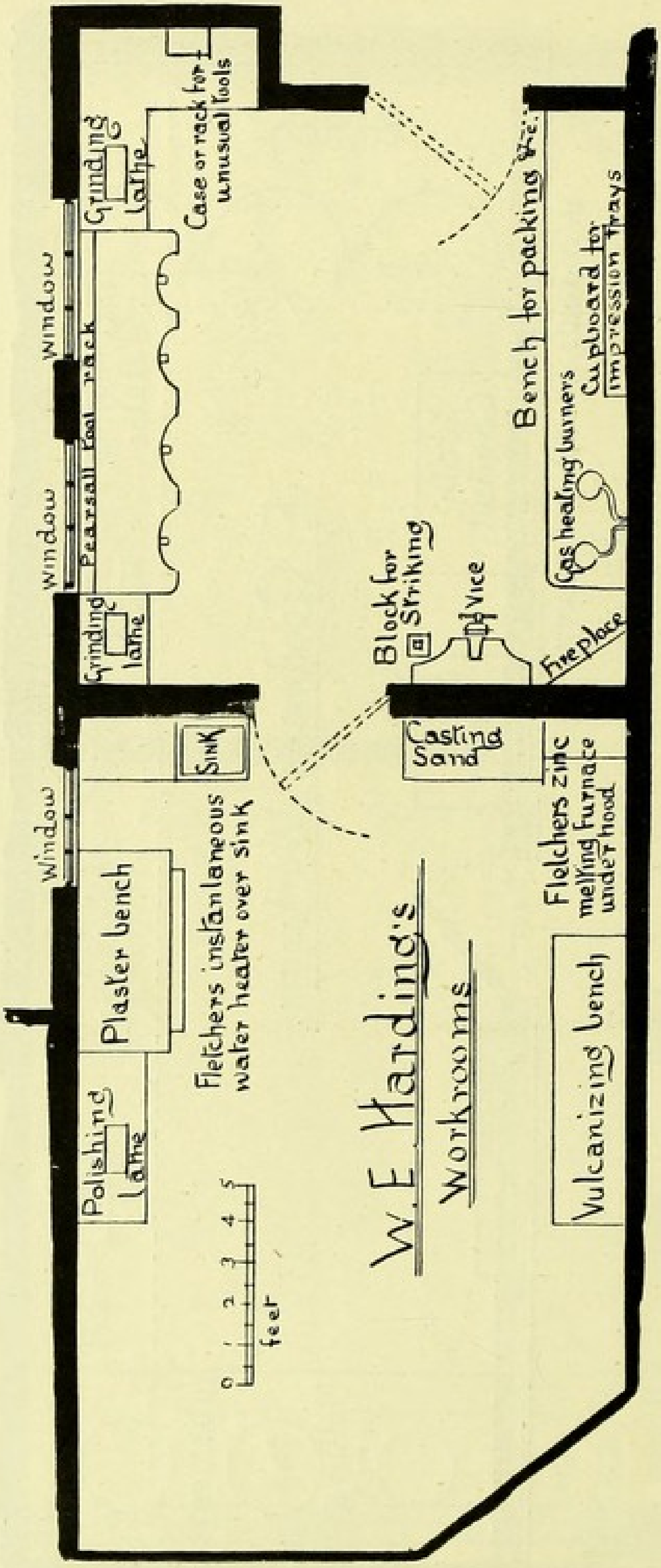
Plan of Mr. J. A. Fothergill's Workroom.

Fig. 30.



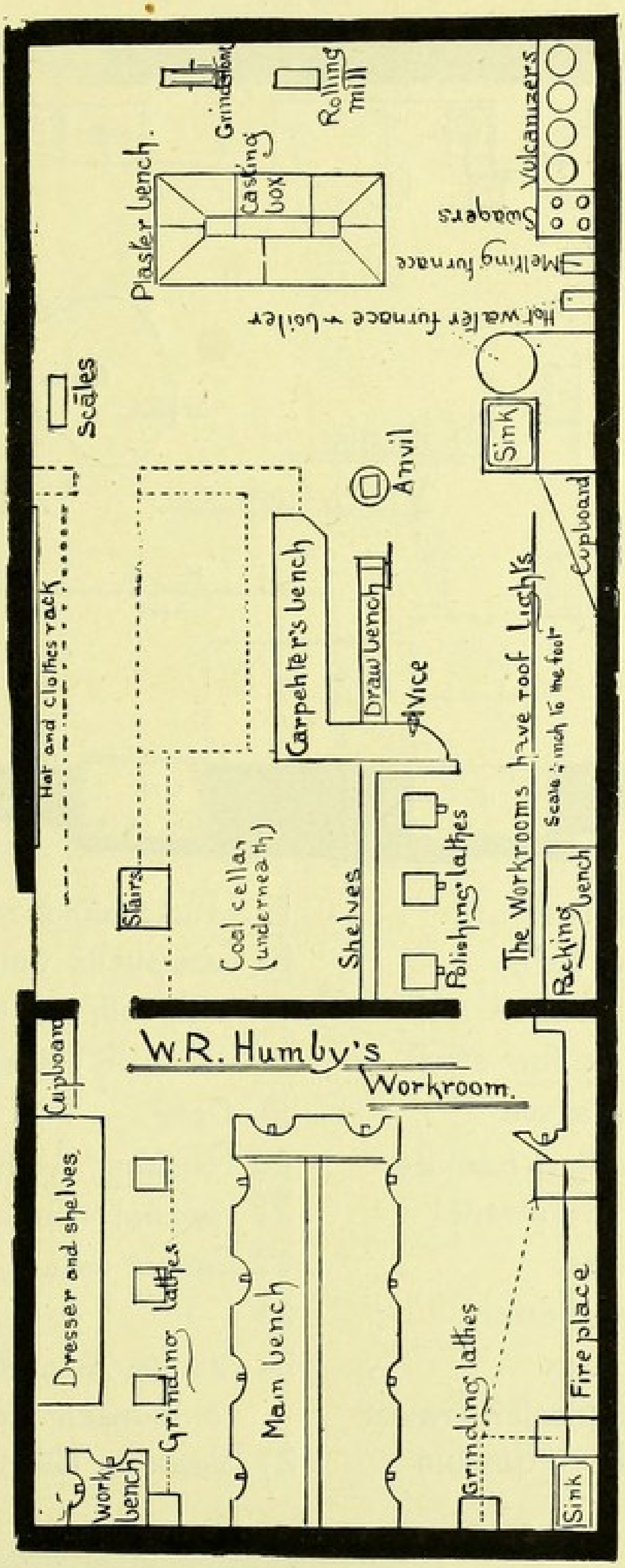
Plan of Mr. E. Goodman's Workroom.

Fig. 31.



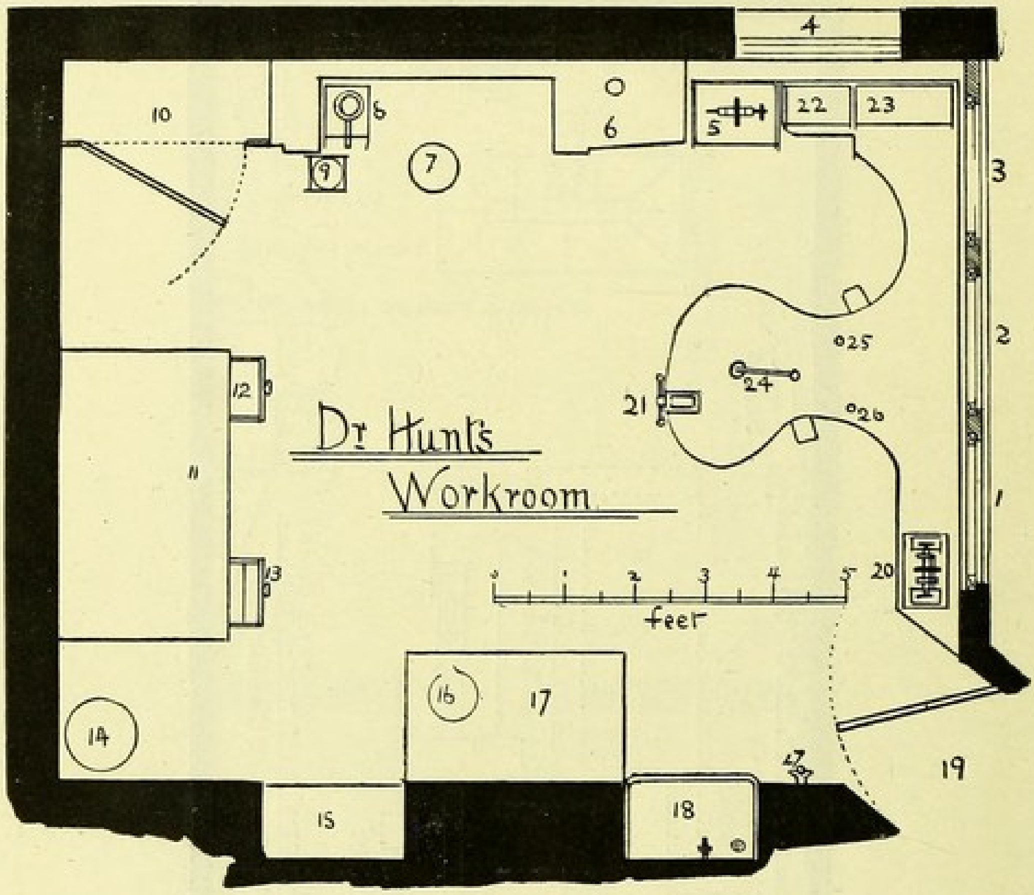
Plan of Mr. W. E. Harding's Workroom.

Fig. 32.



Plan of Mr. W. R. Humby's Workroom.

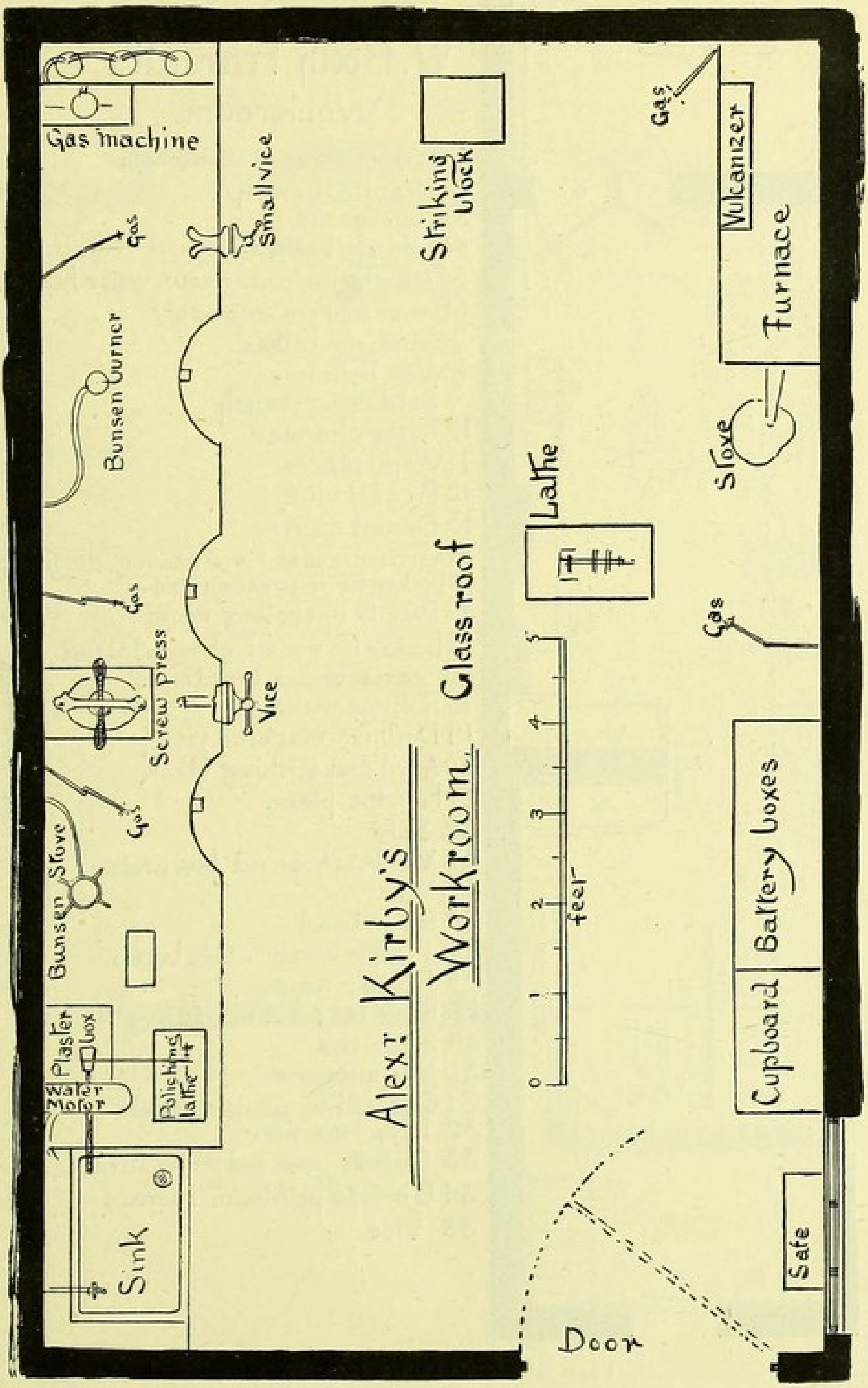
Fig. 33.



1·2·3·4. Windows
5 Fitting lathe
6 Acid cupboard with ventilating shaft
7 Tortoise stove
8 Zinc melting furnace
9. Vulcanizer on pedestal
10 Cupboard
11 Plaster bench
12 Sand box
13 Waste plaster drawer
14 Sanitary dustbin
15. Sand casting requisites
16, Campbells vulcanizer
17 Bench with nest of drawers
18 Sink with water tap
19 Door
20 Polishing lathe
21 Parallel vice-quick action
22 Cabinet containing teeth
23 " " sundry tools
24 · 25 · 26. Standard and 2 Bunsen flames
27 Speaking tube to surgery

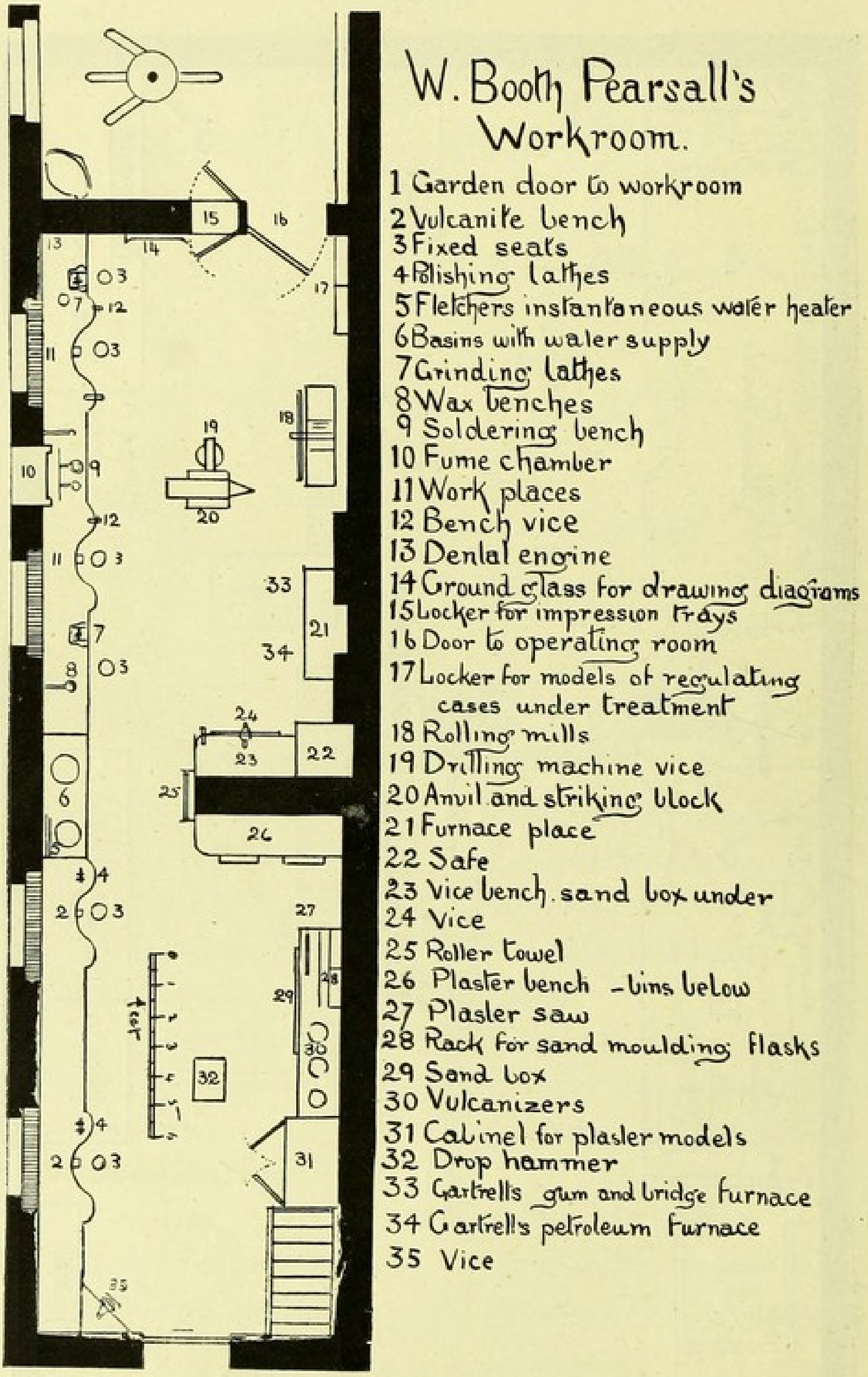
Plan of Dr. W. A. Hunt's Workroom.

FIG. 34.



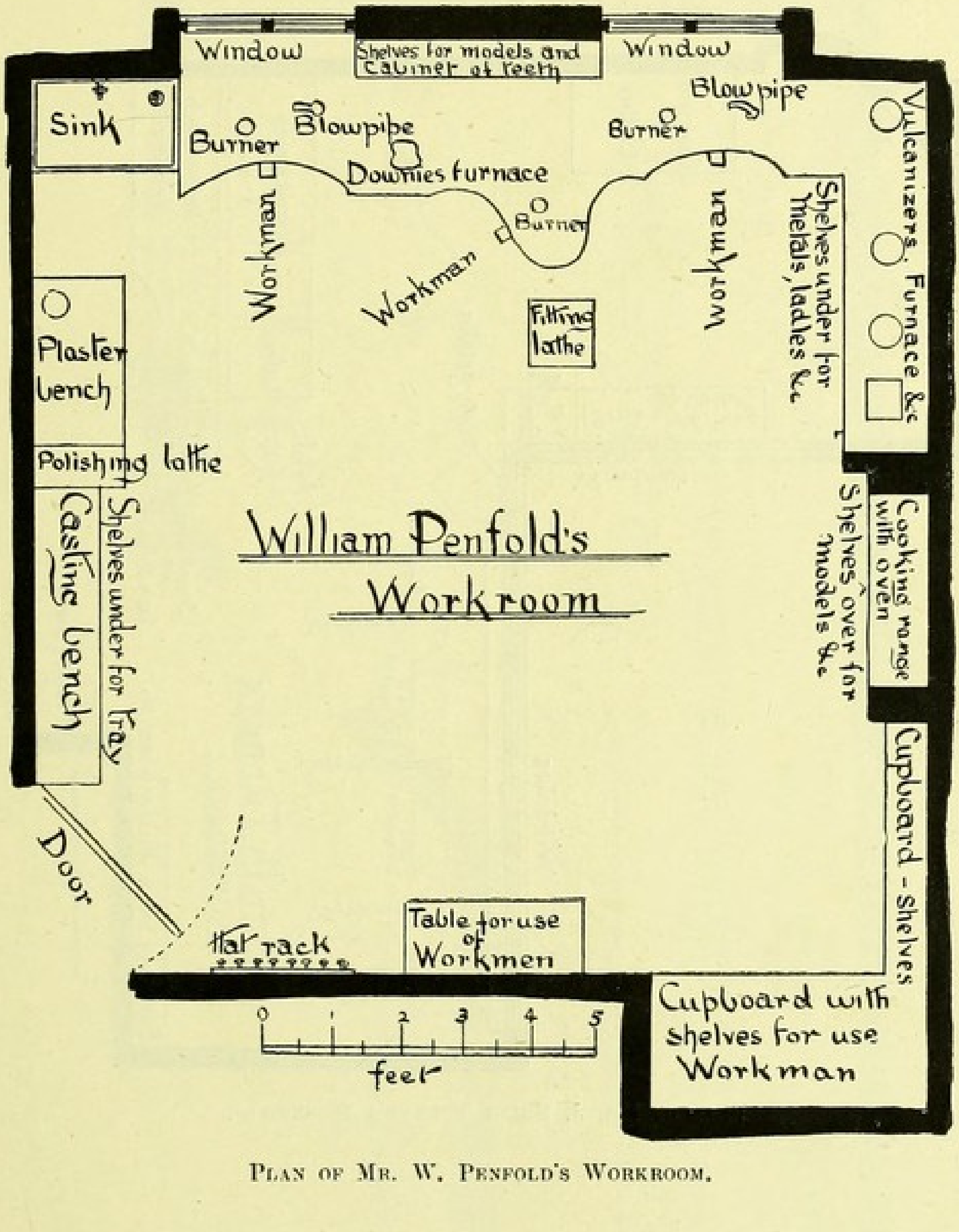
PLAN OF MR. ALEX. KIRBY'S WORKROOM.

FIG. 35.



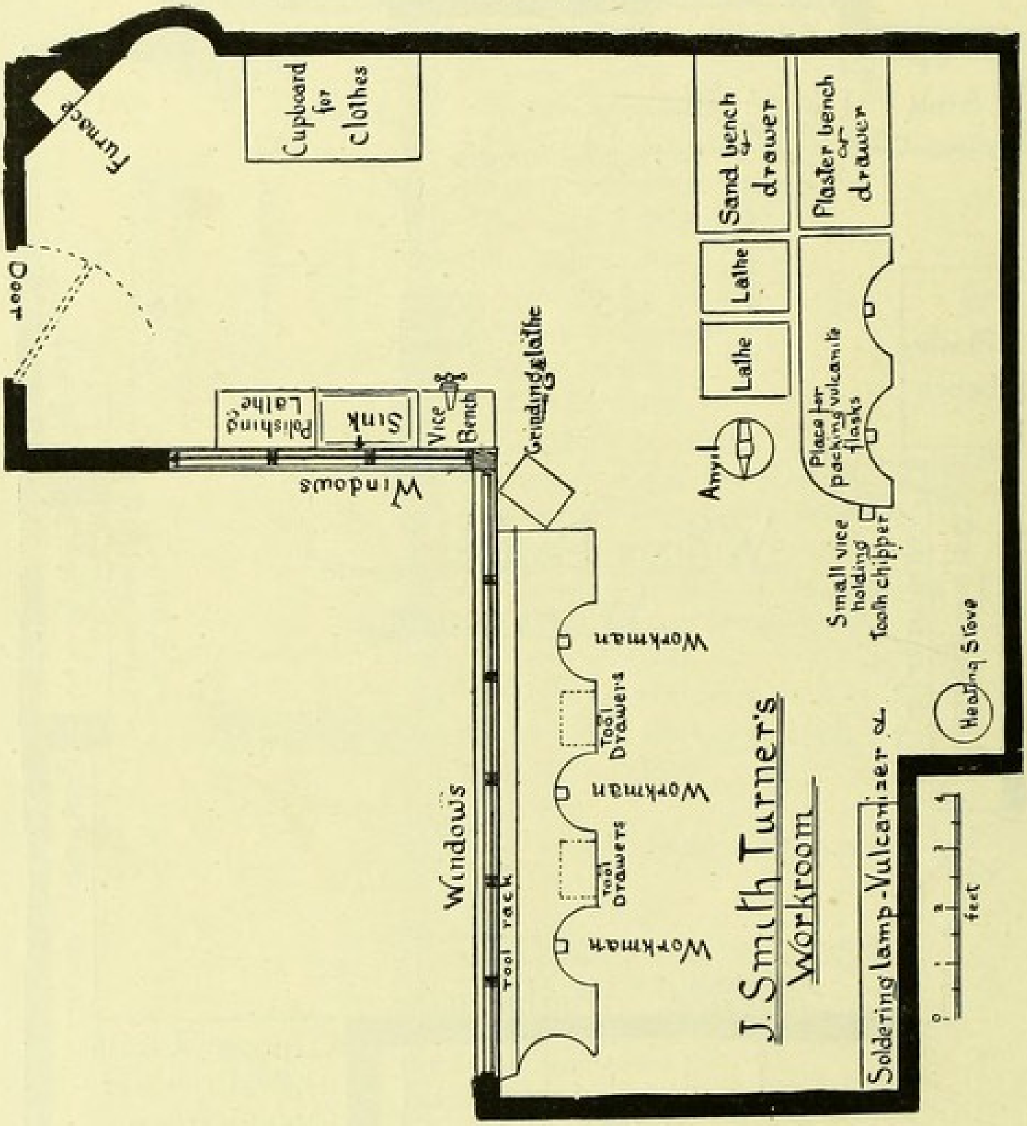
PLAN OF THE AUTHOR'S WORKROOM.

Fig. 36.



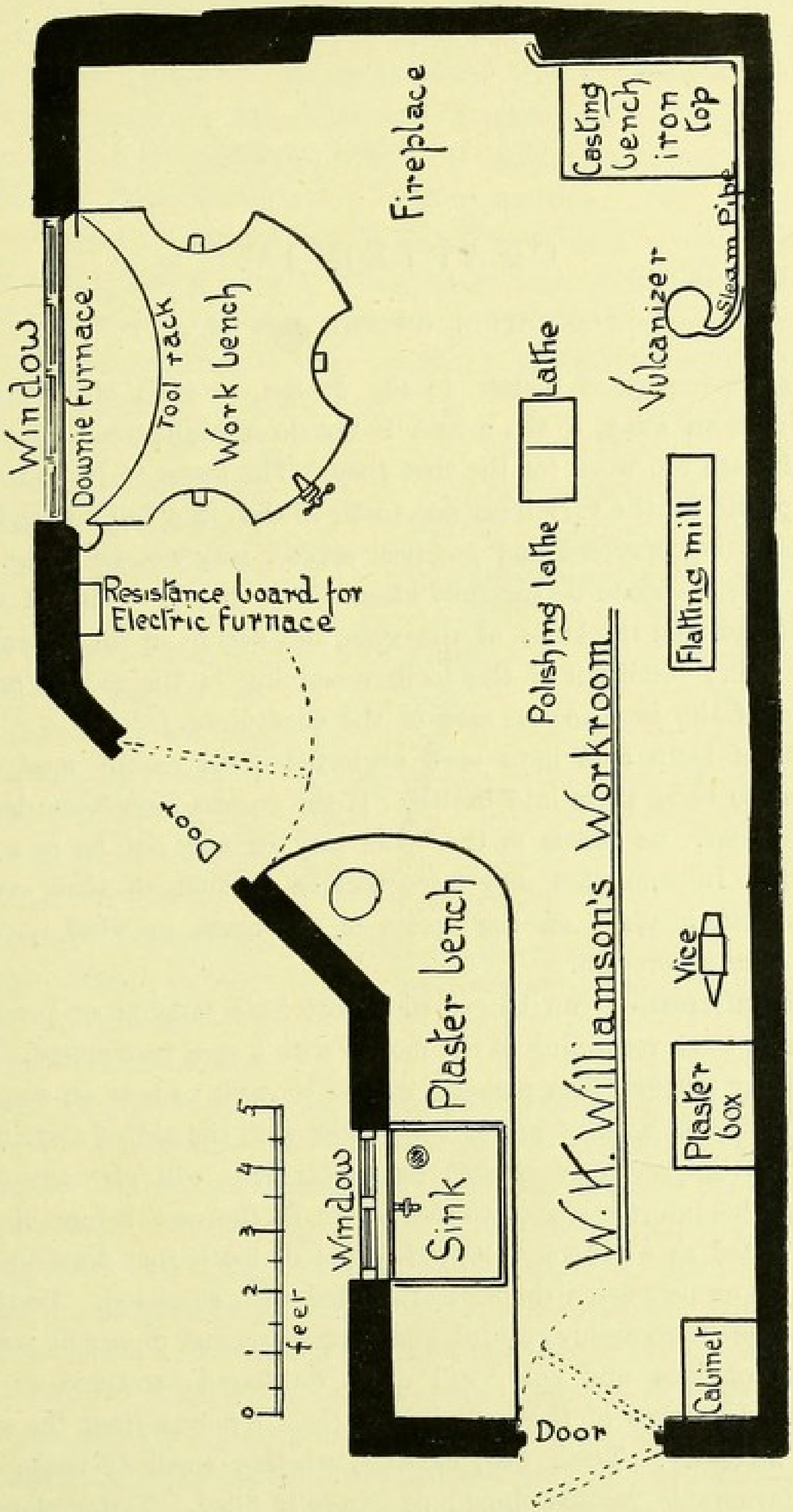
Plan of Mr. W. Penfold's Workroom.

FIG. 37.



PLAN OF MR. J. SMITH TURNER'S WORKROOM.

FIG. 38.



PLAN OF DR. W. H. WILLIAMSON'S WORKROOM.

CHAPTER IV.

CONDITION OF THE MOUTH.

THIS is an important matter to the dentist, as it is often time and trouble thrown away, if the mouth is not in a healthy condition when artificial teeth are worn for the first time. The losses to be restored by the art of the dentist vary from one tooth to that of a full set, and a few words on this important and practical subject may not be amiss.

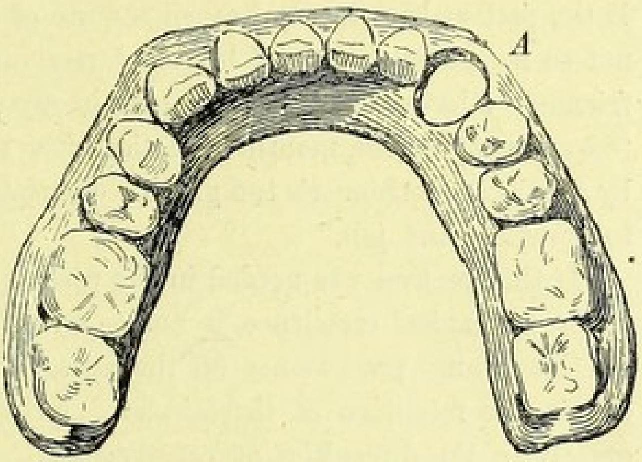
The mouth should be carefully examined from every point of view—the condition and thickness of the gum, the nature of the articulation, the shape and condition of the teeth remaining in the mouth, and the occlusion of the jaws in the case of the edentulous.

Roots of teeth that have been neglected often require most skilful treatment to bring them into health. If the crowns have been decaying for some time, the canals in the roots may or may not be in a septic condition. Inflammation may have become chronic, so that exostosis may have taken place on the apices of the roots, or what is equally troublesome, absorption.

Much information can be gained by carefully tapping or percussing the roots or teeth remaining in the mouth with a steel instrument. With a large bulky plugger, firm pressure can be brought to bear on suspicious roots. Throwing a jet of hot or cold water with the aid of a syringe on irritable teeth, previously isolated by rubber-dam, will give the dentist much valuable information as to the nature of the case before him. It may be stated as a general rule that a root or tooth that does not yield a clear note on percussion should be regarded with suspicion. Teeth and roots that are unbearably painful under pressure, and unusually sensitive to shocks of heat and cold, will often be found exostosed or badly absorbed. In either of these conditions, their removal from the mouth becomes necessary. Teeth with cavities, whether small or large, likely to give favourable results, should be carefully filled. Tartar should be removed by scaling, essentially on the lingual surface of lower incisors when a bar lower has to be made. Roots that give a favourable response to pressure and percussion can be trimmed level or below the gum, and the canals cleaned out and filled with gutta-percha. The general idea should be as far as possible to *preserve the alveoli* by bringing the teeth or roots that are in them into a state of health.

The removal of painful and loose roots or teeth should be done at once, so that nothing may be left to cause pain or irritation under the pressure of the plate. I fear many teeth are removed in the course of the year that could be brought into health, if only patients were intelligent enough to appreciate the value of these organs, and to lay aside their idle fears and endure the necessary treatment. Cases will be seen from time to time by the dentist where the question is whether to retain serviceable but isolated teeth, or make a clean sweep of everything. I have no hesitation in saying, as the result of many years' experience, that the "clean sweep" practice is fraught with serious loss of *expression* to the patient's face, and that the more conservative, if more difficult, method of treatment—that of preserving whatever teeth can with advantage to the patient be retained—is the best answer to the question.

Fig. 39.



Lower Vulcanite Denture, with Right Lower Canine *A* left standing, worn for fourteen years without the loss of the natural tooth.

If the teeth be left undisturbed in the case of a patient who has probably never worn any artificial teeth before, a useful means of retaining the dentures in position is offered till such time as the patient has learned how to do without it. I have seen over and over again cases where a canine, firm as a rock, has been extracted from an otherwise edentulous mandible, greatly to the loss of the patient, and ultimately to the detriment of the dentist, who had not the skill to make use of the old veteran, or was too careless to do anything but what suited his convenience at the moment. Such a case is shown in Fig. 39. Even loose teeth in the mandible are often invaluable to the patient when supported with a well-made denture. It is not infrequent to find that, with a little care in scaling these teeth and in the constructive details of the denture, within a month they have become comparatively firm again. I would therefore recommend that in such cases the forceps be laid aside.

In the mandible, teeth that are moderately firm at the time of examination, and give a clear note under percussion, should be preserved. In the maxilla canines and molars, even when very much exposed by shrinkage of the gum, probably due to extrusion while seeking for work, should be preserved in cases where artificial teeth have never been worn. If the patient has already learned the use of artificial teeth, this caution is not so necessary, as he will be found most unwilling to part with his old friends. I have treated many a case in my time without resorting to the "clean sweep of the mouth" practice after the patient had been terrified by another practitioner's too graphic description of "what was to be done to complete the job."

If this caution was needed in the past, it is just as much needed now, when mechanical excellence is not as a rule the prevailing characteristic of the young practitioner of the age. It is needless to say that, of course, the retention of these isolated, stripped, and extruded teeth adds greatly to the difficulties of construction. Nevertheless, I consider it a part of the dentist's duty to be inventive and patient in the treatment of such cases, although it may happen at times that his skill and experience are not estimated at their proper value.

The preparation of the mouth is a comparatively easy matter to a patient nowadays. The dental engine, carborundum wheels, excavating burs, Herbst's files, &c., all help the patient and the dentist in doing this important service quickly and well. The preparation will naturally fall into the directions of preparing the teeth or roots to endure pressure, without causing pain while under the plate. Elderly patients present themselves to the dentist not infrequently, with the incisor teeth of the mandible quite loose from absorption of the sockets, caused or aggravated by large deposits of tartar. The absorption may have advanced to the apices of the roots of the incisor teeth inside or outside the arch, or it may only have loosened the teeth without denuding them of gum. Cases of this kind are, I think, in general successfully treated by taking an impression of the mouth, preparing the plate from the plaster cast, then extracting the loose teeth, and replacing them with porcelain substitutes at once.

Where pockets of gum remain above the empty sockets, the porcelain teeth can be rounded on the lower end by the wheel and waxed to the plate, and gently but firmly pushed into the empty sockets as far as the teeth will go, till the cutting edges are brought to a level with the canines. In the maxilla, cases of this kind will be seen with a number of beautifully-shaped teeth, loose and troublesome, which no treatment can make firm again.

Opportunity is offered, after extraction, of planting porcelain teeth in these sockets, by judicious grinding of the teeth and finishing the case without delay. It is surprising how slowly "absorption" of the alveoli proceeds in such cases, and patients are not uncommonly most grateful when the dentist treats them with such consideration. In all these cases I have mentioned I have been able, by availing myself of the firm teeth, to carry out important changes in the mouths of patients, *without* loss of expression.

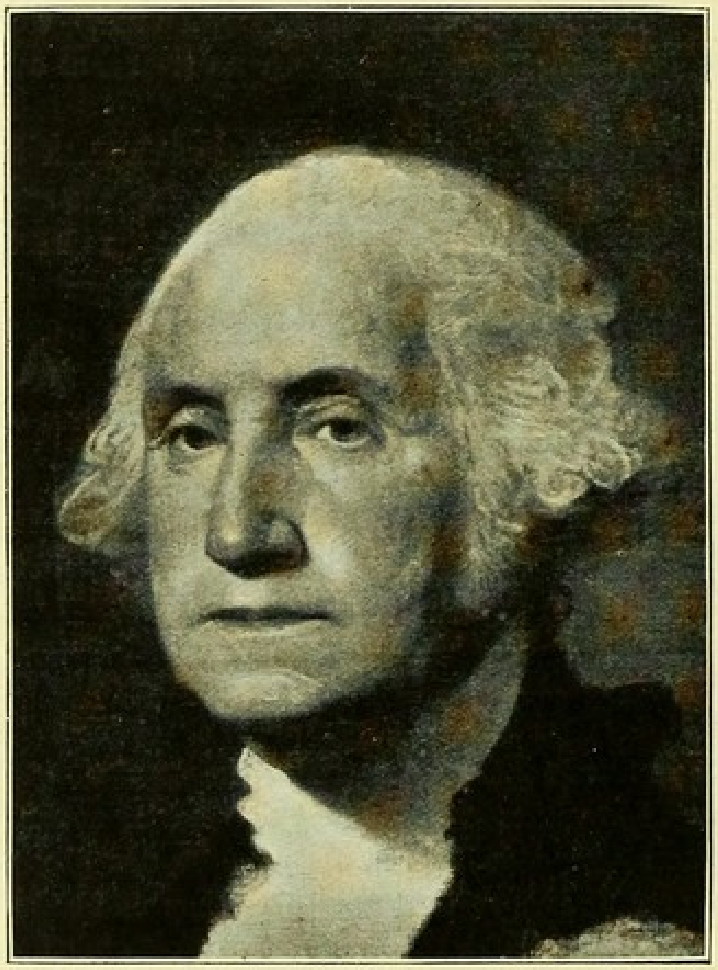
In women especially, it is very sad to see obvious mutilations, the causes of which an experienced eye can easily detect. The denture has been made on the model by a workman who was not an artist, and the superintendence of what ought to be a restoration, not a disfigurement, has been carried out by a practitioner who may or may not take an interest in mechanical dentistry; possibly he may be only an "operator."

Whether for a male or a female patient, the aim of the dentist ought to be the preservation and restoration of feature and expression, not the conventional and workroom ways of looking at such details, and giving them over to those whose nature it is to leave things as they find them. It is, therefore, necessary for a dentist to be able to make up his mind at once how he will treat whatever case may be placed in his hands, regard being paid to the patient's expression, and to the restoration of the functions of speech and mastication. A dentist will learn a good deal by studying picture galleries; he can there see the dignity of edentulous old age from the unsurpassable brush of Rembrandt, or the oral glitter of the Spaniard when depicted by John Philip.

General George Washington's mouth (see Fig. 40), lacking in the firmness and decision natural to his character, as seen in his portrait by Stewart, is an object-lesson in dentistry,—which, alas! teaches us only too well that a conventional dentist, who was tied to his plaster model, was the cause of this disfigurement.

If an artist has to paint constantly from life to reach the highest expression of his art, how much more necessary is it for a dentist to *work from the mouth* and not from the model? In many modern portraits on the walls of the Royal Academy and contemporary exhibitions, it is painful to see how often the inartistic and conventional dentist has been at work in high places — work which with a little insight and study would have left us faces worthy of a painter's brush.

FIG. 40.



GENERAL GEORGE WASHINGTON.

A collection of normal and irregular casts of the teeth and gums in life would be of great value to the artistic dentist, especially if pains were taken to cast accurately the anterior surfaces of the gums and teeth of the maxilla and mandible. Such a collection would show the relations of the teeth to each other, and tend to correct the *set* or mechanical appearance which we too often see in dentures. The colour of the teeth should be accurately noted by one of the standard sets of shades, as well as the age of the patient. Valuable hints could be gathered at a glance from such a collection of well-selected types.

Let us hope that as time goes on the *artistic* aspect of dentistry will be developed, as well as the mechanical and the operative.

CHAPTER V.

IMPRESSION TAKING.

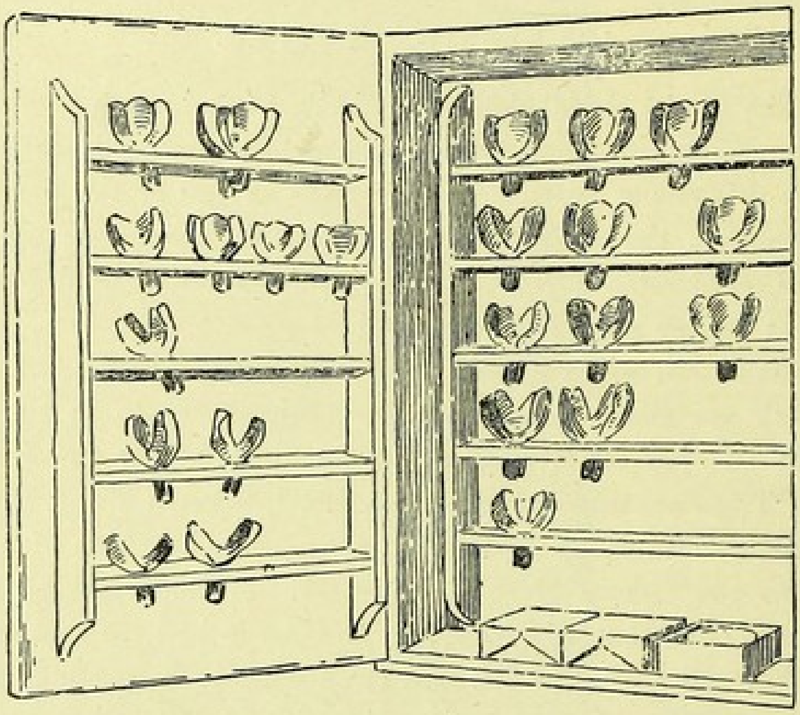
It is the aim of the skilful dentist to obtain as accurate a mould of the jaws as he possibly can, because upon the correctness of the plaster model made from this mould depends, not only the success of the practitioner, but the comfort the patient will experience in the future use of the denture. Considerable difficulties attend this procedure, and it is an art that cannot be too constantly practised.

Impressions are taken of the mouth with the aid of metal cups or trays, which are made of various dimensions, so as to fit the general contour of the jaw while holding in its rigid hollow the impression material. Trays are made of Britannia metal, German silver, and silver, and are stamped in many varieties of form. The selection of a tray or cup requires the exercise of some judgment. It should not be too large nor too small; one that will loosely fit the jaw is best, so that there will be some uniformity of space between the surface to be moulded and that of the tray. Without a properly adjusted tray, a good impression is impossible.

Fig. 41 shows a convenient form of cabinet of my own design, for holding impression trays and impression material.

Having selected a suitable tray, and observed the direction in which the cast will have to be removed from the mouth, the tray is filled with impression material, previously warmed into a plastic condition. Having selected a tray, immerse it in warm water and try it in the mouth, noting in particular in edentulous mandibles that the extreme ends are not so deep that they dig into the soft tissue; and, in cases where isolated teeth stand up high, that the tray is deep enough to reach the gum. It may be necessary in such cases to select a tray with a hole cut in it for the tooth to go through, or even to cut one or more holes in suitable places so that the tray may go deep enough to take a correct impression, and yet not be so full of material as to catch against the cusps of standing teeth, and drag the material out of shape when withdrawn. The tray charged with the plastic material is thinly smeared with vaseline. The tray is chilled with cold water, carefully placed in the mouth, and carried gently but firmly to the position which it is intended to mould. The tray handle should be kept in the centre line of the face and the centre of the jaw.

Fig. 41.



Cabinet designed by the Author for holding Impression Trays and a Supply of Impression Material.

The trays for the Maxilla are arranged on the right-hand side shelves, and those for the Mandible on the left-hand side shelves.

With many patients the tray has to be introduced with great gentleness and care, as the orifice of the mouth is smaller than the diameter of the tray, with which it is necessary to mould the intended surface. Placing one limb of an open horse-shoe shaped tray, for instance, in the mouth, and pushing one cheek gently aside with a mirror handle, till the other part of the tray can be introduced with a rotary motion without straining or pain to the patient, will commonly prove effective.

The charged impression tray being brought on the jaw in the correct position, gentle but firm pressure is used to push it home, until the material embraces all the parts of the gum and teeth required for the object in view. The tray, with its contents, is held in position till the impression has cooled sufficiently to admit of its withdrawal from the mouth, without changing the form of the impression. The method of removal varies somewhat with the nature of the case, and cannot, I fear, be taught by books.

When taking impressions of the maxilla, it is most convenient to patient and practitioner, if the latter stands behind the chair, and brings the palate end of the tray into contact with the maxilla first, raising the handle of the tray till it is brought into the desired position. The chair is used tilted backwards, so that the practitioner can have a full view of, as well as access to, the cavity of the mouth.

When taking an impression of the mandible, the patient is best seated in an erect position, or slightly leaning back, so as not to allow the saliva to flow out of the corners of the mouth. The practitioner stands on the right-hand side and somewhat in front of the patient.

The tray is placed in position with the handle in the middle line of the mouth, and the fingers of each hand maintain the tray and impression firmly in place, while the thumbs of each hand are brought under the mandible, and help to maintain an even pressure till the impression material has time to set, or toughens sufficiently before it is removed from the mouth. As soon as the impression is removed it should be placed in cold water, or, better still, held under a water tap, and the tray should be turned about as the water chills the impression. The cold water not only cools the impression into a condition of stability, but washes away the adhesive mucus that sometimes adheres to an impression, as well as any blood which may ooze from the socket of a freshly extracted root.

The gum often bleeds a little when it has been found necessary to grind or cut down a tooth level with the gum.

If blood is left in an impression, the plaster is spoiled where it comes in contact with the blood, and thorough washing of an impression is a useful routine to follow. A soft camel-hair pencil and water are best adapted for the thorough removal of blood.

In my youth, bees-wax was the material in common use for impressions, and on its preparation for this purpose I have spent many hours. I suppose very few now use bees-wax for impressions,—and yet, when its qualities are well understood, splendid moulds, showing all the lines or rugæ on a well-developed palate, can be made with it. It is usually kept ready for use in the form of cakes, but broken into small pieces and placed in warm water about as warm as the hand can comfortably bear, till the entire mass is softened. The wax is carefully squeezed in the fingers till it is of a uniform plasticity. It is then folded, without delay, into a bar or roll, suited to fill the tray.

Just before the tray, with its contents, is placed in the mouth, the smooth surface of the wax is placed for an instant in cold water to toughen it. Chilling the wax in this way gives a sharper impression than if it were placed on the surface to be moulded, as it came from the warm water. It takes skill and a long experience to make satisfactory impressions with bees-wax. The temperature of the mouth helps the softened wax to retain its heat, and unless the impression is chilled with cold water, and most carefully removed from the mouth, undercuts are apt to drag, *i.e.*, get pulled out of shape where the contour of surfaces, such as at the necks of teeth, are of the greatest importance. Although it has gone out of fashion amongst those who do not know how to use it, I look back upon bees-wax with great respect, as I did satisfactory work with its aid for many years.

Nowadays impression composition is mostly used in dentistry, partly owing to the great improvements made in the modern formulæ for its preparation, and to the dense hardness it assumes when chilled, on which account it may be moved about freely without much risk of injury.

I have tried most of the preparations of this material in the market, and the one I prefer is "Crown Composition," the formula of which was first suggested by Mr. Harding, of Shrewsbury, and much improved by Mr. King, of Newark-on-Trent, a few years ago.* It is greyish-yellow in colour, and put up in boxes of half a pound in the form of cakes, which are moulded in a die of an ornate character. It is not *delicately perfumed*, I am glad to say, for the hair-dresser smell of the usual impression composition is felt by most patients to be highly disagreeable.

I should like this admirable preparation still better if it was put up for sale in the form of strips one inch wide, two-eighths of an inch thick, and four inches long. The thick cake no doubt contains enough, or nearly enough, or more than enough, for two ordinary impressions. It is overlooked by the manufacturers, however, that even when the thick cake is

* The formula of "Crown Composition" is as follows:—

Stearine . .	two parts.	Gum Kowrie . .	four parts.
Olive Oil	one part.	French Chalk . .	eight parts.

broken into fragments, it takes *time* to temper uniformly the mass to an agreeable state of plasticity. I know, from experiment, that this material put up in the form of strips enables the practitioner to estimate more easily how much he will have to prepare for a given size of tray,—and that strips are more easily and uniformly softened than the thicker fragments obtained from the round cakes.

Crown Composition, when properly warmed and placed in the tray, should have the free surface smoothed by the finger, with the aid of a slight touch of soap or vaseline. When it is placed in the mouth, it should be held firmly in position, and chilled with cold water applied on a napkin, or poured from a vessel with a long spout, or by means of a jet of cold water taken from the house main, the patient's head during the process being held over a hand-basin to receive the waste water. Some dentists recommend the patients to keep opening and closing the jaws when an impression is being taken, in order to accentuate on the model the size and direction of the muscular attachments of the cheeks.

The toughness of Crown Composition when warmed is an advantage in most cases, as the elasticity of the gum is reduced, and the palate surface of the cast is brought more into the condition of compression which it is likely to assume under a denture. I have been using this material for some years, and I have been able to undertake difficult cases with the greatest confidence with its aid.

It has also another great recommendation, in that fusible metal can be poured into it without injury, if the precaution be taken to keep the layer of metal thin. If this is neglected, the metal is apt to crystallize in the thicker parts, and to give an inaccurate cast of the mould. I look upon Crown Composition as the best preparation of the kind which I have ever used.

Plaster of Paris is also employed for taking impressions, and if used with judgment, in suitable cases, it enables the practitioner to obtain splendid moulds of edentulous mouths, especially in cases where the gum has become soft and loose. It requires some skill to use it deftly and neatly, without putting the patient to inconvenience. The great point in using plaster with success is to place in the tray only sufficient to flow evenly over the surface to be modelled, and permit it to set of a uniform thickness.

The best way to use plaster for impressions, if the case should present any difficulty, is to take an ordinary impression first and cast it in plaster.

When the model is drawn, by its aid a better fit can be made of the metal tray, with the help of pliers or punches. On the edge or rim of the tray a border of wax should be attached by heat, so that a tolerably uniform space will be found between the tray and the alveolar surface to be moulded. I am in the habit of measuring the amount of water the tray will hold, and I pour double this quantity of warm water into a tea cup or small rubber cup previously warmed. To this water I add the plaster of Paris, gently stir it into a thick cream, and avoid the entanglement of air bubbles in the plaster. A stock solution of three teaspoonfuls of powdered sulphate of potash, dissolved in one pint of water, will be found useful. A measure of the solution, added to an equal measure of hot water, should be mixed with the plaster of Paris before the latter is placed in the mouth. The impression sets more quickly, shrinkage is said to be prevented, and much greater hardness obtained. A few sharp taps of the cup on the table drive the air bubbles to the surface. The plaster is placed in the tray, and the tray with its plaster contents is then smartly placed in the mouth in the position intended. Care must be taken not to imprison air between the surfaces of the gum and the plaster. The patient seated in the chair should be protected against the accidental dropping of plaster, by the aid of a towel or some waterproof cloth. A judicious shake of the tray as it is carried into position will often avoid this. The tray is carried into its position and held there till the plaster sets.

In taking impressions with plaster the head of the patient should be inclined *forwards*; indeed, it is often necessary to hold it over a bowl to allow the saliva to run away freely. The object of the forward position of the head is to avoid the risk of the liquid plaster dropping into the patient's trachea, as well as to get the plaster to flow over the contour part of the jaw where the denture has to be worn. In cases where teeth remain in the mouth, and in cases of undercuts of the alveoli, or of spaces between the teeth, it is not advisable to wait till the plaster has set hard before removing it from the mouth. The condition of the plaster can be readily tested by fracturing, between the fingers, some of the pieces left in the cup, from time to time, till a clean, sharp, crisp fracture is obtained. At this stage, such a cast can be removed with comparative ease; whereas, if the practitioner waits some time longer, the increased density of the plaster renders removal most difficult. It is best, when taking plaster impressions, to supply the patient with a hand basin to hold, in which the plaster impression is placed on its removal from the mouth. If undercuts should fracture from the tray and remain in the mouth, either *in situ* or dropped on the tongue, they can be gently seized with a dressing forceps and placed on the broken part of the impression, or near the region they belong to on the bottom of the bowl.

Warm water and a pinch or two of table salt, and also sulphate of potash in solution, are used by dentists to increase the rapidity of the chemical action in setting, or to harden the plaster impression. If plaster is of good quality and tolerably fresh, warm water is quite sufficient to hasten the setting within a manageable time. When the plaster has sufficiently set, it is well to draw the soft parts of the cheeks and lips away from the plaster, and direct the patient, while you hold the handle of the tray, to bring the lips together, and, at the same time, to make an effort to blow. This elevates the soft palate and allows air to pass between the hard palate and the plaster. The plaster impression can then be removed in many cases without fracturing the edges.

Many books recommend that an impression of the mouth should be taken in wax or gutta-percha, and that this impression should then be carved away sufficiently to hold the plaster when the tray and its contents are placed in position in the mouth. In my experience the naked tray is preferable, as it can be used at once without the delay of carving a wax impression, and, should the plaster impression fracture, the broken parts are larger, and therefore more easily replaced in position in the rigid tray. When plaster is used in a carved wax or gutta-percha impression, the cast will, in parts, be found as thin as a card, and it is difficult, if not impossible, to replace any broken pieces in a flexible support if they are very thin.

Impression-taking in plaster needs practice and study, careful examination of the surface to be cast, and also a knowledge of the most favourable direction in which to dislodge the tray and its contents from the alveolar surface. When taking a plaster impression, we are mostly concerned to get an accurate one of the surface on which the denture is to be worn. It does not matter, therefore, if the labial border of some is not very complete, as it is usually on only a small part of this surface that the denture can rest. One great advantage in plaster impressions is the graphic way in which it shows the muscular attachments of the cheeks where they join with the gum, in cases where much absorption has taken place. In upper cases these muscular attachments frequently cause great difficulty in the use of suction plates, if they are not remembered, and if provision be not made in the labial borders of the denture for their action. If the muscular attachments are very well marked, it is recommended to request the patient to open and close the mouth frequently while the plaster is setting, as by doing this the space needed by the muscles when in action is recorded in the form of grooves in the plaster. Plates made on models when this precaution is taken with the impression are said to prove more accurate in fit and more comfortable in wear than when the impression is taken in the usual way. The surface of the mandible, when much absorption has taken place, requires to be thoroughly studied, and all indications of muscular movement recorded, at least as far as high-water mark. The factors of success in plaster impression-taking are, (1) a suitable tray, and (2) the use of plaster of a proper consistency; if the plaster is too thin, it takes longer to set, and does not readily harden; the prolonged retention of an impression tray in the mouth causes great discomfort to many patients. It is well, therefore, to bear in mind the two points I have mentioned. Where the impression has of necessity to be fractured, a little hand-basin held by the patient under the chin will prove a convenience.

In the event of the plaster impression not coming away with the tray, but remaining firmly fixed in the mouth, an accident which sometimes happens with the very best manipulators, recourse should be had to some judicious cuts with a knife, so as to make sections of the buccal surface, which can be replaced in a tray. The central or palate portion can be deftly prised out and placed in the tray. Sometimes it is desirable to introduce a piece of stout string in the tray when the plaster is soft, so as to assist in dislodging the impression by affording a flexible handle to the operator in a position in which it is difficult to place one after the tray has left the plaster in the mouth. Some practitioners make a careful study of overhanging teeth beforehand, and then place ridges of wax in the tray in such positions that the plaster will be held in the mouth when the tray is removed.

With a chisel and hammer, or light mallet, the plaster can be fractured and prised off the surface of the palate and the teeth, the parts being replaced in the tray. Spaces between teeth, which the dentist does not intend to make use of, can be filled up with wax, cotton, or cotton and plaster, so as not to leave too strong an anchorage for the plaster impression. If many teeth remain in position in the mouth, and it is considered desirable to obtain a plaster impression of the palatal or lingual surface of the teeth, it can be secured by modelling a strip of wax to the labial and buccal surfaces. Its position in the mouth secured, it can be invested with plaster, placed in a tray and pressed home.

The plaster of Paris is allowed to set, and removed from the mouth without disturbing the wax; the latter can be chilled with cold water, and placed in its position in the tray. The plaster impression is then taken into the workroom, and the fragments are put together. Others wait till the plaster is hard, as they consider the difficulty of bringing the broken surfaces together is much lessened, and the chance of injury to the delicate parts that have to be placed in position is greatly reduced. A little practice will enable the dentist to place them rapidly in position on the impression in the tray. Having found the true position of a fragment, if it does not interfere with the replacement of any other fragment, it can be cemented in its position, with the help of a little shellac made thin in spirits of wine.

Wax or varnish, warmed over a bunsen burner and dropped from the end of a spatula, between the mould and the fractured parts, will bring the plaster impression into a good condition for casting. When all parts of the mould, that are necessary for the uses of the dentist, are set in position, the whole of the model can then be varnished with shellac varnish. When this has set hard, the varnished surface can be oiled or coated with a weak solution of soap. The impression can now be cast with plaster of a suitable consistence. It is recommended to varnish the impression twice with shellac varnish, and to lay a thin rim of wax along the upper edge of the impression. The impression is soaked in soap solution, and just before pouring in the plaster of Paris the soap is washed off by holding the tray under a tap. When the model is well set, the impression can be held in scalding water for a few minutes. The wax is melted away, leaving a space in it, and the hot water enters, and if a couple of notches are made in the labial portion of the impression, the mould can generally be separated from the model in four pieces. These cores can be replaced in the impression-tray without injury, and several models made if necessary.

It is well, having cast the plaster of Paris into a badly fractured mould, not to invert the cast, but to pile or build on it as much plaster as the model will need in depth. In some casts, if the impression is inverted, movement will take place, and if any of the fragments should float out of position, or become dislodged, an inaccurate model will result. These casts should be left several hours to set—if possible, all night—before separating them from the mould.

Many practitioners colour the impression-plaster before it is used in the mouth, so that when the waste mould is picked off the plaster cast, there need not be any doubt as to which is the model and which is the waste mould. Others colour the model-plaster, but there is no doubt as to the necessity of one or the other being coloured. In many forms of edentulous maxilla or mandible, several models can be made from the same impression, with a little care, as the surfaces readily part, with the help of gentle tapping, or pushing with the handle of a tool, lifting off in the tray, or even with the aid of the fingers. (For illustrations of Impression Trays, see Appendix.)

CHAPTER VI.

PLASTER MODELS.

Models are cast in impressions taken of the mouth, and made with a fine white powder, the product of roasted gypsum, ground in a mill and sold as plaster of Paris. Gypsum is found in many places in the United Kingdom as well as in France, the capital of which has given its name to this mineral product.

The best English plaster comes from Nottinghamshire, and the mines and plasters manufactured by the Newark-on-Trent Plaster Company are known all over the kingdom. This powder is placed on the market in three qualities—coarse, Italian fine, and superfine.

For most dental workroom purposes Italian fine answers admirably, not only for casting models, but also for use in vulcanite flasks. It is to be purchased by the ton, by the cwt., or by the bag—the last form of package weighing from seven to fourteen pounds.

Good plaster of Paris has the property of combining with a certain quantity of water, when it is rapidly mixed together, and of setting into a hard mass. It should be sprinkled into a bowl with sufficient water to make a mixture which will be thick and creamy in appearance, yet sufficiently liquid to pour into a mould. This liquid solidifies in from four to five minutes—rapidity of setting being dependent on the freshness of the plaster.

Plaster of Paris left exposed to the air absorbs sufficient moisture to retard the ordinary setting of plaster and water, which should set quickly into a hard, dense mass. It, therefore, should be kept from unnecessary exposure to the air, and as dry as possible. It is usually mixed in bowls of earthenware or of flexible rubber; the latter are now very commonly used because they are not broken by falls. By squeezing the sides of the flexible bowl together, plaster that has been allowed to set in it can be rapidly crushed out without scraping. Being able to fold the flexible bowl at any part of its circumference, and thus form a spout with which to pour wet plaster in any desired direction, is an advantage.

When mixing plaster, it is best to estimate how much will be wanted, and then to pour sufficient water in the bottom of the bowl to make a creamy fluid with the added plaster. Plaster is best mixed by sprinkling it into the water a little at a time, so that the air contained in the dry plaster will not be carried to the bottom of the bowl, and cause air-holes or hollows in the details of the model when it is set. The plaster having been sprinkled into the water in sufficient quantity for the purpose for which it is wanted, the surplus water is gently drained away, and the creamy or pasty mass is rapidly stirred with a spatula or other blunt knife-like tool, till the mixture becomes uniformly plastic. The plaster is then cast into the mould prepared for it, which is sharply shaken or tapped during the process of pouring, in order to expel any bubbles or cells of air that may have become imprisoned in the crevices of the model.

When impressions are taken of the mouth in wax, wax and gutta-percha, Godiva, Stent, or, best of all, in Crown Composition (first recommended by Mr. Harding, of Shrewsbury), they should, as already directed, be thoroughly washed in cold water, so as to remove any mucus or blood that may possibly adhere to the surface of the impression, which would spoil the surface of the plaster when it is cast into the irregularities and allowed to set. The impression having been wetted, a little plaster is taken up on the end of the spatula from the bowl, and gently dropped into the hollows formed by the patient's teeth. As the plaster is dropped into the impression with the knife or spatula held in the right hand, the left hand holding the tray by the handle is rapidly tapped on the bench or the edge of the bowl, so as to expel the air and water as well as to shake the heavier plaster into the bottoms of these hollows. This shaking or tapping is continued till there is a cast of plaster about half an inch thick over the impression in the tray. The tray with the plaster is then laid on one side, and the rest of the plaster is taken from the bowl and piled on the bench in a round mass. The plaster in the impression is quickly and dexterously inverted on the plaster on the bench, and with rapid strokes of the knife the upper and lower surfaces of the two masses of plaster are united and allowed to set. A margin of plaster is commonly left outside the edge of the impression tray, which slants from the impression outwards to the bench. The cast is left undisturbed to set for some time, till the heat is felt which is evolved by the chemical action developed by the combination of the water and plaster.

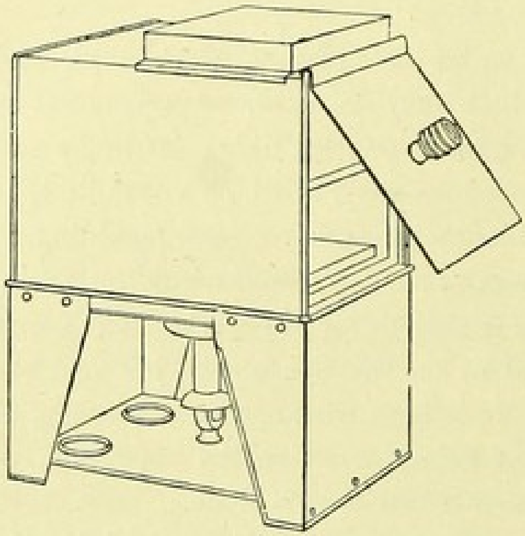
Some workmen prefer to test the condition of the plaster by breaking some of the surplus bits which are on the bench. If the plaster fractures in a crisp way and with some resistance, it is sufficiently set for drawing the model, *i.e.*, for removing the impression from it.

The vertical depth of models varies in different workrooms, and according to the class of work for which they are used. Apart, however, from the question of use, some men have a positive liking for bulky and clumsy models. Plaster models intended for cases in which vulcanite is to be used do not need to be so deep as models intended for sand-moulding, as it is commonly practised. If the practitioner uses sand-moulding flasks, a shallow model of one inch in depth is enough for any work. The depth of the model is more or less dependent on the size of the jaw and the depth of the palate, in upper cases. It is best, whenever it is possible, to leave the plaster to set for some hours before removing the impression, as it certainly becomes harder and denser when this is done.

In order to save the building-up of plaster models required for the usual method of casting metal dies, some dentists recommend wrapping the impression in a rough cone-shaped wall of brown paper, sheet-tin, band-box chip, cardboard, or sheet gutta-percha, to hold the plaster up while it sets. To make this kind of mould takes time, and any one accustomed to rapid work would have a model cast, trimmed, and placed in the hot-water oven before the plaster in a deep mould was set. A well-trained workman knows the earliest moment a plaster model can be "drawn" from the impression, by placing his hand on the plaster and feeling the temperature of the model. Models are "drawn" or uncovered by immersing them in water, warm enough to soften the impression material, whatever it may be made of. As soon as the impression material is plastic, the impression tray is gently removed from the model, great care being taken to draw off the tray in the direction least likely to fracture the teeth. Some dentists "knock off" impression trays while the impression material is cold.

Wires, in the form of pins, are usually placed in the cavities formed in the impression by the patient's teeth, in order to stiffen the plaster teeth should they prove to be slender or isolated. If common brass pins are used, the sharp-pointed end is pushed into the impression, or the head is warmed and thrust into the most central part of the tooth cavity in the impression. The latter method enables a workman, by partly sawing through the plaster round a pin, to break a tooth off the plaster model, upon which it can be replaced. After the plaster model has been carefully "drawn" from the impression, without fracturing the teeth, it is carefully trimmed with a sharp knife to a suitable shape. If it is intended for metal work, it is pared into a conical form, to give it a broad, steady base, and to admit of its withdrawal from the sand.

Fig. 42.



Fletcher's Drying Oven with Water Jacket.

A suitable shape having been given to the model with quick cuts of the knife, the surface is carefully smoothed by repeated strokes of the knife, and by taking off less and less plaster each turn. The prepared model is now placed in the drying oven with water jacket (Fig. 42), or near a stove or fire, and subjected to a heat not exceeding 212° Fahrenheit. If it is subjected to this temperature for too long a time, it becomes overheated, porous, and brittle, or what workmen term "chalky" or "rotten."

Excessive haste in "drying" often destroys or seriously deteriorates plaster models. Many workmen dry them in front of a fire, by turning them from time to time, and taking the greatest care *not* to expose the surface of the palate to excessive heat, as this surface is the one on which the success of all the future manipulations depends, whether it be for metal or vulcanite work.

Models which are to be cast in sand are the better for having the surface hardened in some way. The old-fashioned way was to "dip" the model in melted bees-wax while it was hot, after a spike had been driven into the bottom of it, by which it was held during its immersion in the melted wax. Another way was to use a wire dipper on which the model rested while in the wax, and by which it could be removed without being touched by the fingers. The model was then held in front of the fire till the excess wax had dried in or run down the sides, so that the working surface was evenly coated.

Instead of using bees-wax, some dentists prefer to harden the surface of plaster models with a coating of spirit varnish, paraffin wax, or shellac varnish. Resin, dissolved in spirit, is also often painted on the surface for this purpose. Others dip the models in a solution of alum. A solution of borax is also highly recommended for hardening plaster. It is, however, subject to efflorescence, if the models are not kept in a very dry place.

Powdered sulphate of potash, popularly known as alum, is used to mix with the plaster before it is cast, in the proportion of two teaspoonfuls to a pint of water, in order to increase the rapidity of the setting. It is also employed to harden the plaster when taking plaster impressions of the mouth, and its presence materially reduces the shrinkage of the plaster while setting.

The object of all the above-mentioned protective casings is not only to toughen the surface against accidental abrasion, but also to produce an extremely smooth surface, which will readily part from the sand when the models are used in sand moulding.

A model thus carefully prepared should be critically examined by the dentist who made the impression, and, if possible, compared with the mouth, and any imperfections carefully removed. Should there be a doubt as to the excellence of the model, it will save much future trouble if a fresh impression be taken, and a new model made which should be free from the defects of the rejected one. The defective model should be *destroyed.*

When the plaster model has been finished for work, the dentist who has charge of the patient should give very definite directions as to the shape of the plate, the thickness of the metal or wax to be used in modelling, and the number and position of the fastenings to be used, in order to retain it in place. A satisfactory way of doing this is to draw neat pencil lines on the model, showing the extent of the plate, where the bands are to go, and also to draw their size on the plaster teeth.

The mineral teeth intended for use should then be selected and handed to the workman, precise directions should be given as to the position and other details involved in the processes of "fitting," and the work at every stage of its progress should be carefully tested by reference to the bite.

CHAPTER VII.

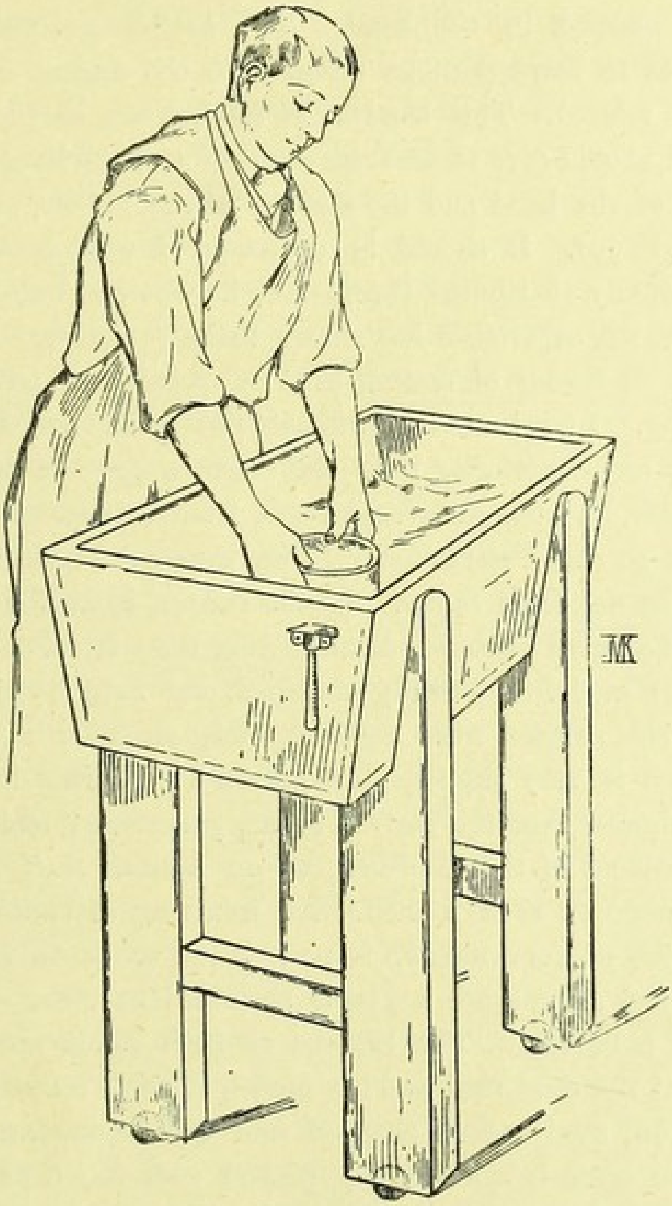
SAND-MOULDING AND METAL DIES.

METAL dies of some kind or other are needed for shaping flat sheets of metal into a form that will fit the alveolar ridges of the mouth as "plates." The common practice of making such dies is by moulding or casting in sand, such as is used by metal-founders, the plaster model of the jaw for which the plate is to be made. The sand commonly sold in bags has too much loam in it, and is troublesome to temper with water, as well as to keep free from lumps or cakes after the action of heat. The sand should be carefully selected beforehand. There is no subject connected with the workroom on which greater variety or conflict of opinion exists than on the qualities of casting sand. Mansfield sand, which is of a red colour, is very much liked in England by experienced workmen. The sand which I have used for many years I obtain in the neighbourhood of Belfast, and, although other workers do not like it, in my hands it has been of great value in making dies. This sand is of a red colour.

The use of sand in the workroom necessitates the use of some kind of box for holding it while moulding the model. Opinion is much at variance as to the requirements and dimensions of a sand-moulding box. The best style of sand-box, which I have experience of, is one shaped like a trough, and mounted on legs shod with strong casters (Fig. 43). Such a sand-box can be easily wheeled from its position under the vulcanizer bench, or other convenient place, into the middle of the floor, where the full light of the window falls. When the sand-moulding is completed, the sand in the box is collected together and brushed into a heap at one end, the lid is placed over all to keep out dust, and the box is wheeled back to its usual place. Its dimensions are as follows:—Thirty-six inches long, eighteen inches broad, eleven inches deep, with the ends made upright, and the sides sloping. The bottom is made of hard wood.

This box or trough is of ample dimensions for the sand to be worked without tossing it over the floor. The dry sand should first of all be carefully sifted through a wire sieve, so that lumps, particles

Fig. 43.



Sand-Moulding Trough.

of zinc from previous castings, or foreign matter of any kind may be removed from it. The sand should then be evenly spread over the surface of the floor of the sand-box, and moistened with water poured through a fine rose. New sand is not so easily manipulated as sand that has been for some time in use, but it can be improved by the addition of some sour beer as a tempering agent. It is best to make good the waste and keep up the proper working quality by frequent additions of such small quantities of new sand as may be required. The sand should be so moistened as to bind together without falling asunder when firmly grasped in the hand. The sample grasped should not be so damp as to leave particles clinging to the fingers or palm when the grasp is relaxed. This handful of sand, when in good order and well-tempered, should give an accurate impression of the lines and wrinkles on the palm of the hand and the surfaces of the fingers, and thus show how it was grasped. It should be so tempered with moisture that it will contain, evenly distributed throughout its whole volume, the amount of moisture which experience has shown to be sufficient.

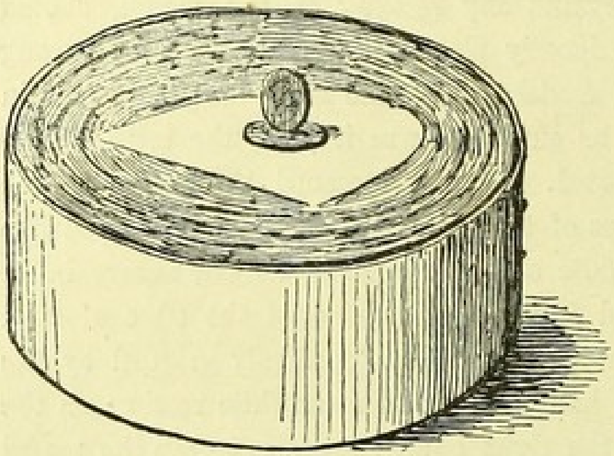
I am not in favour of casting sand tempered with oil or glycerine for zinc casting. I tried some experiments many years ago, but the result did not show any superiority over the common practice of moistening with clean water, and the unsavoury smell, from contact with the heated metal, was not an added attraction. In use the sand tempered in this way appeared to be decidedly messy. As the dentist is usually his own die maker, I will now give a detailed description of the method of making dies.

The plaster model is carefully examined, and French chalk is gently rubbed over the surface with a hare's foot, or other suitable brush, till the surface is very slippery and polished. A little loose chalk is then gently dusted over the surface of the plaster cast, and the latter is set on the bottom of the sand-box, or on a small shelf if the sand-moulding is done on such a shelf. An iron ring of suitable diameter, having a depth of four inches, is now placed so as to surround the plaster cast, and some sand is gently sprinkled over the cast with the fingers till it is covered. . The thumbs of both hands are then thrust firmly between the sand ring and the model, so as to centre the latter in the ring. More sand is then dropped into the depressions left by the thumbs. The sand is again firmly packed with the thumbs in fresh places, and the ring is quickly filled up to the top. The sand is now heaped on, and pushed down into the ring and condensed with a moulder's mallet, such as is used in working sand. When scraped level with the top of the iron ring, the sand will be found very firm, and equally hard all round, if the work has been properly done. The sand ring is then turned up, so as to expose the back of the model. The loose sand adhering to the model is blown away by a quick puff of air from the mouth of the workman, and the flat surface or back of the model is gently tapped with quickly repeated taps of a short-handled hammer.

It is well to follow the action of the hammer, with the fore and middle fingers of the left hand gently placed on the surface of the model. This action of the fingers prevents any rocking of the model, should the sand be found to be too loosely placed in the sand ring. Strong hammering on some forms of models alters the shape of the palate in the mould, and possibly also its surface where it joins the teeth, if the foregoing precaution is neglected. Having loosened the model in the sand by light and judicious taps of the hammer, a steel point, shaped like a spike, is tapped into the middle of the model, and made secure in it. Then a little water is squeezed from a sponge around the edge of sand nearest the model. The spike or "sand point" is firmly grasped by the fingers and thumb of the left hand, the wrist meanwhile resting on the edge of the sand ring, and, as the right hand continues to tap the model with the hammer, the left hand slowly and steadily lifts it out of the sand mould. The model, with any sand that may be sticking to it, is then quickly laid aside, the sand ring is taken up by both hands, and the mould is exposed to the best light. A careful examination is made of the surface of the sand at the bottom of the mould, and any particles of loose sand which may have fallen in from the edge are blown out of the impressions of the teeth by sudden and energetic puffs of air from the mouth of the workman. This is or should be so deftly done that only the loose particles are blown out. The eyes of the workman are best closed during the delivery of these puffs of air, else the sand will be blown into them as it comes out of the mould. The mould is then examined most carefully, and if necessary compared with the plaster model.

Another method of removing the plaster model from the sand is, first to bevel away the sand surrounding it with a small knife to the depth of about a quarter of an inch, then to turn the ring upside down again and support it by its lower edge on the tips of the fingers of the left hand. While thus held, the lower portion of the ring is gently tapped all round, with the hammer, till the model drops out into the palm of the hand. If the ring be too large to be so handled, the workman should bend over the sand-box, hold the ring with the left hand against his body, and tap it all round the lower margin till the model drops out on to a bed of sand prepared to receive it. When the model has cleared, the ring should be turned up, set on the sand table, and the bevelled edge of the mould should be gently pressed all round so as to make it smooth and to free it from all loose particles of sand that might fall into the mould, and thus spoil what would otherwise have been a good mould.

Fig. 44.



Mr. Lennox's Model Lifter.

Mr. R. P. Lennox has lately designed a most simple and effective appliance for removing the model, which is illustrated in Fig. 44.

He thus describes it on page 26 of his work on *Some Methods and Appliances in Operative and Mechanical Dentistry*: "There is a hint, which it may be worth while to add, on the method of removing the model from the sand when about to cast a zinc. The common method of driving a sharp point into the model, especially when the model is thin or over-dried, is a troublesome and sometimes risky operation, often attended by failure. If by another method small portions of the sand are removed so that the model may be lightly grasped, the zinc comes out with some unwelcome additions, however small. A better plan than either of these is to let fall a drop of wax upon the centre of the back of the model when embedded in the sand, or earlier if a Pearsall flask be used, and to press down upon the wax a heated metal disc, say a farthing, furnished with a handle, which may be a second farthing standing edgewise on the first and soldered to its centre. By this handle the model can be lifted without the least risk of its falling back; and a very little heat applied to the disc suffices for its removal from the model as well as for its attachment to it."

There should never be any doubt as to the excellence of a sand mould. If the mould is not good, the sand should be knocked out of the ring and placed in a corner of the sand-box, to be used again in making up the body of sand after the model has been covered. Better casts can be obtained by the use of freshly-worked but unused sand, than from sand which has been compressed by previous packing. It is important not to *delay* the plaster cast in the moist sand, as the damping of plaster from contact with such sand makes the clean delivery of a dental cast difficult. When adhesion of portions or lines of sand has taken place on the rugæ of a highly-developed palate, or at the necks of the teeth, they are lifted out of the mould with the model, and leave the mould imperfect in places of vital importance to the dentist. In cases of undercuts the sand will not "deliver," and the portion lying under an overhanging tooth or the alveolar border is pulled out of the mould. In cases where teeth are long, and in places where natural teeth have been lost, dove-tail spaces are often to be seen, which are a difficulty in themselves.

The method of partly sawing through and then breaking off a plaster tooth from the model, referred to on page 66, now comes in useful. If this is resorted to, the saw-cut should, if possible, be made from the outside or labial aspect of the tooth, about an eighth of an inch above the level of the gum, and the saw should be run into the pin which supports the tooth. When the fracture is made, the slight pressure required to break off the tooth should be made towards the saw-cut, so that the junction of the lingual portion of the tooth will be sharp and the form of the tooth unimpaired, when the two portions are put together again. The tooth should be removed after the fracture has been made, and the pin left standing in position on the model. A piece of soft wax should then be placed round the pin, large enough to cover the whole of the newly-exposed surface, but tapering up to the top of the pin. There is thus provided an inter-space wider at the top than at the base, which the sand will easily clear. For the surface of the metal die to be perfect, the moulding of such models needs patience and skill, if time is not to be expended in making cores to part from the model and yet remain in the mould.

Loose portions of sand pulled out of the mould, when the overhang is considerable, can sometimes be shaken back again with the aid of a slender rod of wood. A loose part having been replaced, can be made to re-unite to the rest by letting a drop of water from the wooden rod touch the sand at the site of fracture. As the water enters the sand it pulls the loose bit securely into position by capillary attraction. This manœuvre is a very useful one to know and practise when sand-moulding with the ordinary form of plaster model. Too much water should not be permitted to run on the fractured surface from the slender rod, else the loose part will be washed out of shape and the mould made valueless for casting purposes. Clumsy workmen remove the plaster cast by digging the thumb and fingers into the sand and grasping the back of the model, which is then rocked and pulled out; this should never be done if good dies are to be cast.

Many workmen hold the sand-ring in the left hand without inverting it, the model remaining back downwards just as where it was packed in the sand. When held in this way, gentle taps with the hammer on the edge of the ring, or on the plaster model itself, will cause it to drop out on the sand in the bottom of the sand-box. This manœuvre is quite an easy one to execute with edentulous models; a skilful sand-moulder can even throw them out of the sand-ring without tapping it, by a quick jerk given to the ring while held with both hands.

In the case of models having standing teeth with spaces between them, this method is not always successful, for part of the wall of sand will sometimes come out with the model, and the moulding has to be done *de novo*. These difficulties in ordinary sand-moulding, which are not trivial, can be overcome by practice. A slight alteration in the *position* of a model, made by placing it slant-wise on a handful of sand, so as to make it more easily "deliver," then investing it with the sand-ring, filling up with sand, and packing it, firmly or loosely as previous experience may dictate, will often make its withdrawal easy.

Firm or loose packing of the sand requires some judgment. Models which do not easily "deliver" when firmly packed with sand, will often come out of the mould quite readily if the sand is *not* packed too densely. Much practice is necessary in packing, to be able at will to make a good die in difficult cases. The difficulties described are increased by the size and height of the ordinary plaster model, which, as a rule, is from two and a half to three and a half inches from the foot to the cutting edge of the teeth. It must be obvious that it is not easy to conduct the passage of such a thickness of plaster out of the sand, and yet leave behind a good mould in which to pour the melted metal. The constant repetition of these difficulties has set several minds searching for a better plan, and has resulted in what are known as sand-moulding flasks, which I shall now briefly describe.

The ordinary die when "dipped" in lead presents a surface to the hammer, which is indeed broad and spacious, but sometimes set at such an angle that it is difficult to strike an effective or solid blow on it. In the case of metal dies intended for stamping lower plates, this form of cast is very weak in situations where it ought to be strong, and the consequence is that, under the heavy and repeated hammering required in the construction of lower plates *doubled* in thickness, it is not an uncommon experience to find that the die has cracked, with the unfortunate result that the plate will no longer fit the plaster model. Cracking a die in making lower plates is not at all infrequent ; it may also occur in making upper plates, even in the hands of experienced

Fig. 45.

The Bailey Sand-Moulding Flask.

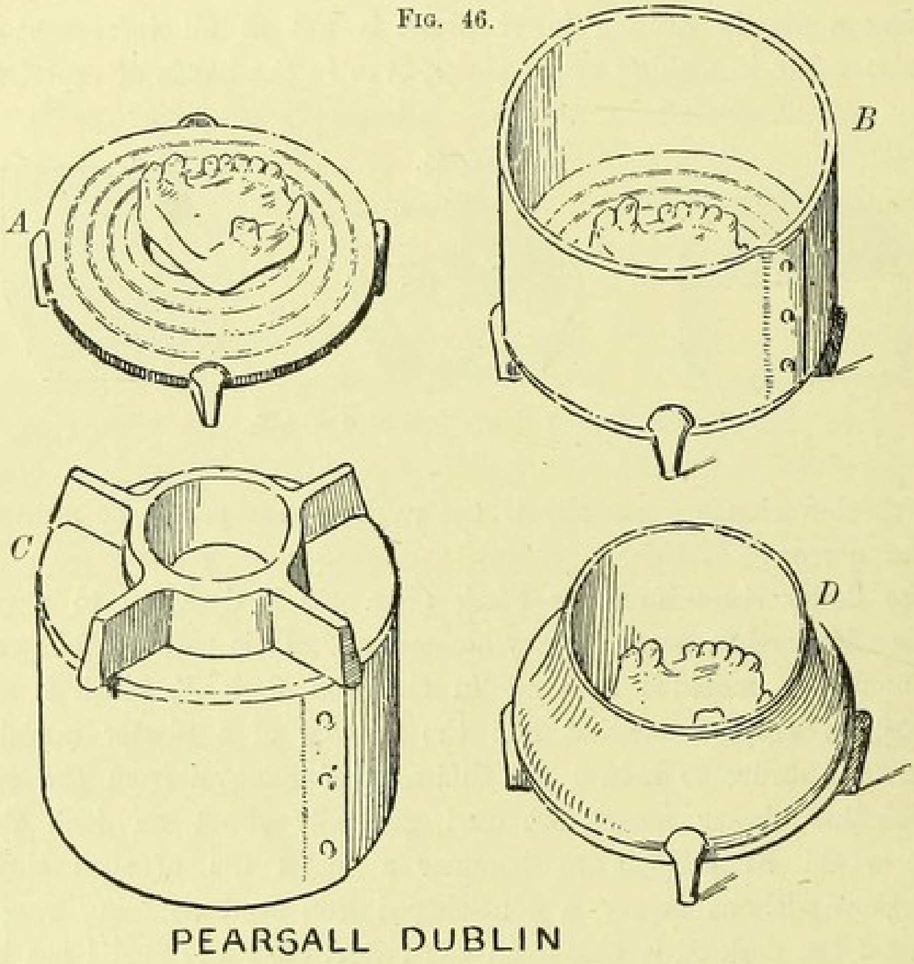
and skilful workmen, especially if the vault of the palate be unusually deep or narrow.

The Bailey Sand-Moulding Flask (Fig. 45) is designed to prevent cracking by careless or too heavy hammering. It is used as follows :—The model is moulded in sand in the iron flask *F*, which is semi-elliptical in shape, somewhat like the bottom of a plaster model in outline. In order to reduce the difficulty of removal from the sand, only shallow plaster models are used, generally about an inch deep. As it would be difficult to hammer a metal die of such shallow proportions without injury, a cone-shaped iron sand-moulding ring *R*, which fits the flask *F*, is placed on the latter, after the model has been removed from the sand, and the melted metal is poured into this greatly enlarged mould.

It is easy to see from the design of this flask that the conditions of the ordinary die are reversed ; the palatal surface appears as if it had been sawn off its support, placed on the broader surface for support, and the narrow end of the truncated cone had been left as the surface on which to strike the die into the lead counter. The use of this flask certainly places at the service of the dentist a die that cannot be "cracked" by any hammering which it is likely to get in a dental workroom. It has, to my mind, one great objection, viz., the base of the truncated cone overhangs the die so much that it is difficult to know whether the plate under the die in the lead counter is in its right place.

I suppose it is possible to get used to anything, but the great weight and clumsiness of this die detracts from its merits, so far as mere strength is concerned. I had been in search of a good method of making dies

FIG. 46.



THE AUTHOR'S SAND-MOULDING FLASK.

for years, and made many experiments before I succeeded in designing my sand-moulding flask, the method of using which I shall now describe.

A shallow model is used, as with the Bailey Sand-Moulding Flask, and the model is laid on what I call a sand-moulding plate (*A*, Fig. 46), instead of on the bottom of the sand-box. This plate is made of cast-iron, with a cone-shaped opening in the middle, and is supported or strengthened by four feet which radiate to the edge of the plate, and terminate in blunt tabs or projections that rise above the surface on which the model is laid, so that they keep the sand-ring *B* from easily falling or sliding off the plate. On the surface on which the model is laid are formed a series of concentric grooves.

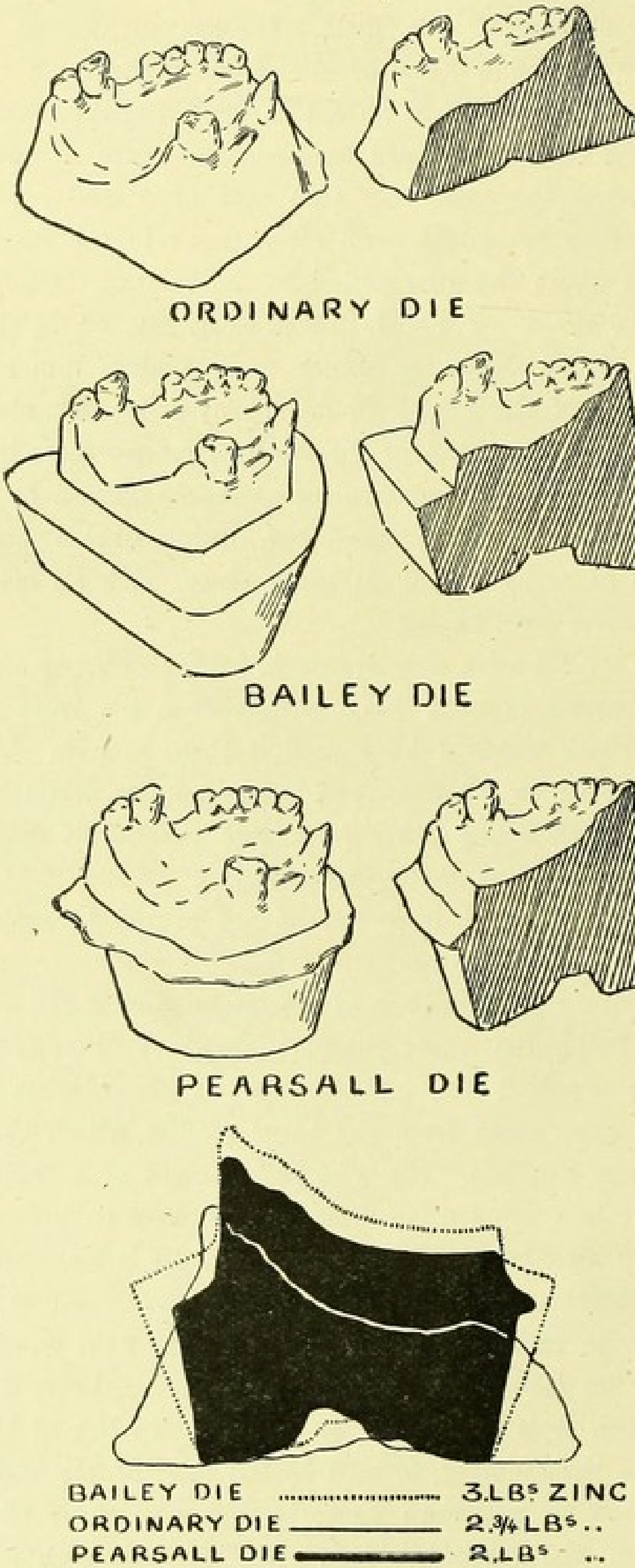
These grooves are designed as an aid to centering the position of the plaster model over the cone-shaped opening, and serve as guides to the workman in placing the cone over that part of a model which needs strengthening. Dies for lower cases often crack in the incisor region, and in that part where the gum dips into the floor of the mouth, where the bicuspid once stood. For such dies plate *A*, Fig. 46, is, therefore, of great service to the workman, inasmuch as it enables him to place the cone over any part of the model which he may desire to make unusually strong. I have used this form of die for nearly nine years in my work-room, and I have had in my employment assistants trained to other ways of making dies and striking up plates,—but, during all this period, despite the construction of many a difficult lower plate, such an accident as a cracked die has never been known.

The average weight of a zinc die made in the ordinary way is about two and three-quarter pounds. The weight of a die from the Bailey Sand-Moulding Flask which I have used is three pounds. The weight of the form of die which I recommend is two pounds, while at the same time it is stronger than any other form, and permits of discrimination in the choice of the position of the plaster model.

The advantages to be gained by the use of my invention may be briefly summed up as follows :—

(1) Great saving in the amount of zinc to be melted, the comparative weights being—Bailey die, three pounds ; Ordinary die, two and three-quarter pounds ; Pearsall die, two pounds. These weights have been taken by careful experiment from the three models, which the diagrams clearly explain (see Fig. 47). (2) The employment of a shallow model, which saves time in casting and drying, and is easier to deliver from the sand than a deep model. (3) The cone-shaped die is stronger than the one commonly employed, especially in lower cases, and it cannot be cracked or split in hammering. (4) The die is held securely in an ordinary vice during such processes as filing, trimming, heavy hammering, or chasing. When it is hammered, it will not slip out of the jaws of the vice, because the shoulder, formed by the base of the model, causes it to rest securely in position ; there is thus no danger of its falling on the floor or on the workman's feet. (5) The ease with which plates

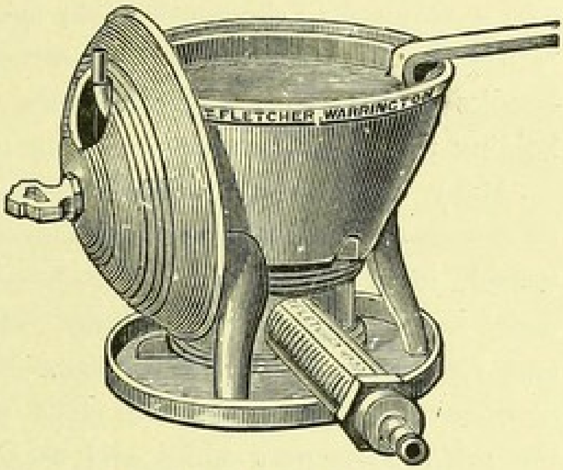
Fig. 47.



Three Kinds of Dies.

can be struck which need to be highly developed. (6) The choice of position afforded to the die-maker: he can deliberately place the strength of the die where it is wanted to withstand the concussion of heavy hammering. (7) The hammer surface of the die is more easily and squarely struck than that of the ordinary die, consequently the whole force of the blow reaches the plate.

Fig. 48.

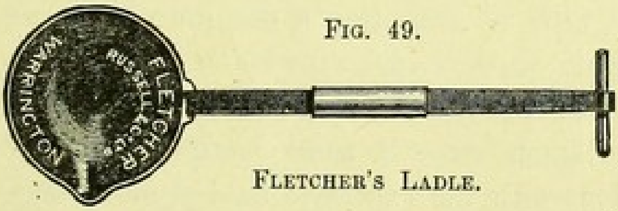


Fletcher's Ladle Furnace.

After the sand-moulding is completed, the ring *B* (Fig. 46) is inverted, plate *A* is lifted off and warmed, the model is "drawn," and melted zinc is poured into the mould. The zinc should be poured on the back part of the palate till the mould is nearly filled. The warmed plate *A* is then replaced on the sand ring, and cone *C* (Fig. 46) is filled with melted zinc, which is allowed to cool.

I have for several years used Mr. Fletcher's furnace (Fig. 48) for melting zinc and lead, and in my opinion it is one of those inventions which no workroom should be without. The ladle (Fig. 49) of malleable iron, with its ingenious form of handle, on which the sliding brass tube serves as a holder for the left hand and permits of the ladle being rotated with great ease, renders die-making a pleasure. This gas furnace and ladle are a real boon to the workroom, and no greater praise can be given to them.

Fig. 49.



Fletcher's Ladle.

Counter-dies can be made by placing the zinc die on the sand-moulding plate and surrounding it with sand, leaving exposed the zinc surface that is needed for making the plate. In lower zinc dies it is best to pile some sand in front of the incisor teeth of partial cases, in order to secure a wider groove than usual in the counter, in which to conduct the somewhat troublesome details of making a "bar lower."

The iron cone-shaped ring (*D*, Fig. 46) for holding the lead is now laid on the sand-moulding plate, and the melted lead is poured in on the zinc and sand. The ordinary die is commonly "dipped" in melted lead poured in a hollow, made in sand by a block of wood or by the bottom of a jam crock. As the lead shows signs of cooling, the die is "dipped"; care is required to choose the right moment, else the fingers of the workman will suffer from the heat absorbed by the zinc. The ends of the handles or shafts of a pair of plate shears make a good medium for holding the zinc when dipping it in the lead.

Many dentists are wedded to the use of a mechanical mixture of metals, commonly known as Babbitt metal. In some dental schools, indeed, it is the only metal used. The qualities claimed for Babbitt metal are non-shrinkage, hardness, cohesiveness, smoothness of surface, and fusibility at a low temperature. It is made of copper one part, antimony two parts, and tin eight parts. The copper is fused first, the antimony is next added, and then the tin. I have made a careful inspection of Babbitt metal dies in several workrooms, but I have not seen any better surfaces on the dies than can be obtained from zinc in good working order, *i.e.*, zinc in which the power of crystallization is retained by adding a little fresh zinc to each melting. The difference in temperature is only a matter of ten degrees Fahr., a point not worth claiming any special merit for in temperatures over 700° Fahr. Assistants who make these dies tell me that the tin wastes and gets pasty, when more tin has to be added, the result, of course, being an uncertain composition.

The reason for using Babbitt metal is stated to be that its toughness enables the workman to strike up a plate with one or two dies instead of requiring three, as is usual with zinc. The amount of trouble thus saved is not worth talking about, as with my invention a die quite as strong can be made with zinc, and a plate can be struck up with two of my dies, although a third is kept at hand in case of accident, an event which seldom or never happens. A little common sense in these matters will show that the work is not better done with the expensive Babbitt metal than it is with zinc, when the latter is cast in the strong form given to dies by the aid of my sand-moulding flask.

Mr. R. P. Lennox, of Cambridge, uses only one die made by my sand-moulding flask and two counter dies, one of lead, and one of tin, for even difficult lower cases. He has used my form of die for many years, and has never yet experienced such a disaster as a cracked die.

Mr. J. H. Gartrell has for some time been using a die metal which is composed of a mixture of copper, antimony, zinc, and tin, which has to be made on a large commercial scale, but can be purchased in four-pound ingots at the dental depôts. Mr. Gartrell informs me that it melts at a lower temperature than zinc, and does not waste in use, or deteriorate by becoming pasty, as is the case with Babbitt metal. I lately saw some dies made of it which had been melted many times, and they certainly looked just as good as dies made from fresh material.

The few experiments which I have been able to make with the metal, during the short time that it has been in my hands, appear to prove that it has little or no shrinkage. It is much harder and tougher in use than zinc, and severe hammering does not lower or bruise the surfaces by which plates are stamped, while casts of highly developed rugæ appear to wear far better in all details than when the dies are made of zinc.

CHAPTER VIII.

DESIGN AND CONSTRUCTION OF DENTURES.

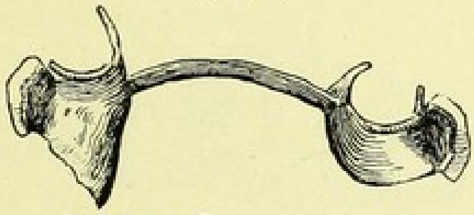
It should be borne in mind that artificial teeth and their plates are subject to injury in the mouth, as well as out of it. It is necessary, therefore, that a denture should be so constructed, that it can be repaired without anxiety to the workman, and without undue delay to the patient.

Some years ago I had sent to me for repair a full set of teeth belonging to a busy man of high position, with the most extraordinary combination of materials I have ever seen. The case was edentulous, and the teeth were kept in position by spiral springs. In the construction of the case, plate-teeth and tube-teeth, vulcanite and celluloid were combined, and the celluloid had gone wrong, having become offensive in smell and ragged in substance. A tube-tooth with its pin had come off, owing to the undermining of the support on which the bicuspid had been fitted,—and the celluloid margin had been pressed on the gold plate, after the pins and plate-teeth had been soldered. The upper case was designed with plate-teeth incisors and canines, and tube bicuspids and molars, with celluloid pressed to the plate as a gum. In the front of the lower case tubes were used, vulcanite supporting the biscuspids and molars. The bicuspid tooth that had been broken off had to be mounted on a fresh pin long enough to rivet to the plate, and then cemented on the pin with floss silk and varnish. So far as the upper case was concerned, it could have been more easily made mounted with tube-teeth, for the patient did not show his gums, nor his teeth for that matter, as they were hidden behind a full moustache and beard.

I am still at a loss to know what was the gain to the patient or the dentist, from the combination of so many incongruous materials. A gold plate mounted with plate-teeth in the incisor region, and tube-teeth in the bicuspid and molar regions, is a sensible design, as the breaking of one or more teeth, whether plate or tube-teeth, can be replaced by a workman of ordinary skill, in such a way that, so far as appearance goes, when the repair is completed, the accident might never have happened.

Gold plates carrying plate-teeth in front, with bicuspids and molars mounted in vulcanite, are not uncommon. In my opinion such cases show great capacity for bad design, for if the bite be a close one, it is better to use all plate-teeth, and make all the articulation with blocks of gold soldered to the plate. If the bite be not a close one, there cannot be any difficulty in attaching the incisor teeth securely to the plate with a vulcanite mounting. Gold plates mounted with plate-teeth extending all round the arch are sometimes "finished" with a piece or band of pink vulcanite on the plate at the back of the incisor teeth. This, to my mind, is another example of thoughtless work, for the first thing to be done in the event of a repair being necessary is to destroy the vulcanite, before a new plate-tooth can be soldered in the room of the broken one.

Fig. 50.



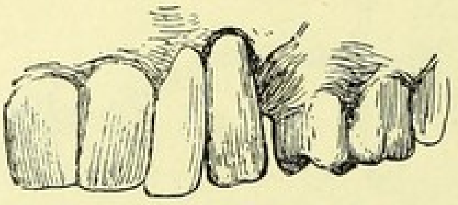
Bar with Clasps, deficient in rigidity.

Vulcanite plates made with metal "strengtheners" show us that in wear these appliances, so far from strengthening the case, really add to its weakness from defective vulcanisation, alteration in the form of the alveoli, or unsuitability in the design of the strengthener itself. It is better, therefore, to rely upon vulcanite and teeth in combination with a gold plate for extra strength. Vulcanite alone, in combination with porcelain teeth, admits of splendid work being done in suitable cases, if any art is used in the arrangement of the teeth to suit the face of the patient as well as the articulation of the jaws.

Fastenings made from vulcanite are seldom effective, owing to their want of elasticity, and to their clumsiness and bulk; they cover the teeth, and too often induce rapid decay at the neck. Fig. 50 shows a faulty method of mounting two bicuspids "without a plate." Dentures designed to retain their positions in the mouth by being wedged or jammed between the teeth, are rapidly destructive to the teeth they impinge upon. If the patient is able to endure the pressure long enough, the teeth yield after some time, and the denture becomes loose, provision not having been made to take up the increasing space owing to the movement of the natural teeth.

On the maxilla it is easier for a patient to wear a large plate than a small one. Narrow plates often cause a lisp when speaking, which disappears if a deeper plate is used. The insalivation of food is commonly most troublesome to a patient wearing a small plate, and as the pressure of the fastenings is just as great in a small plate as in a large one, if they are placed "in the usual manner," the advantage is in favour of a large plate, even as a matter of security against its accidental deglutition.

Fig. 51.



Shows a Lateral "stuck-on."

Gum teeth should be used with art and tact, so that the line of gum surrounding each artificial tooth will be placed in harmony with the gum lines of the teeth at each side of the space which it fills. The gum tooth should not be "stuck on," as we too often see it placed, for in such cases it forms as great a disfigurement as the one which it is intended to obviate.

The cutting edge of artificial teeth should be altered by the dentist so as to avoid the painful regularity that looks so charming on the wax card of the depôt, or on the plaster model in the workroom. Artificial teeth should not, in my opinion, attract attention in the patient's mouth, and the "mechanical" regularity too often visible in the faces of patients who have fallen into the condition of "the sere and yellow leaf," shows only too plainly that many dentists are indifferent to æsthetic considerations, or that they leave the mounting of their work to others who are deficient in taste.

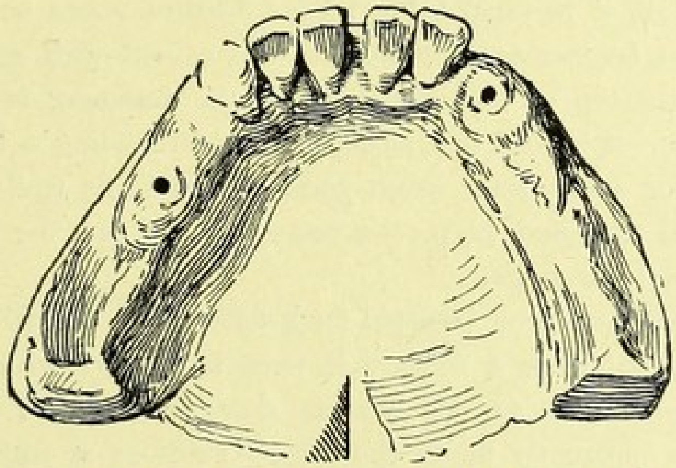
The contour of crowns or roots is often very inartistic in appearance; the "stuck-on" appearance (Fig. 51) of many upper canines shows only too plainly that what was intended to be a restoration has become a positive disfigurement, and the part of the tooth resting on the gum is too often fitted to go *over* the gum instead of *into* it.

Balkwill tubes set in sound canine roots, to be used as a means of supporting dentures, can be depended upon to last many years in the hands of intelligent and careful patients. A solid pin should be used, made from hard platinum. This alloy is very stiff and not crystalline in structure, but I personally prefer honest eighteen- or sixteen-carat gold wire to it, as gold is far less brittle, and, in my experience, lasts much longer without accident than ordinary platinum.

Cases will appear from time to time where it is not possible to use fastenings for want of grasping power on the teeth remaining in the jaws, or for the sake of appearance on the part of a lady patient. In such cases advantage can be taken of sound canine or bicuspid roots, in which to place Balkwill tubes or other sockets, in which the pins soldered to the upper or lower surface of the case may be inserted as dowels (Fig. 52). Whenever such pins can be used advantageously, they afford a firm support to the denture as long as the tooth-root remains firm in the mouth.

This kind of attachment may endure for from three to fifteen years, according to the condition of the root, and the way it has been "treated,"

Fig. 52.



Shows Platinum Tubes in Canine and Bicuspid Roots.

as well as to the amount of stress it has had to bear during mastication. Cases treated by this method have a natural look that is very attractive to the wearers, particularly ladies. With some skill and art, gold will be inconspicuous even during laughter. It is obvious, therefore, that a patient's mouth should be *studied*, and the nature of the design, suited to the case, faithfully carried out in all details ; moreover, the possibilities of accident necessitating repair in the future should always be borne in mind.

The assemblage of incongruous materials in a denture should be avoided,—and, whether the case in the course of time requires to be repaired by soldering, by vulcanizing, by riveting, or by renewal in the furnace, as in the case of continuous-gum, the work should be so designed that it will always be possible to repair it. In cases where many teeth have been lost by the patient—whether dentures be constructed of gold and vulcanite, or of vulcanite alone, or with continuous-gum—thick edges should be the rule where the plate edges impinge upon the gum. In the first place, with thick edges more pressure can be borne than when the margins are feather-edged with the file—and, secondly, necessary movements of the cheeks and the floor of the mouth are provided for in a way that does not cause constant pain and discomfort. Cases of this kind are far too often filed and finished with regard to their appearance *on the model*, and without due regard to the comfort of the patient. If the dentist or workman would only think that he would not enjoy feather-edges pressed into *his* gums, the patient would be saved a great deal of discomfort and the practitioner much trouble.

The duration of bicuspid teeth, when a denture has to be worn on the mandible, can be increased by *banding* the crowns with gold from the gum up to the top of the crown, where the fastening of the denture has to be worn. I banded two bicuspid teeth for holding a lower denture in position for a lady some seven years ago, and the teeth, bands, and dentures were all found in perfect order when I saw her last summer on her return from India.

In some patients, lower bicuspid teeth suffer from a rapid deterioration of enamel surface when a denture is worn in contact with these teeth. It is not uncommon to see one bicuspid decay, and another not, although the teeth are apparently under the same conditions as regards stress of fastening and correct fit. Banding in suitable cases offers, I am persuaded, additional security for the duration of the natural teeth and of the denture. I have not a favourable opinion of the behaviour of iridium-platinum in the mouth under conditions of tensile strain. There is no metal we can be less sure about than iridium-platinum, which is, I am told, only an impure form of platinum. My opinion, I see, from some recent deliverances on the subject, is also shared, after an enthusiastic, if mortifying experience, by one of our "dental engineers."

My friend, Mr. J. H. Gartrell, informs me that he has a high opinion of *hard* platinum, both in the form of plate for continuous-gum, and in the form of dowel-pins for crowns. Although platinum has been used by dentists for many years, the tendency of some kinds to become brittle and crystalline, as well as the difficulty of making a strong soldered joint even with fine gold, renders it, to my mind, inferior in tensile strength to eighteen-carat gold soldered with a good cadmium solder. I am myself at present disposed to regard platinum and its properties as one of those subjects which are still open for careful investigation and experiment, and to continue staunch in my adherence to the use of eighteen-carat gold, and a good solder like cadmium solder, for work, the durability of which serves far beyond what can be expected from much of the modern and fashionable work, which is made not infrequently without any intention of being used for mastication, because "it has a beautiful appearance."

CHAPTER IX.

PLATE MAKING.

THE first step to be taken after the finished plaster model is cast in sand, and copied in the form of metal dies and counter dies, is to study the plaster model on which the dentist has carefully drawn the outline of the plate with firm lead-pencil lines. These lines should show the exact shape the plate is to be made, and on the plaster teeth lines should also be drawn, showing the shape and direction of the fastenings, as well as the height which the gold is to go on the teeth.

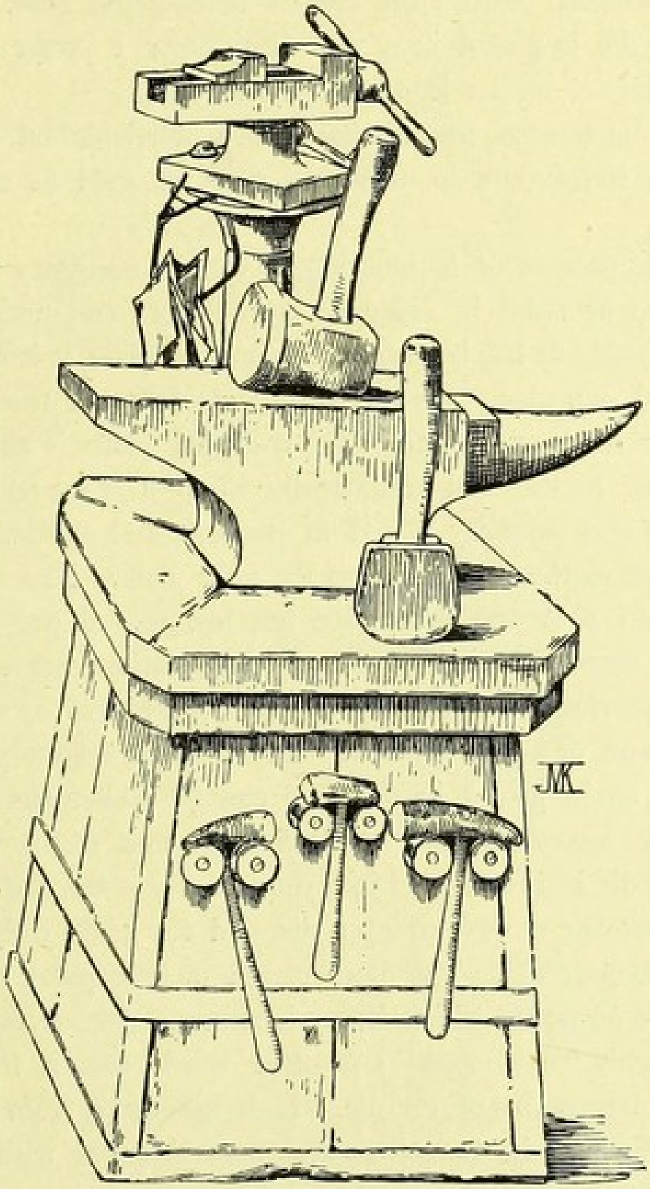
Patterns are cut from thin stiff paper or from sheet lead. It requires some skill and experience to cut a satisfactory pattern. A suitable piece of paper is first roughly cut, with scissors or shears, into an approximate shape; it is next held on the model or the first die (the die which has the teeth filed down) by the thumb and fingers of the left hand, and then trimmed in various directions with the scissors or shears, according to the area which the plate is intended to occupy on the gum. Open or horse-shoe-shaped plates, with some teeth still remaining in the jaw to be provided for, have to be very carefully cut by pattern.

Mr. R. P. Lennox cuts a *paper* pattern to fit in the lead counter die, which is cast with a large groove outside the teeth or labial surface of the die. By care exercised on this detail waste of gold is avoided, by making the plate too large on the one hand, or on the other by cutting out such a pattern that the plate will buckle or tear when the first blows are given to it in the counter die.

It should be remembered that the sheet of gold becomes stretched on the surface of the die under the blows of the hammer. A plate, for instance, that was one inch wide before striking may become one inch and an eighth when struck home on the die.

The pattern having been cut to fit, it is opened out. If of lead, this ought to be done gradually, commencing at one end of the pattern; the process is continued round the outer or greater margin to the other end, then followed on with the centre and inner margin, avoiding pressure which will cause distortion. If the pattern be distorted, the plate will with

Fig. 53.



Anvil, Striking Hammers, Horn Mallets, and Drilling Machine Vice.

difficulty be got into its place, and probably the gold will be so strained that the fit of the plate will never be satisfactory. The pattern is now laid on the surface of the sheet gold, and its extent is carefully scribed with a sharp steel point round the edge ; lead pencil is also useful for marking a plate, as the pencil does not scratch the gold. The pattern is then removed, and the curved shape of the plate is cut out neatly with a pair of shears, which may be bent or straight as required.

It is well always to anneal the sheet gold before cutting out the pattern, as annealing reduces the risk of tearing the gold.

The metal die is placed in a vice (Fig. 53) ; I prefer the vice of a drilling-machine set on an iron pillar (Fig. 54).

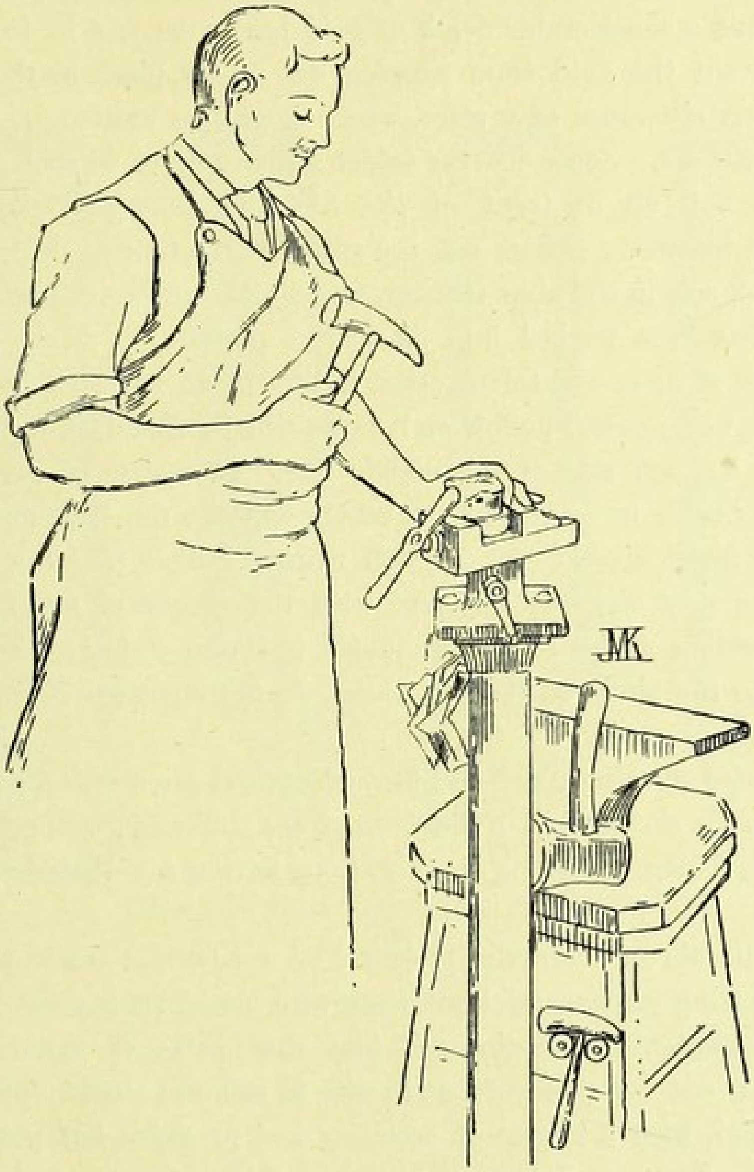
The metal die secured, the workman, with judicious and deft blows of a horn mallet, endeavours to make the sheet of gold fit the surface of the die.

During this process of hammering, it will be necessary to anneal the gold plate once or twice in order to keep it soft and malleable.

Once a tolerable fit has been made of the gold plate, it is dipped in acid to clean it, and annealed. Brown paper is folded over the zinc die, and struck into the lead or counter die ; the gold plate is then placed on the bed of paper in the lead counter die, where it is intended to remain. The zinc die is now carefully placed in position, and a blow with a heavy hammer is given to the die resting on the gold plate. The die is removed to make certain that the gold plate has not moved out of its correct position, a few more blows are given, the indentations made in the plate by the teeth previously filed down on the die are cut away with plate-nippers, or shears, or a piercing-saw. The plate is carefully pickled and annealed, and again placed in the lead counter under the die, which is struck with the heavy hammer till it fits the first metal die.

The second die is now treated in a similar way to the first, with brown paper struck into the unused counter die, and the plate duly annealed is placed in the counter die. The die is placed on the plate, and struck as often as may be necessary with a heavy hammer. Care is taken that the plate is thoroughly " developed " ; in other words, that it follows all the elevations and depressions of the die. It is necessary, from time to time, to cut away the gold in directions that may interfere with driving the plate home to fit the die. When this is done, the surface of the plate is chased or punched in the depressions with light taps on a blunt steel punch given by a chasing hammer. Chasing the plate spoils the fit, although it has introduced more detailed markings on the surface of the plate ; so that once this stage of plate making is completed, it is necessary to anneal the plate again, and file away any sharp edges. By one or two careful blows on the plate, replaced in the counter die under the zinc die, the result should be that it thoroughly fits the model as desired.

FIG. 54.



DRILLING MACHINE VICE ON IRON PILLAR HOLDING DIE IN POSITION FOR USE OF HORN MALLET.

In plates intended for some types of maxillæ a warp or spring gets into some of them, which mere pounding in a counter die will not remove. Careful examination will show some place where the plate *binds*, and until this unequal tension is removed it will continue to spring. Lifting the binding edge with pliers, or putting a folded bit of stiff paper on "the *hard* spot," will often release a plate from such a warp, with the aid of a few taps of the hammer, when done by the hand of an experienced workman.

Edentulous cases not infrequently need great care in pattern making, for sometimes a considerable depth of gold has to be left in front of the die to prevent the gold from slipping out of its place in the die, and cause a short allowance of surface, where it may be wanted, on the labial surface of the die. Some dentists solder strips of gold in such a way that they come well up in front of the die, and thus prevent the plate slipping backwards. Others cut the plate with a tongue-shaped piece in front, which acts in the same manner, and which can be trimmed off after the plate has been worked into its correct position.

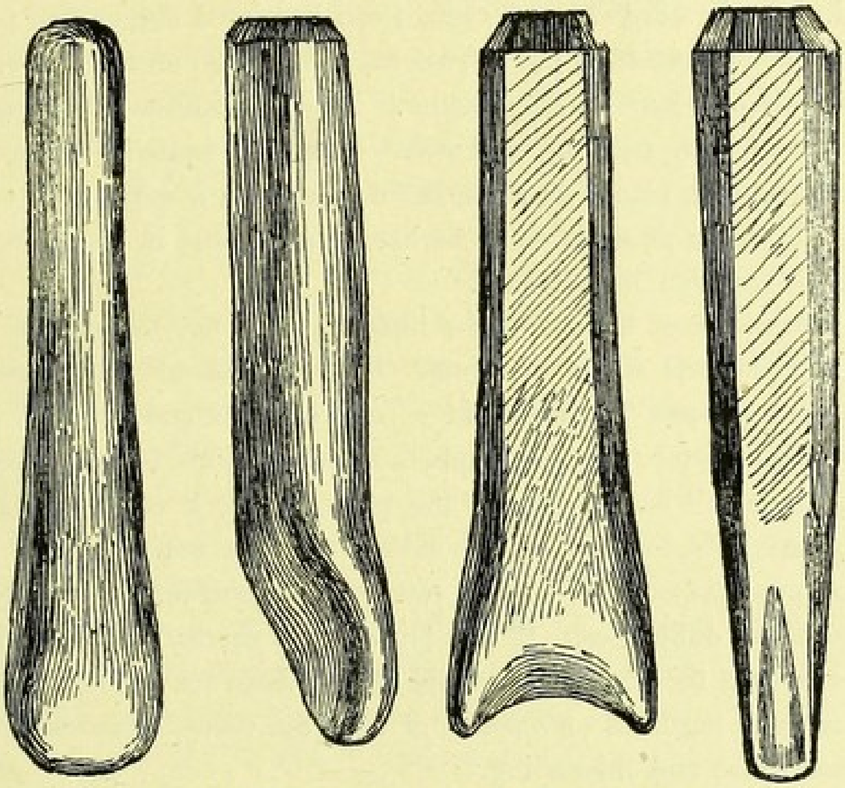
In some of these edentulous cases, if the alveoli have not been greatly absorbed, a well-marked hollow or hollows will be found above the alveolar border on each side of the middle line. In a case of this type the plate must buckle or crinkle at the centre opposite the frænum, or else at the canine fossæ, should they be well marked. This buckling in one or more places may seriously interfere with the successful striking of the plate. Buckling makes the plate difficult to stamp, owing to the increased resistance to the blows on the die, caused by the increased strength of the plate at this place.

It is stated in some text-books that edentulous cases with a considerable overlap can be stamped on a die without any difficulty, without crinkling the plate, cracking or tearing it, or without having a V-shaped space to be soldered!

With the aid of hydraulic pressure, or a powerful screw press, such work as pressing ornamental brass work with undercuts is commonly done It must, however, be remembered that the blanks of metal are most carefully cut out for this purpose in dies to suit the mould and ornament to be pressed, with a degree of accuracy and precision not possible with hand work. The use of such powerful machinery is out of the question in most of our workrooms, not only on account of the expense, but also on account of the limited use which there is for such an equipment, owing to the infrequency of suitable cases for its employment.

The pattern should be cut to the best advantage by providing for the fold at the central line of the plate, and, if necessary, cutting it and soldering the joint. Extreme cases of this kind can be also dealt with by striking the plate to go to the edge of the alveolar ridge, and providing a second piece of gold struck to fit the labial surface. The overlapping edges of the plate, and of the piece of gold for the labial surface, can be filed to a feather edge and tacked in position with a few panels of solder. The united plate can then be struck thoroughly home without any further

Fig. 55.



Copper Punches designed by the Author.

difficulty, the joined edges carefully soldered, filed, and finished. If this procedure is carefully carried out, and the overlap is not plastered with unnecessary solder, evidence of the soldered joint need not be seen when the plate is finished.

Close adaptation of these difficult plates to the surface of the die can often be assisted by the use of the chasing punch among the rugæ of the palate, *while the plate lies in the counter-die.* Narrow punches should not be used, but punches made with such a rounded end as to bear some resemblance to the surface to be "bossed" out (Fig. 55).

Further developments of this surface can be carried out by annealing the plate, placing it on the die, and chasing the hollows to be seen on *that* surface, taking care to have the plaster model at hand for the purpose of accurately studying the depression. By these alternate processes of punching and striking the plate, the result should be a thorough fit of the model in every part.

It is worth while, in cases where well marked areas differing in density can be distinguished by the aid of the finger on the palate, or alveolar ridge of an edentulous patient, to mark these areas on the plaster cast with a pencil. On the hard areas of surface can be placed one or two pieces of thin sheet copper carefully cut to pattern, and worked on the plaster model with the help of a large steel burnisher. These thicknesses can be attached to the model with sticking wax where they are wanted. Sometimes a little sticking wax, placed on the needful spots with a warm tool, will help to take off undue pressure on these hard bony places in the gum, before the cast is moulded in the sand.

In the middle of the palate, for instance, it is not uncommon to find a hard ridge covered with a thin gum. Such cases should have these ridges raised or "developed" with the aid of sticking wax and tin foil, or thin sheet copper as before mentioned, else a most vexatious form of discomfort to the patient will be set up, and the plate will rock on this ridge—the elastic gum yields to pressure, the bony area does not.

Some practitioners recommend scraping the surface of the model to overcome these difficulties. If this procedure is carried out, it ought only to be done when the patient is at hand in the chair, for exact confirmation of the areas of hardness or softness of the gum tissue, otherwise it is apt to be inaccurate and misleading.

In many edentulous cases, in the centre of the alveolar ridge there is to be found a nodule of gum; in some cases this is quite hard, in others quite soft. When making a plate for such a case, it is often wise to saw a straight cut in the front of the plate, in order to let the portion of plate intended to lap over the labial portion of the alveolar ridge fold together without creasing. The sawn edges will overlap, after a tap or two on the first die, sufficiently to permit the workman to saw through the folded part in such a way that there is only one straight line to be soldered. Some prefer to saw each side of this fold separately, and file a feather edge to the sawn surfaces in such a way that there is a neat joint as well as an overlap, which can be easily soldered.

In plate making, many dentists use plate benders,—a form of pliers with rounded noses so arranged as to bend the plate without scratching or bruising it. There is nothing, however, that can be done by the plate benders that cannot be as well executed by the aid of a horn mallet, reinforced with a copper-headed hammer used with a skilful touch. The advantage of the latter form of hammer over a steel one is that it does not bruise the gold.

When plates have to be made for deep palates of the V-shaped type, they can be prepared for the use of the horn mallet, by placing an ovoid piece of wood made from boxwood, or lignum-vitæ, in the concavity of the palate, and securing it and the plate in position on the die with the aid of the vice. This holds the plate very firmly, and if the plate has been correctly cut to pattern, the labial surface can be turned by drawing the plate over and beating it into the curved surfaces of the alveoli, with the copper or horn hammer. Other dentists pour a sufficient quantity of melted lead or tin on the zinc die to fill the concavity of the palate.

When this casting cools, it offers a very perfect reproduction of the hollows, and it can also be held securely in the vice with the die.

This lead or tin casting can also be used with the aid of a hammer, to beat the gold into the hollows of the palate. When the plate fits the palate, the casting and the plate can be held on the die in the jaws of the vice, and the labial or buccal parts of the plate can be brought into position with the horn hammer.

From the details of construction of metal plates which I have given, it will be readily understood that some form of resistance is needed when striking plates. I prefer a smith's anvil raised to a convenient height. Other dentists prefer "a stake"—an anvil of a square form, with a tapering end fitting into a socket cut in a block of wood; others again strike up excellent plates by striking the plate while holding the counter die in the left hand, and striking the die with a four or five pound hammer held in the right hand. Others again, while seated, strike plates on a cast-iron anvil made with a hollow to fit the thigh, and others again strike the plates on a board wrapped in a sheep's fleece and placed across the knees. The two latter ways of plate making are unwise. I have known serious injuries to the knees to result from this method, severe inflammation in the knee-joint setting in from the constant concussion of heavy hammering. In one instance, known to me, the case terminated in amputation of the knee and leg.

Such rough-and-ready ways may be practised with impunity by some; but, in every way, the use of an anvil is more satisfactory. The weight of the die and lead counter is supported by the anvil,—and the anvil, if placed at a convenient height to suit the workman, will greatly assist in offering the resistance necessary to powerful blows. The noise of these concussions can be deadened by placing the anvil in a strong box clamped with hoop-iron, as recommended by Dr. Haskell, of Chicago. In this box is placed a strong canvas bag filled with sawdust or sand. If sawdust is used, it will be found very elastic, so that heavy blows can be struck without cracking the ceiling of the room below and without much noise.

Fig. 56.

Drop Hammer.

A few dentists have screw presses for making plates; but, in point of speed, this powerful aid is not an advantage, from the extra time taken up in casting the dies and counter dies to suit the press.

I have tried for some short time past a simple form of drop hammer used in the "black country," which resembles on a small scale the action of a pile driver (Fig. 56).

By the use of this contrivance a butterfly could be crushed or a horse-shoe forged. With its aid, plate making, with the cone-shaped dies which I have invented, becomes comparatively easy. A true square blow is always struck, so that a novice can use it with as much effect as a skilled assistant. I have been very much pleased with its rapidity and certainty, especially in the striking of bar lowers, which offers difficulties when made "in the usual manner."

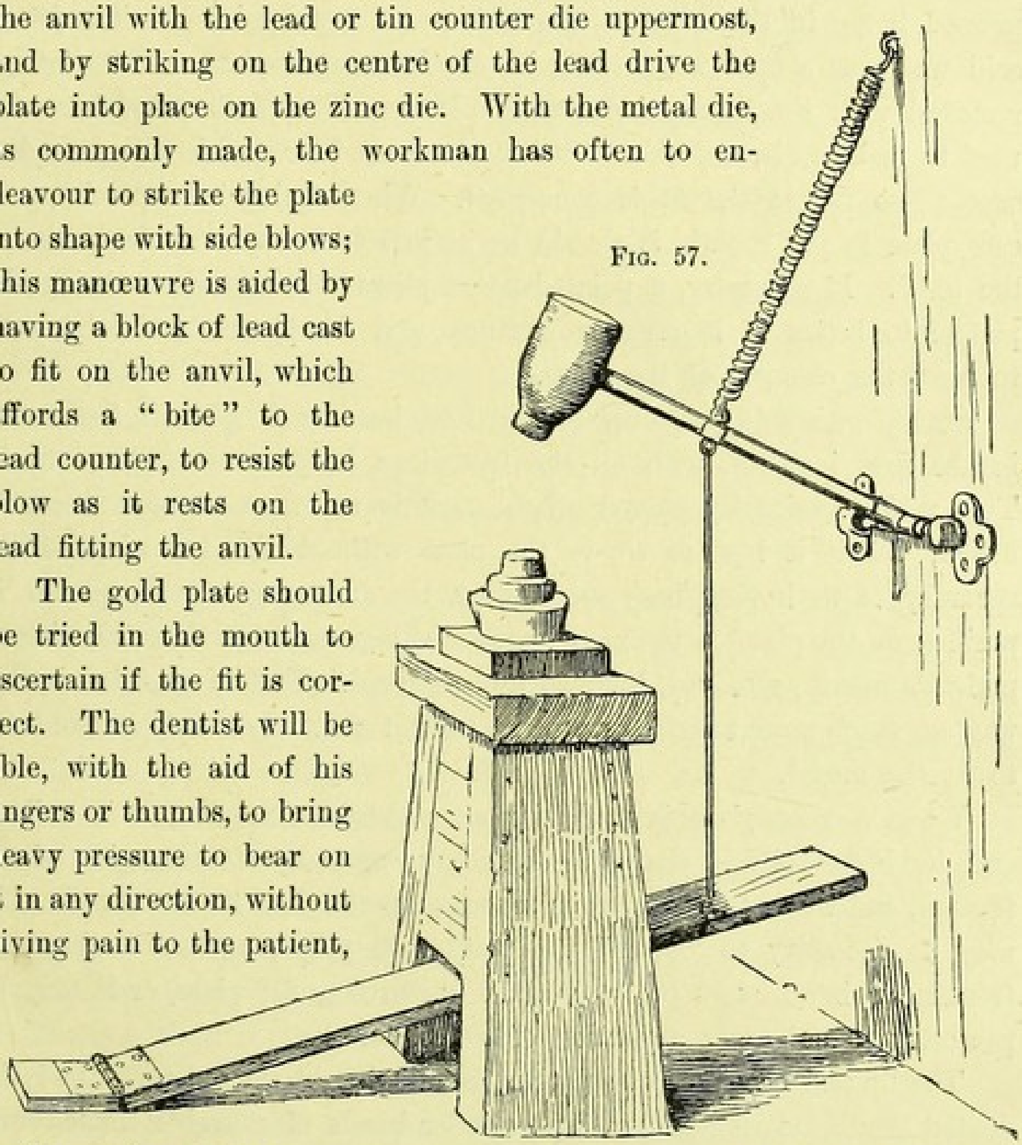
I have to thank my friend Mr. J. Charters Birch, of Leeds, for his kindness in bringing this most admirable tool under my notice. It is now part of the regular equipment of my workroom.

Mr. Birch has also placed at my disposal for experiment a form of hammer, once very common in the "black country" for swaging iron into bars before rolling machinery was worked by steam (Fig. 57). It is commonly known as an "Olliver" or "Ollifer." The hammer is held above the anvil by a spring, and the blow is given by the workman pressing his weight upon a suitable treadle.

Some dentists strike the die by placing a truncated cone of iron on the die, where it is held during use by an iron handle. With the ordinary die this is doubtless a useful tool, as it enables the workman to hit straight, for if a heavy hammer is wielded by an inexperienced hand, many of the blows prove ineffective. With very deep palates it is sometimes necessary to reverse the usual order of things, to place the die on the anvil with the lead or tin counter die uppermost, and by striking on the centre of the lead drive the plate into place on the zinc die. With the metal die, as commonly made, the workman has often to endeavour to strike the plate into shape with side blows; this manœuvre is aided by having a block of lead cast to fit on the anvil, which affords a "bite" to the lead counter, to resist the blow as it rests on the lead fitting the anvil.

The gold plate should be tried in the mouth to ascertain if the fit is correct. The dentist will be able, with the aid of his fingers or thumbs, to bring heavy pressure to bear on it in any direction, without giving pain to the patient,

Fig. 57.



Spring Forge Hammer—commonly known as an "Olliver" or "Ollifer."

should the model and the plate made on it prove inaccurate. A badly-fitting plate is most uncomfortable to the patient if pressure is brought to bear; I may say such pressure is naturally resented by the patient.

A plate produced by a die made from a sucked or dragged impression is a very different sort of article from a plate made from an accurate die, from the patient's point of view. Plates that prove inaccurate, from some oversight in taking the impression, can be made of service to the dentist by softening some modelling composition, heating the plate, and lining it with the softened composition to the thickness of a penny. After it is lined, the composition should be again warmed over a lamp, till there is a smooth surface on it; the plate with lining can then be pressed home in the mouth; the lining will rapidly harden if a jet of cold water or a cold wet napkin be applied to the plate. The plate is removed with the lining and cast in plaster. The plaster model can be used to make a die, and the ill-fitting plate can be restruck with complete success, so far as the fit is concerned. When trying-in a partial gold case plate in the mouth, it should be noticed how it fits at the necks of the teeth. If necessary, a pointed-nosed pliers can be used to bring the plate into better fit in certain directions, and the plaster model trimmed to meet the changes of the plate.

Some dentists do not adopt this method, but try the plate in the mouth in the first instance, with all the fastenings in position soldered to it. This *may* occasionally answer when work is made on a most accurate model, but it is best to try-in the plate without the fastenings. The accuracy of fit having been ascertained, the fastenings can be placed in position on the plate on the model with sticking-wax, and then tried in the patient's mouth, removed, invested and soldered. Fastenings fitted in this way are much more satisfactory to the patient than when they are soldered to fit the model.

When a gold plate is made for an edentulous maxilla, it is well to examine it carefully in the patient's mouth, especially at the region of the frenum, and where the buccinator muscles are attached to the maxilla. It may be necessary to "open" the plate with pliers, so as to allow the frenum or buccinators to act without disturbing the plate, or it may be necessary to cut away a portion of the plate.

The lip and cheek of the patient should be drawn outwards, and the dentist should notice whether these slender bands of movable tissue touch the plate or lift it off the gum. In the latter case it may be necessary to reduce the area of the plate ; the necessary place to be eased can be shown by a lead pencil or a scratch with a sharp point. The change in the plate should be made by sawing or filing it. The plate should be tried in the mouth again, and tested to see whether the action of these little muscular fibres will dislodge it.

Metal work, intended to be worn on the mandible, is much more difficult to make than for the maxilla, partly on account of the narrowness of the plate, and partly from having to fit incisor and bicuspid teeth, which stand either in an erect position or overhanging the floor of the mouth. Care should be taken to work only to a first-rate model, and great pains should be taken in moulding the die on which to strike the plate.

In some lower cases it is not uncommon to find a bicuspid or two overhanging the floor of the mouth. To make a plate to fit correctly on the gum and pass these overhanging teeth, and also fit them, is no mean mechanical problem.

A cursory examination of a few mouths will make a young dentist acquainted with the fact that the lower teeth are by no means parallel with each other, but slope forwards or backwards. Sometimes they are so erect as to make it exceedingly difficult to obtain a correct impression.

In cases where the teeth in the maxilla have been long lost, it is not uncommon to find that the lower teeth have risen, although they may remain quite firm. Considerable spaces sometimes are seen between the teeth, the gum having shrunk and ceased to occupy the spaces between the teeth.

In designing and making gold plates to fit behind the lower teeth, the dentist should be careful to allow the gold to rise above the cingulum of the incisor teeth, so that the plates have a sort of shoulder to rest upon above the necks of the teeth. Plates made for the mandible on the same principle as plates which are usually made for the maxilla will, in the course of a few weeks, sink into the gum and away from the teeth, and bruise the gum between the teeth and the plate. It is well, therefore, when teeth *are* sound and firm, to take advantage of the shoulders and carefully fit the plate to them, as it helps to prevent the downward thrust of the plate in mastication.

Pressure thus applied to the enamel surfaces of incisor teeth is not usually a cause of decay in mouths that are kept in a cleanly condition. Excessive pressure on bicuspids may cause destruction of the enamel surface in contact with a plate. To strike and fit a plate for some of these cases requires great skill and practice. The plates are usually made of two thicknesses, the first being somewhat thinner than the second, or *vice versa*. The first plate should exactly cover the area on the incisor teeth marked by a lead pencil on the plaster model. When this plate has been correctly made, a smaller plate is made to fit from the lower edge of the first plate to a position midway between the upper edge of the larger plate and the necks of the teeth. The narrow plate is struck on the die to fit accurately the wider plate. In striking lower plates, time is saved by using stiffer material than lead as a counter die. Tin will be found most useful, and many dentists can by its aid make beautifully fitting lower plates, without using a punch to develope them. The gold plates having been made to fit the model and each other, are carefully cleaned by dropping them in pickle when hot, and immersed in boiling water for half an hour to remove all traces of the acid.

Borax is carefully ground on the slab, and the solder necessary to be used is cut with shears into small oblong panels. Iron cramps or pieces of binding wire are prepared to pin the plates together. The borax is carefully painted with a camel-hair pencil all over the under surface of the smaller plate, which is then carefully put in position on the larger plate. The plates are now bound with the cramps, or with the binding wire, and securely fastened together. The camel-hair pencil charged or filled with borax is brought over all the edges of the smaller plate to ensure that there is no deficiency of borax to aid the flow of the solder. The pieces of solder are picked up on the point of the brush or with tweezers, and arranged in a row all round the outside edge of the smaller plate. The solder having been placed in position, the plate is slowly and carefully dried or warmed over a burner, in order that, when it is heated under the blow-pipe, the pieces of solder will not leave the places which they are intended to occupy. This detail is worth spending a little time upon, because, if it is properly conducted, there is no chance of the solder dropping from the plate as the heat increases, or of being blown off the plate under the action of the blow-pipe, as the desiccated borax holds it in position. The plates having been soldered, the thick plate is placed on the best die, which is struck with one or two firm blows into the lead or tin counter. The plate should now be tried on the model to see if the fit is exact.

The thoroughness of the soldering can be tested in two simple ways :— One by dropping the plate from a short height on the anvil or work-bench.

If it gives a clear ring as it strikes the anvil or bench, it is well soldered, while a buzzing or discordant note will tell that the surfaces have not been united. Another method is to heat the plate and drop it into clean water; then remove it, dry it with a cloth, and hold it in a pair of pliers over a Bunsen flame. Should the soldering be imperfectly done, steam will blow from the space between the plates, and a scratch can be made over the spot showing where the steam has come from. Steps can then be taken to bind the plates and resolder as before. The plate can be filed to size, care being taken not to leave thin or sharp edges on the lower surface.

Plates can be struck by repeated blows under small shot in the following manner:—The die is surrounded by a heavy iron cylinder, the plate is put in position, "small bird shot" is poured over the plate, and the die is hammered under the shot till the plate fits the die. I have never seen this procedure carried out,—but, except for very thin and soft gold plates, the result will not be an improvement on the use of the drop hammer, with the cone-ended dies that can be made by means of my sand-moulding flask.

Much trouble has been taken to deposit gold plates on the model by the aid of an electric current. The metal so deposited is too soft for use in the mouth. Stiffening the plate by flowing solder over it is a childish way of making a gold plate with any pretence of workman-like skill, and so also is the reticulated plate which was offered to the profession a few years ago. This gold plate is covered with small depressions cutting half through the surface of the metal. It is burnished on the model, and when the fit is exact, solder is "flowed over the surface" to stiffen and finish the plate. These short cuts to easy mechanical work are, I fear, a delusion and a snare to the practical dentist. They seem to me inadequate in result, and more troublesome to the workman than the ordinary way of doing skilled work.

I am unable to understand the popularity of the material known as dental alloy with my profession. It is not a pleasant material to work, and it has to be soldered with a good gold solder. It is much softer than sixteen- or eighteen-carat gold, and does not make as good a plate, whether we regard it from the point of view of rigidity or of colour.

The late Mr. Hogue, of Edinburgh, used for cheap cases an alloy made of equal parts of silver and hard eighteen-carat gold, *i.e.*, gold alloyed with more copper than silver. The alloy is paler than sixteen-carat gold, but it looks well, is rigid in use, keeps a good colour and is easily kept clean. I have seen work made by Mr. Hogue that was worn for many years, and it certainly never presented the black and "cheap" look which a dental alloy denture too often presents. As all the details of plate making are the same for dental alloy as for gold, I would point out that the labour to the dentist and his workman are also the same with both materials—whether plate-teeth, or tube-teeth, or vulcanite attachments are used. The only difference to the dentist is the reduction in the amount of the honorarium which he receives, altogether out of proportion to the difference in cost between the eighteen-carat gold plate, or the argentized gold plate of Hogue, on the one hand, and the dental alloy plate on the other.

I never have been able to see the merit of this meretricious cheapness in the interest of the patient. The details of such work are commonly executed in a perfunctory and slovenly way, with little or no regard to the needs of the case, whether we regard them as intended to restore the features of the patient or the lost functions of speech and mastication. Despite the change of fashion in the direction of bars, bridges, and crowns, there is still a great field of usefulness left for well designed and well made *plates* for both jaws, for the restoration of speech and mastication.

CHAPTER X.

BANDS OR FASTENINGS.

MANY cases come under the care of the dentist where teeth remain in the jaws and are strong and firm in position, although many of their fellows have been lost. Too good to be removed by the dentist, advantage can be taken of their serviceable condition, even if their position may occasionally cause difficulties in the construction of a denture.

Cases involving partial loss of teeth require the use of metal bands, called "fastenings," to retain the denture in position in the mouth. Fastenings are made in many ways, some good, some indifferent, and some positively bad. They are made from round wire, half-round wire, flattened wire, and a wider kind is cut out of sheet gold to a special pattern made for each tooth which is to be banded. There is much to be said for and against the use of fastenings in certain cases. I have no hesitation in saying that if these necessary attachments are made suitable to the case with all proper care, that if they are elastic ~~in their tension~~, and that if the patient who uses them is of cleanly habits, the mischief they are so commonly credited with is greatly exaggerated. It sounds strange to hear a practitioner, who has no hesitation in mutilating sound teeth for the purposes of using them as "abutments for a bridge," inveighing against the use of plates *with* fastenings.

How often do we see gold plates that have done ten or fifteen years' efficient service without the loss of a tooth! Some of us have seen the loss of two or more good teeth follow the construction of a bridge which, the patient was assured, would last him all his life, but which only survived the stress of use for a year and a half or two years at the outside, accompanied with far more pain and discomfort than a plate would ever have given.

Were the same care and pains given to the construction and fitting of plates which we see given to the construction of bridges, more teeth would remain useful organs in the mouth than is the case with a very large number of bridges. It is a remarkable fact that many men practise bridge-work who are unable to make good plates in any material, yet who, nevertheless, have no hesitation about mutilating valuable teeth, if not destroying them.

It is necessary, if we are to have good results from the use of fastenings, that the following considerations should be borne in mind, when designing and fitting a denture in which this mode of attachment forms a part :—

Fastenings should fit the tooth, or teeth, accurately, and the tensile strain on the teeth should be towards the central line at the frenum. If this rule be neglected, there is considerable discomfort imposed upon the healthy teeth should they be thrust backwards, whereas, if the pressure be forwards, a similar amount of strain does not cause discomfort.

Fastenings should be made of elastic or spring gold, not thicker than is suitable to the case. Strong pressure should not be placed on the neck of a tooth, or the *gum* surrounding it. Whenever possible, fastenings should grasp a tooth where there is some enamel substance. Fastenings should be attached to the plate with sticking-wax, and tried in the mouth before soldering, if the most desirable results, as well as comfort in use, are to be obtained. I have for many years used for fastenings sheet gold, hardened by the addition of a small percentage of platinum. Dr. Haskell, of Chicago, recommends one part platinum to sixteen parts of gold plate. Spring gold of this kind not only retains its form during use in the mouth, and in the daily removals for cleanliness, but relieves the practitioner from the labour of "tightening" fastenings, which plays so large a part in daily practice when softer gold is used. The comfort of spring gold to the patient is very marked, as compared with the use of a softer gold.

With carefully made fastenings of platinized gold, there is not that sense of tension, which is so marked when fastenings of softer gold are made bulky in order to increase their stiffness.

I know of cases that have been worn from five to eight years, without needing to have the fastenings tightened.

The use of platinized gold, therefore, I regard as essential to comfortable work, as well as to the exercise of care in the design and construction of the fastenings. With teeth of normal form, bands attached to molars may be cut out of sheet gold (No. 7 gauge), and may be left an eighth of an inch or more wide. A careful study of the bite will show the practitioner whether he may enclose the tooth with the fastening, or only place it on one side.

Isolated twelfth-year molars in the maxilla are usually surrounded by the fastening, a space being left between the ends of the bands on the buccal surface.

Fastenings are most comfortable when soldered to the plate on the lingual side of the tooth; as each arm has then sufficient elasticity to pass over the wider part of the crown, and retain its position when the plate is brought to its bed on the gum. Fastenings are, as a rule, too much soldered to the plate, and this deprives them of that elasticity which is of the greatest value in the direction of comfort.

I have not used round or half-round fastenings for years, as I regard them as unsuitable in contour for the work for which they are intended. Except in the case of very short molar teeth, I do not often use flattened wire, but prefer to make the fastenings to pattern to suit the teeth.

In making them to pattern, the dentist should mark on the model the extent to which they are to be soldered round the necks of the teeth. The longer the soldered surface, the stiffer and more uncomfortable the fastening will be to the patient. Many dentists err in this direction by making fastenings too powerful and too rigid; whereas, elasticity, rather than rigidity, should be the aim.

The strength of the fastening should be proportionate to the amount of traction necessary. A thin fastening can with advantage be stiffened at weak places by soldering another thickness of metal on to exposed curves. As a rule, it is wise to make the fastening somewhat larger in length and depth than it is intended to remain. A flat surface is filed on the plate and a similar flat surface on the fastening where it is to rest on the plate. The plate and fastening are united with the aid of some sticking-wax; they are then carried to the patient's mouth and carefully tried in position. Should there be any alteration necessary, it should be made, and the plate and fastening again tried in the mouth. Should the fit be found to be correct, the plate and fastening are removed from the mouth and invested in plaster and pumice, or in sand, and partly soldered. The plate and fastening can again be tried in the mouth, and the fastening bent into its proper position and finally soldered to the place which was marked on the plate while in the mouth. This will be found a more satisfactory way in many cases than working from the plaster model. Sometimes it is necessary, where the palatine root of a molar is much exposed, to file away the plate where it touches the tooth on the lingual surface. This will enable the workman to place the fastening between the plate and the tooth, where it can be secured with wax. Pains have to be taken when doing this that the fastening fits correctly, else a space is left in which food or mucus may gather and cause decay. The fit can be tried in the mouth, and when correct invested and soldered. The shape and size which the fastening is to be when finished, should be marked on the fastening in the mouth; it can afterwards be filed to shape and finished.

Fastenings used for canines need great care in the making, so as to retain the plate in position without undue play, or motion, on the part of the plate, or undue stress on the tooth on the part of the fastening.

The best type of fastening for canine teeth is one which is made to grasp the bulbous part of the enamel at each side, so that when neatly made, very little gold shows on the labial surface, and what is visible should be filed to resemble a gold filling. In a case where two canines remain standing in the mouth with the incisor teeth absent, this type of fastening works admirably, because the canines are neither drawn together nor forced apart.

Platinized gold by its elasticity permits the fastenings to slip over the widest part of the canines, and to grasp them sufficiently to prevent any up and down movement, that might take place without this help. These fastenings should be carefully filed to shape with rounded or bevelled edges, so that the hard gold cannot scrape the enamel.

Many dentures are made in the course of the year, that depend for their support on spur-like projections, which are thrust into the sulci or spaces between the bicuspid teeth in the upper jaws. This method should *never* be used; it sets up irritation of the gum, and causes the bicuspid teeth to decay, where it certainly is not easy to fill them successfully. Indeed, it is not uncommon to find bicuspid teeth moved out of position from the thrust they are subjected to with this form of denture.

For some time past I have used thin sheet-copper in making patterns for fastenings, as it can be fitted very exactly to the position which the fastening is intended to take. This pattern can then be opened and laid on the sheet gold lengthwise in the direction in which the gold has been rolled, and its shape scratched on the gold with a fine steel point, so that the workman can easily cut it out with suitable instruments. The piece of gold is then carefully annealed and bent into shape with suitable pliers. Care should be exercised when the fastenings are bent to fit the teeth, and before the plate is completed, to see that the fastenings cannot be *bitten* on by the opposing teeth of the other jaw; I have seen very great discomfort caused by this oversight.

Many dentists model to vulcanite cases bulky fastenings which have little or no elasticity. In mouths subject to free deposit of soft pasty tartar, this mode of practice invites rapid decay at the necks of the teeth. It is better to use gold fastenings made with the same care and finish as for gold work.

Fig. 58.

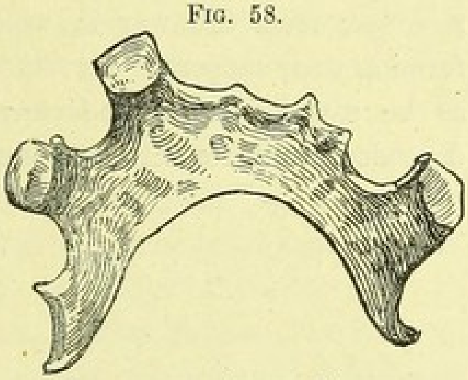


Plate with Short, Stubby Fastenings.

Short stubby fastenings devoid of elasticity, as shown in Fig. 58, should never be used, as their pressure almost invariably causes the surface on which they rest to decay; the teeth are also moved out of position, and the patient is kept in needless discomfort. If we remember that the teeth of most human beings are in a state of forward movement in their sockets for many years of life, this method is undesirable to carry out. Stiff fastenings thrust out of position the teeth against which they press. These thrusts and losses of position are followed up by repeated adjustment on the part of the dentist, to satisfy the patient's desire for stability.

When two or three fastenings are used to a plate, they should be made so as to act in harmony with each other and the teeth to which they are applied, and at the same time to be free from unnecessary strain, when the upper and lower teeth are brought in contact during mastication. Time and care should be given to the bending, shaping, and adjustment in the mouth of fastenings, otherwise the tensile strength is apt to be misapplied or overlooked.

In my opinion, it is essential that a plate and its fastenings should be without reproach in all their particulars. In all cases, plates and their fastenings should be so designed that an intelligent patient can remove them from the mouth at least once a day for the purposes of cleaning.

In the past it was a common practice to make fastenings like cages to cover the crowns of lower teeth when one side of the mandible was edentulous, and a spiral spring was used to retain the upper denture in position.

Very beautiful and skilful work was done in this direction from the workroom point of view. A little reflection, however, would have pointed to the instability of such a form of support. The cages were commonly bitten out of shape, or they caused so much annoyance to the teeth on which they rested, by acting like wedges between the molars and bicuspids, where they crossed the crowns, that their retention was out of the question. In a year or two these fine teeth became loose, and had too often to be removed, from the way in which food became entangled in the wires forming their support. My father never used this method of construction, as he saw its defects too clearly; he treated such cases with two independent dentures without spiral springs, and was constantly successful.

CHAPTER XI.

SOLDERING.

No workroom art is more troublesome to learn than that of soldering with the mouth blow-pipe; "hard-soldering" especially seems to prove an insurmountable difficulty to many. Neat and workmanlike soldering of gold and other precious metals depends on the fit of the surfaces intended to be joined together, on the cleanliness of the joint, on the use of sufficient solder and no more, on the equal and judicious heating of the whole surface before any attempt is made to "flow" the solder, on the quickness of the eye in cutting off the heat as soon as the solder has run in the desired position, and on the use of flux to prevent the oxidation of the surfaces of the metal and the solder.

The mouth blow-pipe is a tapered tube, nine or more inches in length, made of sheet brass or copper, and bent to a quarter of a circle at the lamp end. The end used in the mouth is about three-eighths of an inch in diameter, and the end used in the flame of the lamp is about an eighth of an inch in diameter. Mouth blow-pipes are of various forms according to the nature of the work for which they are used, but excellent work can be done with the common pattern by one skilled in its use. The mouth end is held between the lips, and the air from the lungs is blown through the tube into the flame so as to deflect it on the parts to be soldered. Deep chest breaths are necessary in prolonged soldering so as not to interrupt the blast and thus allow the work to cool. It requires some practice to take breaths through the nose while the air is being expelled from the mouth by the elasticity of the lips and cheeks. The tip of the tongue is also used to shut off the air blast at critical moments.

With the blow-pipe, two kinds of flame can be made: one, a large, rough, noisy flame, made by placing the free end of the blow-pipe touching, or just touching, the nearest part of the flame; the other, a pointed jet with a much higher temperature, made by bringing the blow-pipe into the flame mantle, and projecting it on the surface to be soldered in short, quick darts, so as to coax the solder to run in the desired direction. The large rough flame is used for heating the general surface of the object to be soldered, and the pointed but hotter flame for heating the spot where the highest temperature is needed.

No better practice can be entered on by the beginner than soldering small pieces of silver. Silver melts more readily than gold, and is much more easily "sweated" or oxidized, so that the failures that are inevitable in learning are much more quickly learned with silver than with gold, and at a much smaller expense.

Tube tooth pins especially should be thoroughly soldered to the plate, so that a patient will not come back months afterwards complaining of the dropping off of the tooth and pin,—a defect due to the pin having been originally fitted so tightly in the hole in the plate that the solder could not flow through. Whether the pins are invested or tied with binding wire, it requires the exercise of a quick eye and a strong easy-flowing solder to do this little operation successfully without melting the pins on the plate. Soldering swivels to a gold plate also calls for skill and patience—as so many of the swivels now made are made little better than the solder in carat, and are only too easily melted with the least increase of heat.

Small objects can be soldered with ease by the aid of a potato. It is cut to a suitable shape, and the parts to be united are brought into the desired position by plunging the free ends into the substance of the potato. Securing the object to it with staples, also by cutting a slit or groove deep enough to hold the gold article firmly, are obvious ways of using this kind of support. Working jewellers often reduce the size of rings set with jewels by this means, leaving only the parts to be soldered exposed to the action of the soldering flame.

Mr. Fletcher, of Warrington, has made the soldering of invested plate-work comparatively easy by introducing the Plate Dryer and Heater for dentists' use.

The invested plate and teeth can be prepared for soldering by scalding away the adhesive wax and placing solder and small scraps of gold in position, with borax ground into a paste. The investment is placed on the lighted burner (Fig. 59) under the fire-clay dome, and slowly heated to redness.

The red-hot investment holding the plate is set on the soldering-wig, and a few jets of flame from the blow-pipe will flow the solder quickly and evenly where it is wanted. Solder is best cut in moderately small pieces, and each piece should be dipped in the liquid on the borax slate before it is placed in the position where it is wanted. If the work intended to be soldered is slowly heated to redness, the solder remains where it is placed, and held in position by the desiccated borax. It therefore ought not to be necessary to suspend the soldering in order to add bits of gold or solder for each tooth or pin, as is sometimes done.

Fig. 59.

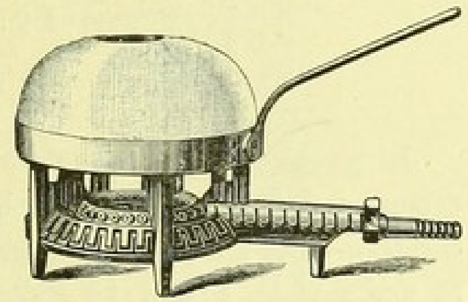


Plate Dryer and Heater.

Some workmen cannot solder without the assistance of a steel point to direct the solder or to hold it in the desired position. If the little panels of solder are laid in position in the first instance with well-ground borax, this ought not to be necessary. I have seen complicated and intricate forms soldered with precision and care by jewellers without adding any more borax or solder when once the work was heated—forms exceeding in delicacy and difficulty any that a dentist is ever called upon to solder.

There are endless varieties of solder to be met with, and some workmen will employ these different kinds on the same piece of work. *One* well-selected, well-tried formula ought to meet all the purposes of a dentist, if the work is well made, as it soon becomes second nature to know what can be done with such a solder employed under a variety of conditions. For some time past I have used a solder made with eighteen-carat gold scraps and cadmium. The gold is weighed and melted on a coal, and due proportions of cadmium are added to the melted gold. The resulting button is hammered on the anvil, and rolled, after repeated annealings, down to a desirable thickness in the form of a ribbon. It is then annealed, pickled, and scoured with pumice and water ready for use. I like this form of solder, as it is very strong and remains a good colour after flowing. It flows like water into crevices and awkward places, if the surfaces are duly scraped, cleaned, and treated with well-ground borax. I think cadmium is to be preferred to zinc in gold solder which is to be worn in the mouth.

My friend, Dr. W. A. Hunt, Yeovil, Somersetshire, has most kindly furnished me with the following formulæ for cadmium solders which he has been using for upwards of thirty years. Cadmium solder is strong and easy-flowing for gold work. It never changes its colour. The formulæ were originated by the late Mr. T. Arnold Rogers, of Hanover Square, London, and were used by the late Mr. Sercombe, from whom Dr. Hunt obtained them :—

No. 1.	Cadmium	1½	grains to 24 grains	of	18-carat	gold.
No. 2.	,,	2	,,	,,	,,	
No. 3.	,,	3	,,	,,	,,	

In practice, No. 3 formula serves for all purposes, is of an excellent colour, and is not discoloured by acids. In making this solder, clean eighteen-carat scrap-gold, or clean scraps taken from the gold employed to make plate, should be melted in correctly weighed quantities in a plumbago crucible, a small piece of borax being used to clear the melted surface of the gold. The gold should be put in the crucible by itself, and the cadmium should be melted in a small crucible held in the tongs over the furnace flame. When melted at this lower temperature, it is suddenly poured into the melted gold ; a hot crucible-cover should be instantly put over the mixed metals to prevent loss of the cadmium by oxidation. In half a minute the solder may be poured into an ingot ; it should roll out without crack or flaw, and can then be cut for use.

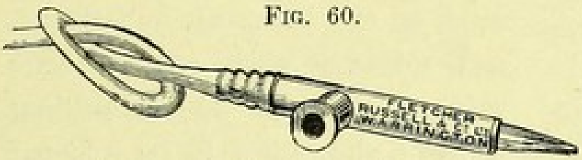
Mr. Edward Goodman, of Taunton, Somersetshire, makes cadmium solder as follows :—He first weighs out six dwts. of clean eighteen-carat gold scraps, and then one dwt. four grains of cadmium. Making the gold as fluid as he can with a bellows flame, he quickly drops the cadmium into it with a pair of tweezers, and uses a fair quantity of borax.

Small quantities of cadmium solder can be melted in Fletcher's little open fire-clay crucibles, such as are supplied with his melting arrangement. The resulting button of solder should be carefully rolled into a ribbon. As it rapidly becomes brittle under such compression, it should be carefully annealed each time it is rolled, and it is scarcely necessary to add that extra care must be taken with the annealing the thinner the ribbon gets.

There are several forms of mechanical blow-pipes which are used by some workmen in preference to the mouth blow-pipe ; and some are supplied for use either with the mouth or foot blower.

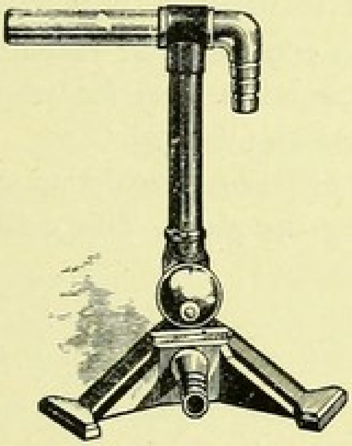
Fletcher, Russell and Co., of Warrington, supply several patterns, which are shown in their list, such as the automatic blow-pipe, pattern C.10; the universal blow-pipe, No. 3 (Figs. 60 and 61); the jewellers' and dentists' pattern blow-pipes, No. 1 (Fig. 62) and No. 3, all of which are splendid tools and work perfectly with their 9 B, size 3, foot blower.

Fig. 60.



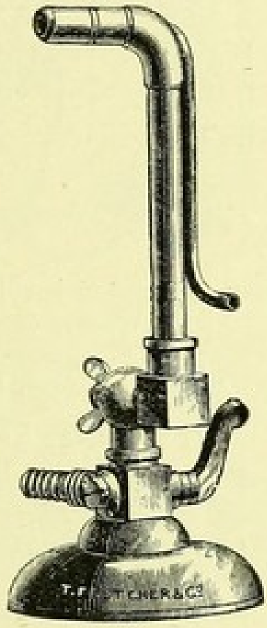
Fletcher's Universal Blow-pipe (simple form).

Fig. 61.



Fletcher's Universal Blow-pipe on Stand, with Swivel Joint.

Fig. 62.



Fletcher's No. 1 Dentists' Adjustable Blow-pipe.

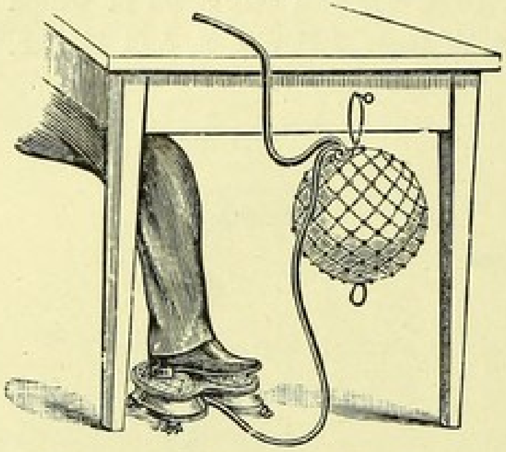
Standing's foot blower (Fig. 63) is also much used by dentists and jewellers.

The illustration (Fig. 63) shows sufficiently clearly the mode of using Standing's blower while soldering seated at a table. This blower is made in two sizes, the smaller one being sufficiently powerful for all ordinary dental soldering. The continuity of the blast is maintained by the aid of the elastic rubber bag, which is hung from the table out of the reach of injury from a spark.

It is, I fear, impossible to teach the art of soldering by description in a book. Practice makes perfect, and one learns more of the art from a few failures than can be learned by reading many chapters of a book, no matter how vividly they may be written.

Many delicate details of soldering crowns and other small objects can be carried out without the blow-pipe by using a Bunsen gas burner, or even a spirit lamp, if the parts do not need investment to hold them together.

Fig. 63.

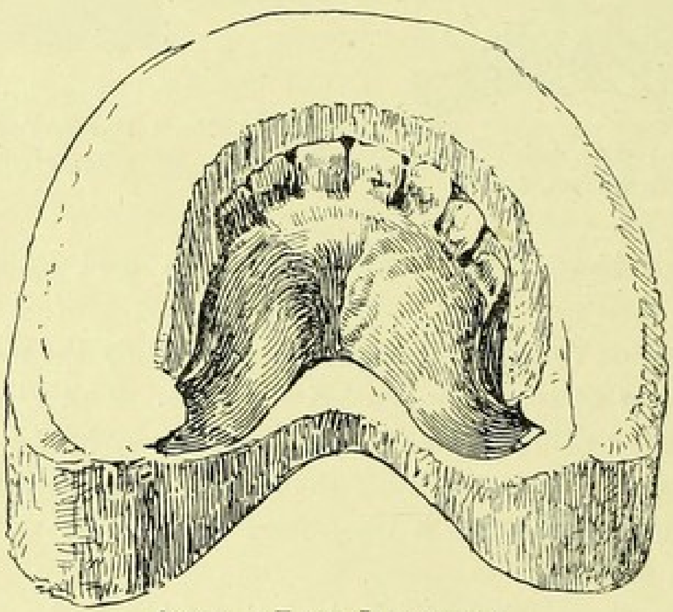


Standing's Bellows for Blow-pipe Work.

The art of soldering in damp sand is one of great importance, and splendid work can be done without difficulty by embedding parts of the object to be soldered in wet sand on a charcoal or pumice soldering block. With the exercise of ordinary care, this way will be found of very great help with some forms of fastenings and plates, when time for preparation by more deliberate ways is not at the workman's disposal.

Much stress seems to be laid on the difficulty of soldering dentures mounted with plate teeth without warping the plate. This difficulty is chiefly caused by injudiciously employing an excess of plaster and pumice in investment (Fig. 64).

Fig. 64.



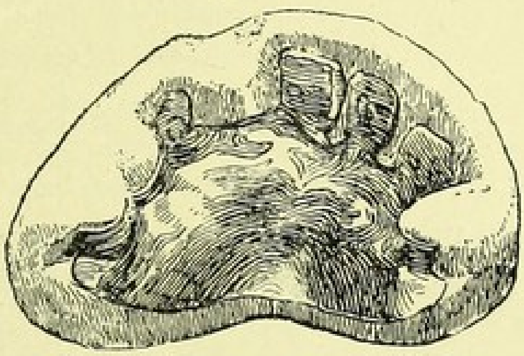
Shows a Thick Investment.

It will be found that a comparatively thin investment (Fig. 65) is less likely to cause misfit, as the thickness of the investment does nothing to ensure the security of the position of the teeth.

In this class of work time is saved if the case be put in the plate dryer with all the necessary pieces of solder or gold placed ready in position. If this investment be brought slowly to a red heat in the plate dryer and heater, the soldering can be completed in a few seconds.

If care be taken that the solder does not flow between the backs of contiguous teeth, but that it is simply used to attach the pins to the backs and the backs to the plate, treating each tooth as a distinct entity, little warping should take place. Should it flow between the backings and attach them, as is recommended in some books, the certainty of misfit is ensured.

Fig. 65.



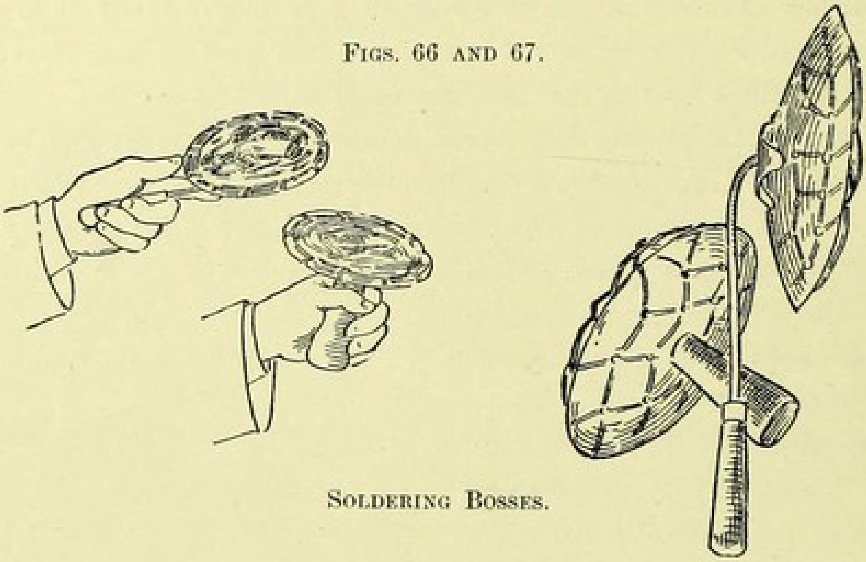
Shows a Thin Investment.

The object of flowing solder in the latter way is to make a smooth surface that does not need much trouble in finishing on the lingual aspect of the denture. In theory this may be a reasonable procedure, but in practice patients do not object to well marked divisions, should they be necessary, provided edges are not left which offer annoyance to the tongue. My experience is altogether in favour of not trusting to the promiscuous use of solder to save time in polishing, and of confining the use of solder to positions where it is necessary. Even if the beginner is not likely to use the mouth blow-pipe permanently, it is the best tool for him to start soldering practice with. Some workmen are so expert with it that they can easily melt two ounces of scrap gold on a coal, while others cannot successfully melt five pennyweights with the same amount of gas and breath. So far as my experience has gone, I have never found the mouth blow-pipe, or the types I have mentioned manufactured by Fletcher, Russell & Co., fail me during many years exercised in the construction of all kinds of gold work.

The illustrations (Figs. 66 and 67) show two useful forms of soldering bosses, which can be turned round by a touch while soldering; they thus readily allow the flame to follow the flow of solder in curved positions.

They have been used by my father and myself for forty-five years, and are as handy and convenient for laying work on or securing it with plaster of Paris as any soldering boss I have ever seen. They are so constructed that the hand is sheltered from the heat.

Figs. 66 and 67.



Soldering Bosses.

Dr. Melotte's soldering outfit is very ingenious and well worth a place in the workroom.

CHAPTER XII.

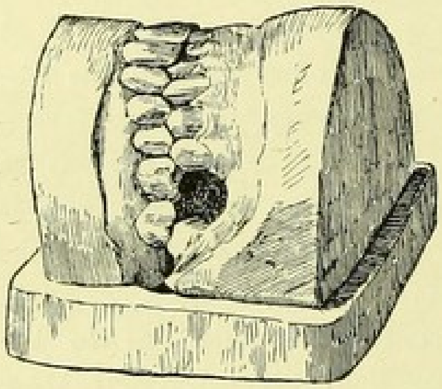
PLASTER BITES AND ARTICULATORS.

During the construction of a denture, it is necessary to ensure the correct relation of the mineral teeth attached to it with the teeth of the jaw with which it is intended to articulate. As a patient cannot be kept at hand during the time which it takes to make a denture—nor, indeed, is it necessary, if correct impressions are taken, to inflict on him the discomfort arising from many fittings of the parts comprising a denture—it is necessary to find a substitute that will, with some approach to accuracy, represent the relations of the jaws to one another. This is found by casting the wax bite in plaster, or by its aid attaching the plaster models of the jaws to metal frames called articulators.

There is, unfortunately, a great diversity of opinion as to the respective merits of plaster bites and of metal articulators. Both these conveniences have disadvantages of their own, but as plaster bites are as old as the century, and as a good workman finds his own way superior to those of the theoretical and ultra-scientific dentist, plaster bites will retain their use for many a day to come. Plaster bites are readily cast and are accurate enough for all purposes, if the relation of the models of the mouth are retained faithfully in the position which the practitioner, from close inspection, has satisfied himself to represent the relative position of the jaws of the patient. It is necessary that the greatest care should be taken to preserve the accurate relation of the parts. Bites are commonly handed over to be cast by the most junior and inexperienced workman, with the unhappy result that the articulation, so carefully obtained by the practitioner from the patient's mouth, is inaccurate and faulty. The wax bite or articulation may have cost the practitioner valuable time and much trouble to secure, and a speedy reference to the patient may prove to be impossible, should any inaccuracy take place in the casting. An accurate bite is therefore to be treasured and preserved, as on it much of the comfort of the patient depends, and to it much of the success in treatment on the part of the practitioner is to be credited.

Plaster bites are to be found of several types. The commonest and very often the most inaccurate form is that known as the slab bite, which is made in three parts, formed by the models and a plaster slab on which they are bedded (Fig. 68). I am not a lover of this form of bite, as it is bulky to handle and has a tendency to alter the relative positions of the models, owing to the expansion of the slab after casting. It is made by placing the upper and lower models in correct relation to each other by the aid of the wax blocks, which have been removed from the patient's mouth. The backs of the models are then oiled, and the models are sometimes tied securely together. The oiled surfaces are gently pressed into a mass of wet plaster on the bench, formed into a parallelogram to suit the dimensions of the backs of the models. The plaster is allowed to set, and the models are separated from the plaster slab, which is then trimmed to a convenient shape with a sharp knife. If the models are allowed to separate during the casting of the slab, an inaccurate bite will be the result, and teeth ground and fitted to suit the relation of the plaster models to one another will not be found in correct relation in the mouth.

FIG. 68.

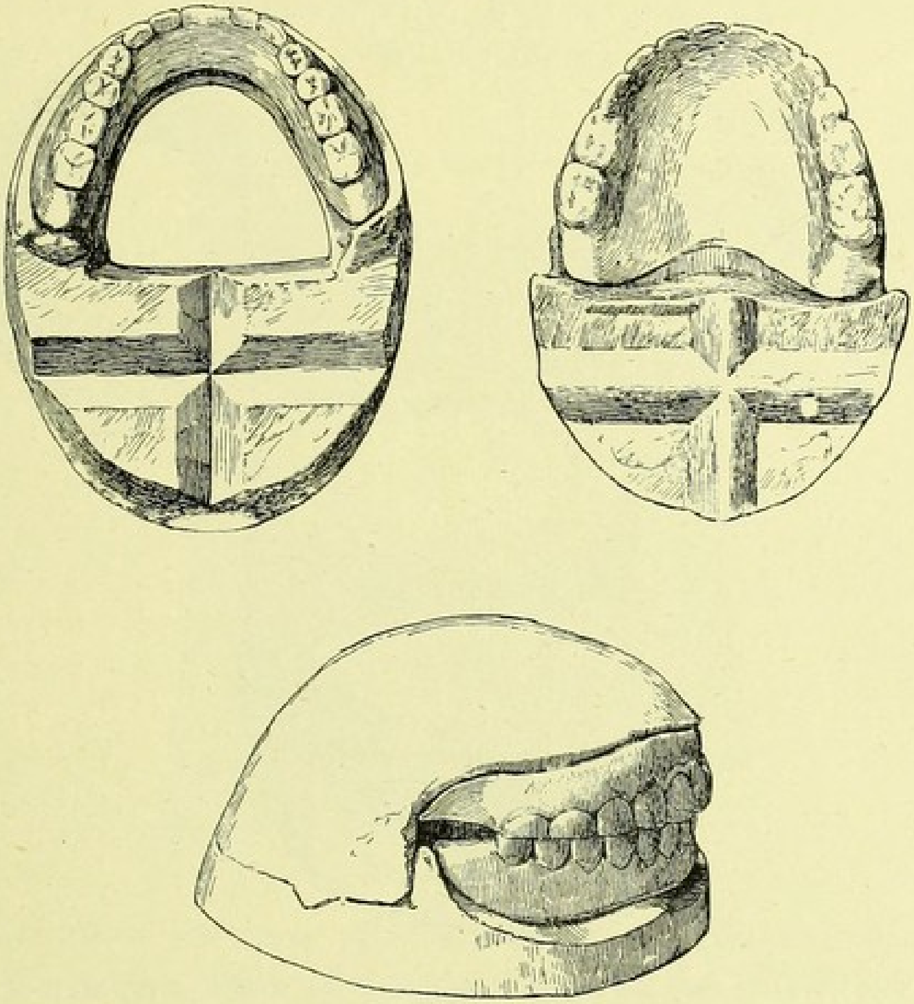


THE SLAB BITE.

Another form of plaster bite will be found in the type known as the tail bite (Fig. 69). This kind of plaster bite has only two parts, its bulk is of moderate size, it is easily handled, and all the details of the needful articulation can be seen during the fitting of the teeth. This form of bite can be used for endentulous mouths, as well as for endentulous maxillas, when the lower part of the bite consists of a cast of the lower teeth attached to the "tail" on which the upper or maxillary part of the bite is cast.

The dovetail plaster bite is another type that is very commonly used (Fig. 70). It is formed of two parts, the model and the "bite," and is used for partial cases on either side of the upper or lower "dental arch" —also sometimes for endentulous upper cases. This bite is made by cutting a dovetail socket out of the end or side of the model, whichever may prove convenient, placing the wax bite on the model, filling the indentations which the patient's teeth have made in the wax, and connecting them with the dovetail by means of plaster. The parts of

Fig. 69.



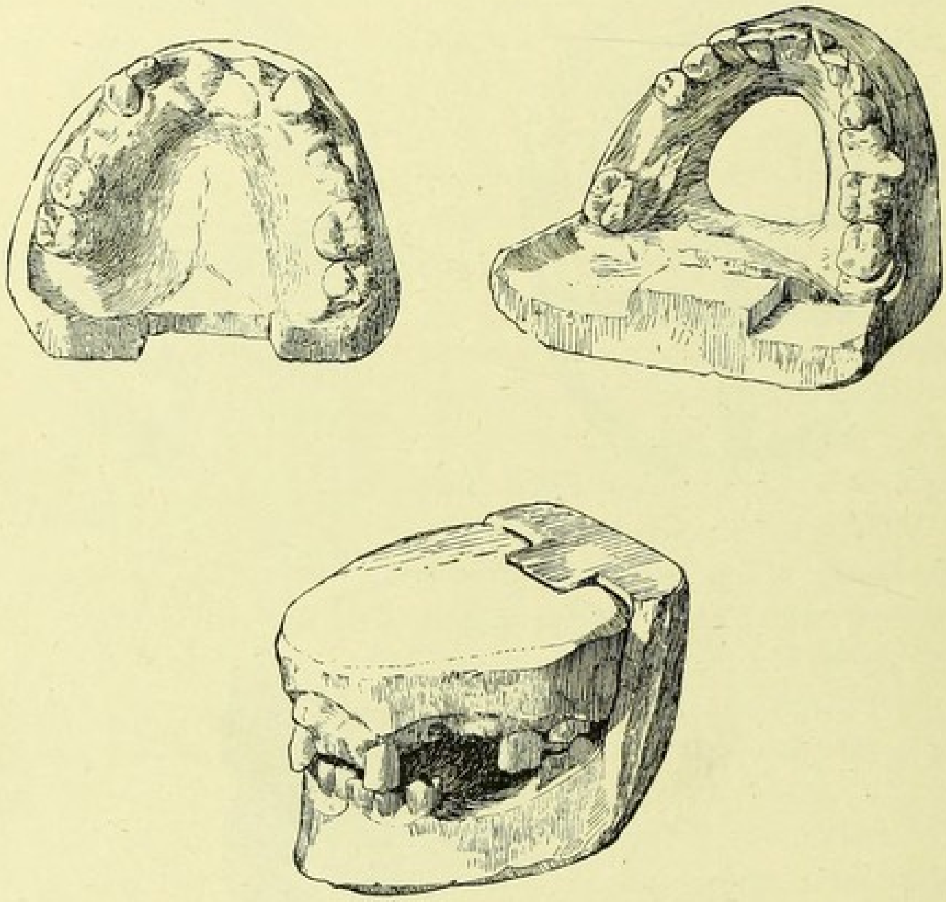
The Tail Bite, with a Window cut in the Model of the Mandible.

the wax, the plaster, and the model on which the plaster rests, are oiled to prevent the plaster adhering to the model.

This form of bite can also be made by placing a cast of the lower teeth in the wax bite on the model and connecting it (after having previously made suitable means of attachment to the dovetail) by casting the intended bite in plaster.

Some dentists prefer a deep V-shaped groove instead of the dovetail, —but from a long experience I prefer to use the tail bite or the dovetail bite, as there is less risk of error. The bites are formed in two pieces, and are more convenient to handle while working. My experience in the use of slab bites is not large, as the only time I ever used them was during

Fig. 70.

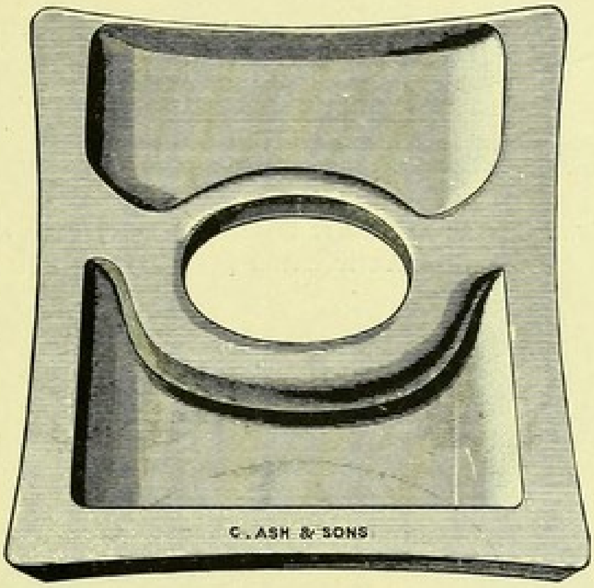


The Dovetail Bite, with a Window cut in the Model of the Mandible.

the *régime* of an assistant who could not work with any other form of bite. The results to me were unhappy,—for, despite every care in getting a correct bite from the patient's mouth, the work came out too high, or, in the case of an unsymmetrical bite, the relations of the models were changed by this man of convention, and I had constantly to take a second bite and see it cast myself, to ensure that the natural relations of the jaws as I had seen them were preserved.

Mr. Lennox, of Cambridge, has introduced an ingenious variation of the slab type of bite by laying his models in a specially made fusible metal slab-articulator with an opening in the middle (Fig. 71), through which the workman can look when the bite is in use, in order to see that the teeth are duly articulated on the lingual side. The bite is made by pouring into the tray sufficient fusible metal to fit the backs of the models to form a slab (Fig. 72). This way of making a bite is about the quickest I know, but it still has the disadvantage of a bite with three working parts (Fig. 73).

Fig. 71.

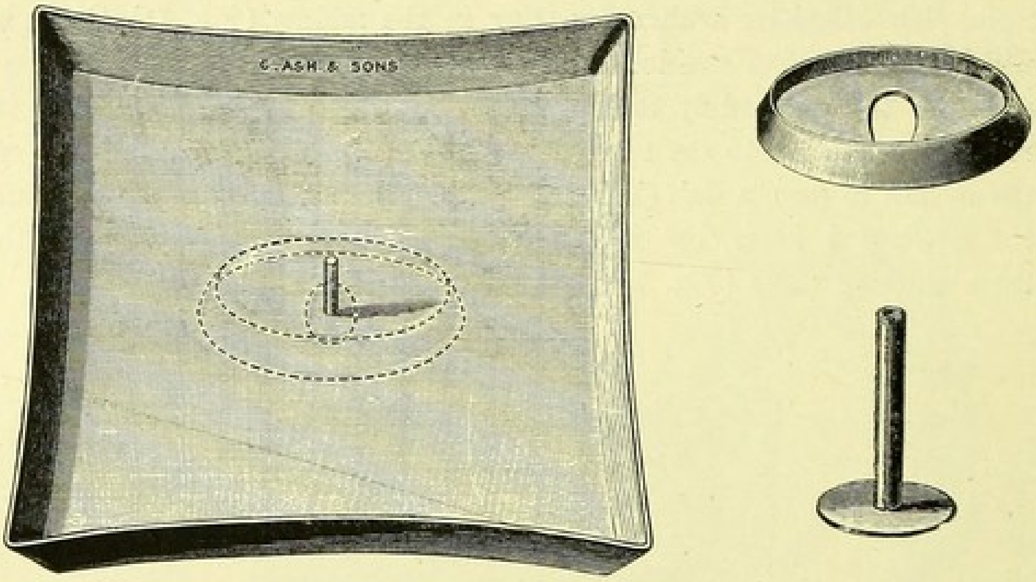


Mr. Lennox's Fusible Metal Slab-Articulator.

Articulators are frames on which the plaster models are secured by means of a little freshly mixed plaster. They are usually furnished with some form of hinge, and some of them are supposed to supply all the movements of the tempero-maxillary articulation. The forms of articulators are very numerous, and many of them can be purchased in the depôts.

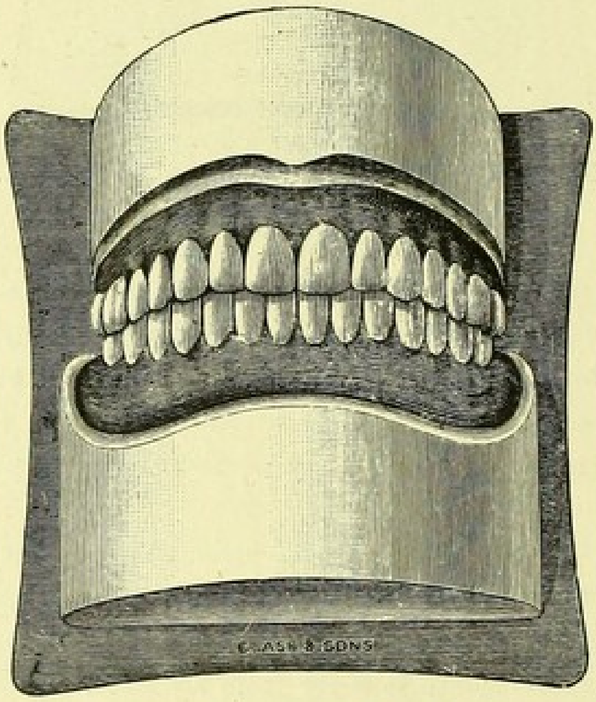
Personally I am not enamoured of articulators, as they are commonly furnished with too many working parts, neglect to secure any one of which may set the bite astray, the result being that when the denture is tried in the patient's mouth it is far from accurate. From an experience of some years in work carried out with the assistance of a workman who

Fig. 72.



Tray, Oval Centre and Split Post with Disc, used in making Slab-Articulator (Fig. 71)

Fig. 73.

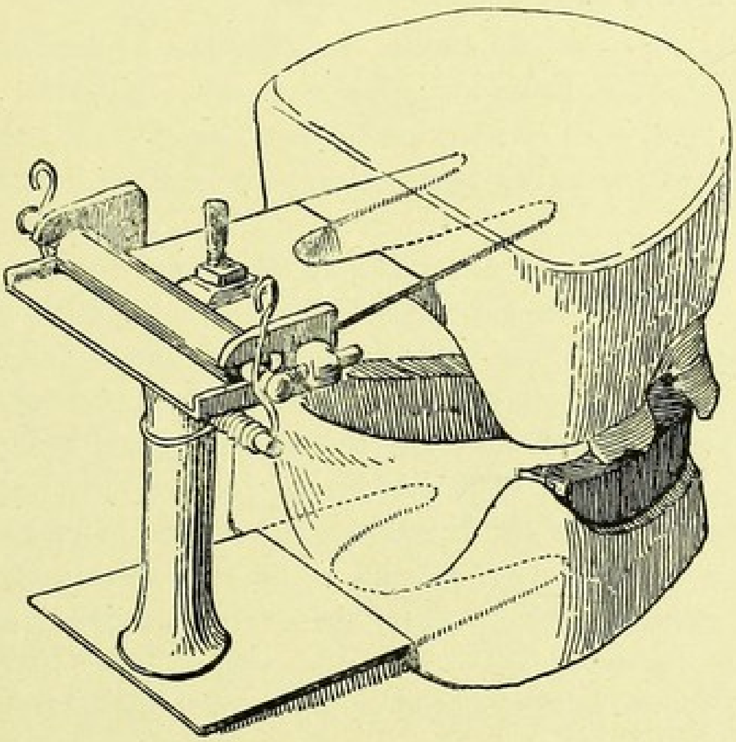


Shows Models in Position on Slab-Articulator.

could use only his pet articulator, I look upon articulators as a fertile cause of inaccuracy in setting up bites: the workman having an irresistible tendency to make the plaster models look symmetrical, instead of casting them to the articulator as the wax bite comes from the patient's mouth and is handed to him by the practitioner.

One of the best articulators which I have seen I find in use in the workroom of my friend, Mr. Amos Kirby, of Bedford, who has kindly

FIG. 74.



MR. KIRBY'S ARTICULATOR.

permitted me to make an illustration of it (Fig. 74). It is easily handled, easily set up, and it gives the lateral play of the tempero-maxillary joint, together with some power of adjustment by means of three screws, which do not easily become loose. The upper case can be shipped in position and unshipped with the greatest ease, even when working at very high speed. The details of the construction of this articulator can be gathered from the illustration.

Whatever form of bite or articulator is chosen, care should be taken during the casting of the wax bite that only the articulation as seen in the mouth is taken for use. Time, trouble, and material are all wasted by neglect in this important particular, and disappointment and discomfort are inevitably experienced by a patient when a false bite has been worked from.

Personal predilection and habit play a large part in the use of inconvenient bites and articulators in workrooms, where the practitioner himself does not take an active part in the details of construction.

Useful tools may be designed and purchased, but no inducement will ensure the use of such in the hands of the conventional workman, because "he is not used to it."

CHAPTER XIII.

MINERAL OR PORCELAIN TEETH.

THE several kinds of artificial teeth used by dentists are made of a strong translucent porcelain. They are commonly called pin teeth—this term represents flat or plate teeth and vulcanite teeth—tube teeth, pivot teeth, diatoric (pinless) teeth, gum teeth, and gum blocks or "sections" of the dental arch.

English teeth are made at one baking in the furnace, the body and glaze being combined in the paste used in the moulds. These teeth are very dense and strong, and can be readily ground and polished, should changes of form be necessary in the arrangement of the teeth, or to make cutting edges of incisors resemble those of the natural teeth that may be left standing in the mouth. By artificial light there seems to me to be a loss of translucency, and the appearance of the mineral teeth is greyer than the living teeth with which they are associated in the mouth.

American teeth and blocks are made by first biscuiting or baking the porcelain "body" without the glaze. The glazes are added to the biscuited teeth or blocks in two or three coatings, each of which has to be "fired."

Gum teeth and blocks have the colour of the gum added by means of an enamel which is fired in the furnace, and is melted or baked on the surfaces which it is intended to occupy. This method of manufacture has a most realistic appearance both in and out of the mouth, but it has the disadvantage that if changes of form are made by grinding the teeth, the surfaces exposed below the glaze cannot be polished to match the glossy surface which has not been ground.

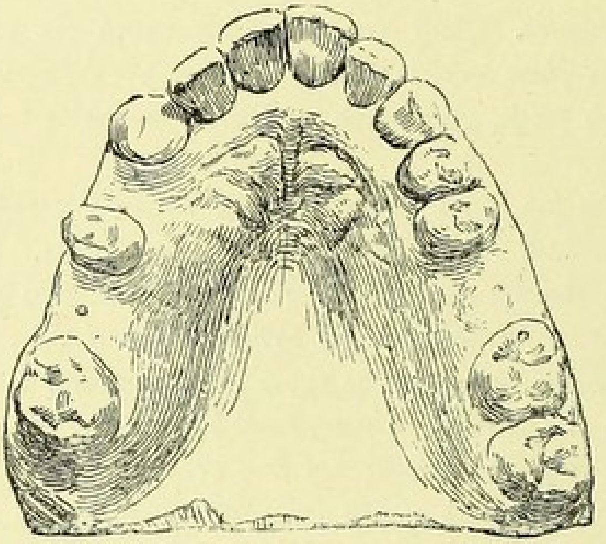
Plate teeth are commonly used by passing the platinum pins baked into the back of them through perforations made in small plates of metal called "backings," which are fitted to the backs of these teeth, and to which the platinum pins are secured by bending or riveting and soldering.

The "backed" teeth are attached to the plate by soldering that part of the back which rests on or near it.

Gum teeth are a variety of this type of tooth, which have a gum colour added to their necks. They are intended to fit into hollows on the labial surface of the alveoli, where much absorption has taken place, from accident or extraction, in cases where patients expose their gums by the action of the lips.

Plate teeth are also commonly used for vulcanite work, and many dentists consider that they possess advantages over vulcanite teeth.

FIG. 75.



RHOMBOID SPACES.

Vulcanite teeth, with platinum pins baked in their substance, differ in form from plate teeth, by having a section of the lingual contour of the teeth left projecting above the pins.

Pivot teeth are crowns prepared to receive a pin or pivot in the middle of the surface which rests on the end of the prepared natural root, the crown of which has been lost by accident or disease.

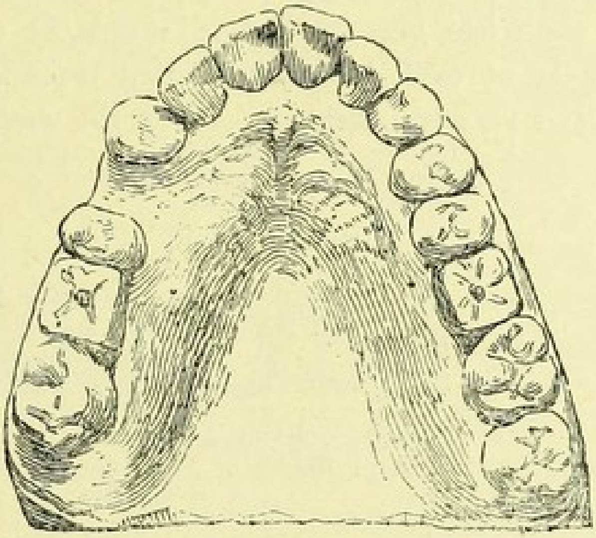
Hickory pegs, gold and platinum wire, and other kinds of wire are used as the means of securing the crown to the root.

Tube teeth have a tube of platinum baked in the long axis of the mineral, by means of which they are mounted on pins soldered to the plate.

Diatoric teeth, which are used in vulcanite dentures, are hollow crowns with lateral openings from the central cavity, so as to attach them firmly to the vulcanite placed in these hollows when the process of vulcanization takes place. This type of tooth obviates the use of the costly metal platinum in the form of pins.

Gum blocks consist of two or more teeth modelled with a surface of gum, and can be had in an endless variety of forms. They are also called gum sections, as they are also supplied in groups of three or four sections, which carry out the articulation of the dental arch, whether for the maxilla or the mandible. Some practitioners are enamoured of this class of work, but the limit of adjustment and the absence of symmetry in

Fig. 76.



Rhomboid Spaces, filled with Square Tube Molars.

many mouths tell against their use by dentists who have not artistic feeling.

There are dentists who employ "carvers" to model teeth into gum blocks, and bake them for special forms of irregularity of teeth characteristic of certain patients.

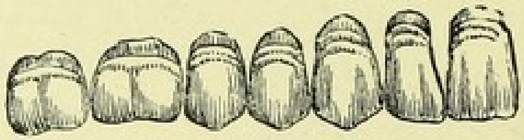
During the past fifty years much attention has been given to the manufacture of mineral or porcelain teeth, and one would think that during this period, in which the most extraordinary developments of mechanical and scientific invention have taken place, something more realistic in the external forms of the human teeth would have been placed in the hands of dentists by the manufacturers. The manufacturers undoubtedly deserve very great credit for the improvements they have made in the colour and texture of artificial teeth.

During the past twenty-five years, however, it cannot be said with justice that such attention has been paid to the production of anatomical tooth crowns as might have been expected.

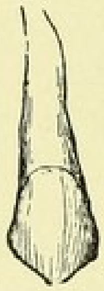
In the manufacturers' stock will be found teeth possessing forms that may be roughly divided into two classes—one, a conventional modelling of the forms of the natural teeth; the other a class in which a realistic treatment of certain abnormalities in form, mostly in the creasing of enamel, is attempted, but many of these attempts at reproducing the grooves or creases in enamel are, I must say, ridiculous.

The artificial abnormalities are made so inhumanly symmetrical in all the incisor teeth, as to be mechanically ugly when used to replace the lost natural teeth (see Figs. 75 and 76); and the creasing of the enamel at the necks of teeth is only too often carried out on teeth upon which we never see such markings, even in the most extreme types of abnormality.

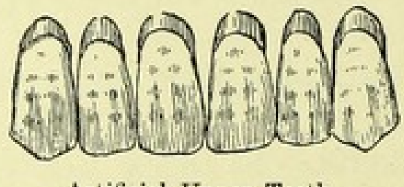
Fig. 77.



Realistic Treatment.
Pattern Making or Tooth Creasing—never seen in Nature.

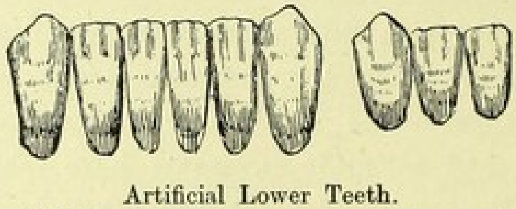


Upper Natural Canine.



Artificial Upper Teeth.

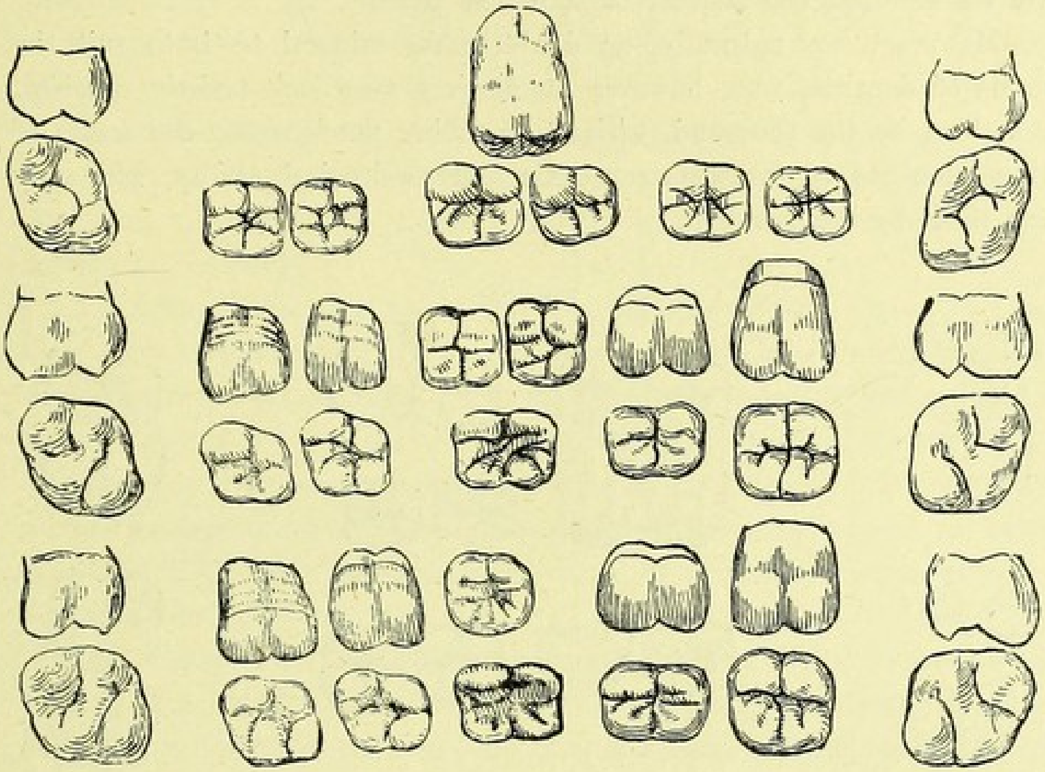
Lower Natural Canine.



Artificial Lower Teeth.
Pattern Making by Tooth Carver who does not study the Natural Teeth. Centrals practically same size as Laterals, Canines, assegai shape.

Absurd Conventional Modelling of Artificial Crowns.

Fig. 78.



Natural Teeth which show the Cusping of the Upper Molars.

Conventional Artificial Tooth Forms, which show the Eccentricities of the Tooth Carver. All these Forms are issued as Upper Molar Crowns.

Natural Teeth which show the Cusping of the Upper Molars.

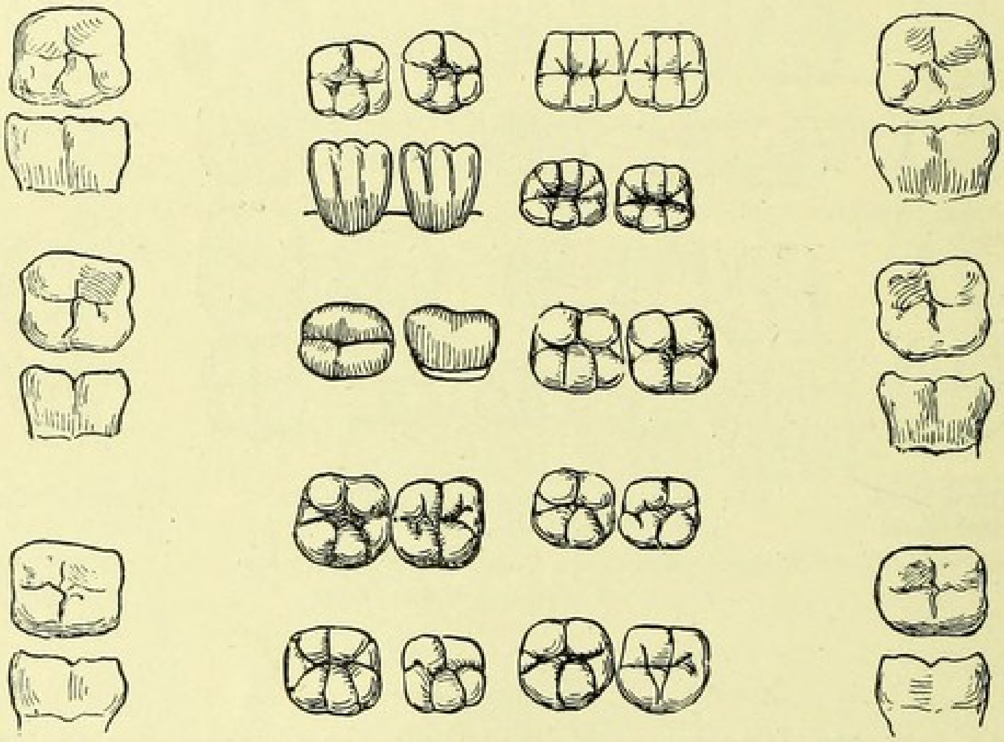
If our manufacturers would only study the characteristics of the *normal* anatomical human tooth, in cusps and in contour of crown, very useful additions could be made to our resources. Fidelity to nature, useful restoration of articulation where spaces in the maxillary arch should be filled by teeth of rhomboidal form, instead of the double cube or cube-like forms we have to use, from no choice of our own, could be easily attained. The form of a mineral tube tooth, for instance, whether it is of the conventional or so-called natural pattern, leaves much to be desired. The illustrations (Figs. 77, 78 and 79) show how far removed these teeth are from the natural contours.

This negligence of form can, perhaps, be explained in two ways :— (1) The indifference of a large body of dentists to really artistic restoration of the defects of articulation caused by the loss of the natural teeth ;

and (2) the lack of proportion to be observed in mineral teeth when they are set amongst the natural teeth of the patient.

Manufacturers naturally, no doubt, make mineral teeth to suit the needs of dentists, who, however much they may lack artistic capacity, use them by the thousand, without troubling much about the wants of those dentists of far higher artistic and mechanical ability, who only use them by the hundred.

Fig. 79.



Natural Lower Molars. — Artificial Lower Molars, which show the eccentricities of the Tooth Carver. — Natural Lower Molars.

Another reason why indifference to natural form is so marked is the startling fact that the workmen, who carve the metal moulds in which the mineral teeth are formed, *never* study natural teeth.

If it pays porcelain manufacturers, in such places as Worcester and Etruria, to maintain schools of art and valuable collections of ceramics, with which to educate the eye and cultivate the tastes of their modellers and painters, surely it would be of advantage to the manufacturers of mineral teeth to place a fine collection of natural teeth at the service of their mould carvers.

During a recent visit to the works of the largest manufacturers of mineral teeth in the world, I was painfully impressed with this omission to supply the clever carvers of moulds, whom I saw at work, with suitable natural teeth for study or imitation.

It is a fact that the mineral teeth in the full sets of uppers and lowers, which we see so beautifully arranged upon wax cards, will not articulate with one another if taken from different sets, as a similar collection of human teeth would.

Practical dentists are aware that simplification of the cusps of mineral teeth may be necessary. Yet as we have never had even normally correct anatomically cusped mineral teeth placed at our disposal, this point cannot be determined off-hand by the manufacturer without experiment.

The feeble attempts at cusping, seen on the crowns of some of the molars manufactured by our very best firms, show that something better is needed than these empirical decorations of masticating surfaces, which are only worthy of the bone age.

One would think that a few weeks' experiment would show the uselessness of much of the misplaced ingenuity of these molar crown cuspings, and free us for ever from the vile conventionalities of the mould cutter, who never seems to study nature accurately, if we may judge by the results of his work.

The grooving and creasing of enamel, following the line of the gum margins, which has become so prevalent with some manufacturers, might be omitted, more especially the concentric grooves on such teeth as bicuspids and molars, in which these abnormalities rarely, if ever, appear in the natural teeth; they may occasionally appear on the labial surfaces of centrals and laterals.

A cursory inspection of the Bernard Davis collection of skulls in the Hunterian Museum will show how much at variance with anatomical accuracy are many of the forms of mineral teeth.

It is becoming quite unusual to find any difference in size between the lower centrals and laterals in mineral teeth, with the natural result that many patients are disfigured by having to wear teeth that look like garden palings or piano keys. Nothing can be more disfiguring than such teeth. A little attention to the forms of the incisors, on the part of the manufacturers, would alter this inartistic conventionality, and permit of a less noticeable and more natural-looking restoration.

Some manufacturers supply us with teeth which are said to be copied from natural teeth. They are somewhat less unnatural-looking than the conventional types which I have mentioned, but they also are disfigured by an unnatural bulging or thickness at the necks of the incisor teeth, where in natural teeth a *constriction* is well marked. This contour becomes spheroidal, instead of possessing the beautiful lines seen on the natural teeth, which are like the "entrance and run" on the hull of a well-designed boat.

Why this clumsiness of form and indifference to the needs of articulation in the mineral teeth for middle-aged patients should be the persistent outcome of labour, enterprise, and the employment of large capital and machinery, is a mystery to me. Were the material, which is wasted in accentuating these peculiarities, scraped away, many more sets of teeth could be made from the same amount of body, and dentists would be saved many weary hours of labour at the grinding lathe.

Much skill and taste can be shown in the selection of the mineral teeth which are required for the construction of a denture. If the dentist is colour-blind and careless, the result, when seen in the patient's mouth, is not happy; the teeth do not seem to belong to the mouth.

In my opinion artificial dentures should be designed to fulfil, in an *unobtrusive way*, the purposes for which they are intended. Study of appearance in this direction is much appreciated by intelligent patients, who do not like to see their mouths "built out," or furnished with "a hedge of ivory" many times too light in colour for their complexion and their age.

Ignorant patients are too apt to overlook the fact that the natural teeth darken by age. Porcelain crowns are often seen standing in the mouth, which have been set on natural roots for many years, and which show a great contrast in tone to the neighbouring natural teeth, owing to the darkening of the latter as the years have passed. Mineral teeth should, therefore, be selected to resemble as nearly as possible the lost natural teeth in form and colour, and to occupy the same position, should the position have been normal.

Cases do occur, where patients are found with their sense of vanity so highly developed, as to be willing to sacrifice good and useful teeth for the correction of some irregularity in form or position. The honest dentist should decline to be a party to such sacrifices. It may be said, of course, that the patient may apply to another and less scrupulous practitioner in the event of his doing so. Be this as it may, I nevertheless believe that nothing is gained in reputation by a practitioner who yields to such solicitations. There are plenty of opportunities to be gained of showing our skill in useful directions without sacrificing sound teeth to a mere sense of vanity on the part of a foolish patient.

Pains should be taken in the selection of mineral teeth, and they should be matched with the natural teeth in good daylight, *or actinic artificial light.*

CHAPTER XIV.

MOUNTING TEETH.

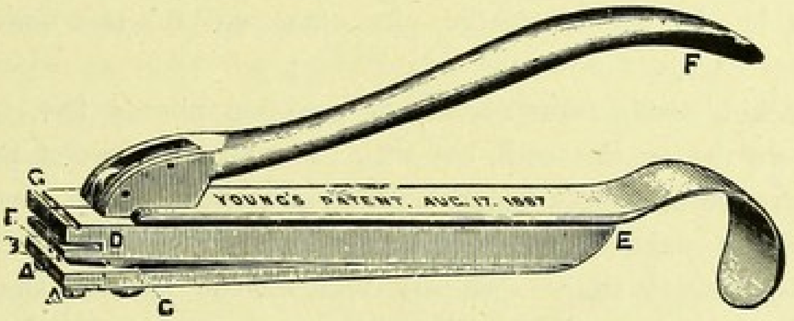
THE mineral teeth used by dentists are attached to, or mounted on, plates by various methods, for which methods they are adapted by the manufacturers. Plain pin, or, as they are usually called, flat or plate, teeth have a porcelain body, representing the labial surface of the incisor and canine teeth, and the buccal surface of bicuspids and molars; the back of this porcelain body is made "flat," and two platinum pins are baked in it, to which is attached a metal "back," either by bending the pins, or by riveting them and then soldering the back to them. These teeth are intended to fit *in* the gum, and they give an appearance of reality if the fit is well executed, and the teeth are arranged in a natural way. From their design it is obvious that they are easily fitted to the plate so as to rest on the surface of the gum, by grinding away the neck of each tooth where it unequally touches the gum or the plate, as the case may be.

Some dentists prefer to grind the teeth first, and back them afterwards. In certain cases I grind them when I have carefully matched them, and try them on the gum of the patient while he is seated in the chair. They can be backed in the workroom, and, after the plaster model has been scraped to bring them, as they have been fitted to the mouth, into the positions which they are intended to occupy on the finished denture, attached to the plate with sticking wax ready for trying in.

Some workmen place the backed teeth on the soldering wig or coal without investment, and then and there solder the backs to the pins; the teeth are thus highly finished before they are invested, and, consequently, the workman's attention can thus be entirely devoted to soldering the backed teeth to the plate. This is not the usual practice, but I do not see why it should not be, as it lessens the workman's anxiety in plate work, besides avoiding the restraint which bending or riveting the pins exercises, when expansion takes place under the great heat of soldering.

The object of backing plate teeth with sheet gold is to support and protect the porcelain. I prefer to have the teeth backed to the cutting edge, as partly backed teeth, when worn in the mouth, are easily noticed by a skilled eye under artificial light. Holes corresponding to the pins are punched in the gold plate, after the plate has been lightly pressed against the pins, the ends of which are touched with vermilion paint and, consequently, leave their impression on the gold. A small centre punch is driven through each impression, and the holes are enlarged with a broach till the pins will easily pass through, and the back will

FIG. 80.



MR. J. C. YOUNG'S PERFORATORS FOR PUNCHING METAL "BACKINGS."

fit on the tooth. Punching is simplified by the use of perforators or pin nippers, with the help of which one hole at a time can be punched.

The best tool for punching the metal backs for teeth is one invented and patented by Mr. J. C. Young, of Warrington (Fig. 80), which punches two holes at a time. I have used it for several years, and no mishap to the tool itself, to the pins, or to the teeth has ever happened.

I was much surprised, during a visit to the United States in 1895, to find that this admirable tool was almost unknown to the dental profession there, although it has been for a considerable number of years in use in the United Kingdom.

The advantages in the use of the tool are "exact correspondence between the holes to be backed," and "quick and easy disengagement of the plate from the perforating pins after punching; the difficulty of separating without twisting or injuring the perforated plate is entirely removed." Further, "the risk of fracture in backing teeth is reduced to a minimum .... no measuring is required; the tooth to be backed is its own gauge."

I would not be without this splendid tool for anything; and I have been surprised to see so many workrooms without it.

The late Mr. Chas. Hunter disparages it in his *Manual of the Dental Laboratory*, when he writes as follows: "Nevertheless, there is much reason for doubting whether even the above excellently designed instrument is to be preferred to that represented by the preceding illustration."

I can honestly say that with the aid of Mr. Young's perforators teeth *can* be backed more accurately and speedily than in any other way.

The backs of plate teeth are sometimes not as flat or level as we could wish; there are nodules of porcelain about the pins, which are produced by the use of moulds in which the pin-holes have become worn, or by the use of smaller pins than will fill the holes in the moulds.

In backing teeth, these nodules of porcelain prevent the gold backs going down flat on the teeth, but with the help of a pair of pliers or a light convex-faced copper hammer, bends and twists can be given to the gold backs to make them fit. When a fit is obtained, which is readily known by a total absence of play between the surfaces, the back of the tooth is painted with some ground borax and water, the gold back is laid on it, and the pins are bent down so as to hold the gold back lightly in position.

I find that the pins can be easily bent down on the gold back in any direction desired, with a push given by a sculptor or a flat graver, if the tooth be held on the bench pin with the finger and thumb of the left hand.

Some dentists do this work with pliers, while others bend the pins, then cut off the excess length with cutting pliers, file them flat, and bring them closer together with ordinary pliers.

It has been stated by one or two "authorities" that borax should never be used between a tooth and the backing; all I can say is that I have seen it done without any mishap for forty years. The cracking, which the authorities wail about, is caused by careless soldering, and also by cramping the porcelain so tightly in gold crowns, that the contraction of the crowns after soldering cracks the porcelain by bending the gold back too closely to the tooth.

When we remember how rarely a good workman cracks a tooth, if it has been properly invested and heated ready for soldering, the nonsense talked by these "authorities," who surely are not workmen as well as dentists, must be set down as extravagance.

The teeth having been ground and fitted to the model, or to the mouth, as the case may be, are carefully tried in the mouth on the plate, and brought into the desired position, not only with respect to the gum on which or in which they are to rest, but also to the contiguous teeth, be they neighbours or antagonists. The certainty of fit is often much aided by the use of a small wooden handle of sufficient bulk to be comfortable to the hand, with a notch cut in the end of it to hold the cutting edge of a tooth. If the plate is held firmly in position with the first and second fingers of the left hand, the several teeth can be pressed into their places without disturbing others, by means of the little handle held in the right hand.

I always cut away the gold in the incisor and canine region of a plate intended for plate teeth, so that the teeth can be bedded in the gum or steadied on a root.

In from twenty-four to forty-eight hours after the plate is finished and worn by the patient, the gum overlaps the edges of the porcelain, and the usual crack or black line is invisible. In many patients' mouths beautiful work can be done in this way, which is impossible when a semi-circle of gold is left under each tooth "as a support." I have mounted thousands of teeth in this manner, and I never saw any break-down for want of support on the plate.

To make such teeth comfortable in wear, I am always careful to give them a *rounded* edge, so that under the most severe pressure the irritation of the gum, the results of which we so often observe when sharp edges impinge upon this membrane, is never experienced.

The fit and arrangement of the teeth having been tested, the plate with the teeth is removed from the mouth and "invested" in a mixture of plaster and pumice, plaster and bath brick, or plaster and marble dust. The main thing to remember is to avoid forming a bulky investment, and to mix the plaster with water of the same temperature as that of the mouth. If a case so prepared is placed in an investment made with very cold water, the teeth will be found to have moved,—a trifling distance, no doubt, but enough in some instances to worry a conscientious dentist,– owing to the loss of the close fit which he had taken so much pains to obtain. The investment is allowed to set, the wax holding the teeth in position is picked away, or, better still, scalded away, borax is ground into a thin paste, and with its aid the solder and such small scraps of gold as may be wanted to bridge over a crack are placed in position with a camel-hair brush or solder tweezers; the investment is then placed on Fletcher's lighted plate-dryer (Fig. 59, page 111), and slowly heated to redness, when a few puffs of the blow-pipe will complete the soldering. The plate is then cooled, pickled, and polished at the lathe.

Very beautiful and artistic work can be made for the front of the maxilla with plate teeth, provided the teeth are correctly fitted to position, and a very symmetrical contour is not adhered to. The piano-key arrangement may look splendid on a plaster model, but it lacks individuality and does not harmonize with the features of most patients.

It is not a bad plan to gather, from time to time, plaster casts taken from mouths of good natural contour, as they often suggest little life-like touches during the process of mounting.

Tube teeth are made with platinum tubes passing through the long axis of the mineral body. They are used neither as much as they deserve to be, nor as they would be if only the manufacturers would make their appearance a little more natural.

To do good tube work requires much practice and skill in selecting, as well as in mounting the teeth. Some workmen never can do decent tube work, others delight in it. As compared with mounting other teeth on plates it must be regarded as laborious, although in result nothing can be better than tube teeth in suitable cases. I have, in my experience, seen many cases worn from fifteen to thirty years without a mishap.

Absorption of the alveoli may make the use of tube dentures uncomfortable, a matter which we are so far unable to combat or remedy. If a suitable case be chosen and the teeth selected, the latter are carefully ground and fine-fitted to the places which they are intended to occupy on the plate.

Grinding tube teeth may be divided into two stages—fitting and fine-fitting. Fitting is usually understood to mean the alteration of a tooth till it takes its place on the plate or the model, but is still too long for the bite. Fine-fitting is understood to mean the close adaptation of the end of the tooth, by grinding it to fit on the plate, as if it were cast upon it, in addition to reducing its length to suit the bite.

The tube teeth can be mounted singly or in pairs, or all at one time. Some dentists grind one tooth at a time, and fit and solder to the plate the pin which is to receive it, and then proceed to the next, which is similarly treated, and so on; others proceed in the same manner with two teeth at a time; while others first mount all the teeth, and then fit and solder the pins to the plate.

Having made many experiments, and having ground many tube teeth, I am of opinion that it saves time first to fit all the teeth and attach them to the plate with sticking wax. The arrangement is then compared with the bite, and if the teeth show that fine-fitting will bring them within a measurable distance of the bite, the plate and teeth are invested in plaster; and when the plaster has set, the position of the tubes is marked by using a steel wire of suitable gauge, which should smoothly fit the tubes and have one end filed to a smooth centre point. The pointed end of the wire is passed into the tubes and rotated between the fingers and thumb when it touches the plate.

This form of "point" on the gold plate shows the centre for each pin. A steel wire with the point ground "three-square," like a countersink, is better than a round point, for the simple reason that when it is rotated it cuts a pit in the plate. If this is carefully done with each tooth where it rests on the plate, the plaster investment can be broken up, and the holes drilled in the plate where they have been marked, to take the pins on which to secure the teeth. I prefer, however, to use a sharp drill,—and, with the aid of the bow, to drill each hole in the direction to suit the tooth, without destroying the investment. In doing this, care has to be taken to use a drill smaller than the tube, else it may burst the tooth by jamming in the tube. With a suitable drill this work can be carried out by using ordinary care. The holes for the pins being drilled, the pins have to be prepared from wire that will pass smoothly through the tubes. The wire is cut into lengths to suit each tooth, sufficient excess being left to pass through the plate.

Some dentists practise and recommend that the pin should *tightly* fit the hole in the plate. I prefer a loose fit, as the soldering is more certain in its flow with such a fit. Others file the end of the pin three-square. Pins treated in this way fit the hole, and the workman can see that the solder has flowed through by holding the plate to the light. If the solder does not pass through the plate all round the pin, the stability of the pin cannot be depended upon. I have often seen pin and tooth "drop off," when the soldering was more apparent than real—that is, when the pin was soldered on one side of but not through the plate.

Pins can be held in position with binding wire twisted from pin to pin, or the plate and pins can be invested. When the pins are thus secured in position, the parts to be soldered are boraxed, and the panels of solder laid where they are to run. Investment has to be carefully done, and it is often a practical convenience before placing the plate in position to put some ground borax on it where the pins project, and to cover it where it surrounds the ends of the pins with bits of tissue paper wetted with borax. This will prevent the plaster of the investment getting into the joint to hinder the solder flowing through. Investment-soldering of pins is a very safe way of doing this work, as the invested plate and pins can be heated to redness, when a few touches of the mouth blow-pipe will complete the work.

Soldering pins set in the plate with binding wire is much more difficult, except to a most expert workman, as while the plate is being heated, or a pin soldered, some other portion of the plate, or another pin close by, may be melted,—moreover, the iron binding wire may be sweated into a pin, or it may be melted, and thus allow a pin to fall out of place. This kind of soldering needs the skill and patience of a workman with a quiet and placid mind, and should be done when he is not likely to be disturbed by having his attention drawn to other matters. When the pins are duly soldered, the plate is cooled, and the ends of the pins projecting through the plate are cut off with a special nippers made to cut pins in confined situations. The remaining part of each projection is then cut down level with the plate with a sculptor or a file, or with a bur in the dental engine. The solder will have surrounded the pin on the free side of the plate with a sort of bevelled collar, which helps to give the pin great stability. The plate is then tried on the plaster model, and the teeth are tried on the pins. Any pin that has fallen out of position is carefully moved into line by the aid of a pair of pliers, which has a groove cut in each jaw to take the pin. Sometimes one or two pins require adjustment, at other times none; it all depends on the skill and luck of the workman.

Tooth after tooth is tried on the pins till the dentist is satisfied that they are correctly placed in the position for each tooth. During this adjustment reference should be made to the bite. Many dentists cut down the free ends of the pins at once to the bite, as a guide for fine-fitting the teeth to the plate. As each tooth is ground it becomes shorter, and the pin becomes visible in the tube. It is thus an indicator that the fine-fitting must not be carried so far as to leave the tooth too short.

Fine-fitting requires much patient skill, especially with the incisor teeth of the maxilla, which have very often to be fitted to inclined planes. If the neck of an artificial tooth is chipped or broken, it is a loss to the dentist, as it has to be replaced by another, and it is sometimes very hard indeed to obtain a new one that will match it.

With a symmetrical maxilla plate, the overlaps of the teeth are ground into beautifully symmetrical curves by a skilful workman, so that the pairs of teeth—centrals, incisors, and canines—represent similar curves reversed to suit the right or left side of the arch. With an unsymmetrical maxilla plate this cannot be done; each tooth has to be fine-fitted to the place which it is intended to occupy on the plate. Fine-fitting requires the use of small grinding wheels, nipples, and a steel counter-sink (which should be dipped in spirits of turpentine or in vaseline from time to time), with which to cut the bur of the platinum tube away, and also to adapt the porcelain to fit the bevel of solder, where it touches the plate. Tube files have also to be used—slender files made to fit on the tubes in the teeth—to take off the bur which the grinding often leaves in the platinum tube. These files have to be used with caution, else the platinum tube will be cut away, and the *look* of the work spoiled. Even by thinning the tube too much the strength of the tooth will be reduced.

Fitting and fine-fitting are carried out by the use of vermilion and oil made into a pasty paint. Too much oil makes a paint that will not cover or stay on the part to which it is applied. On the other hand, too much vermilion or rose pink makes a pasty mass which is troublesome to use, owing to its thickness producing false marks. The paint should be smoothly mixed, so that the oil does not readily part from the vermilion.

By painting the plate about the pin, placing the tooth on the pin, and grinding away the mark made at the point of contact, time after time, the long tube tooth becomes "mounted," having been correctly fitted in a neat and workmanlike way.

Teeth as they touch each other sometimes "bind," and a little of the contour at the point of contact may have to be ground away till a proper fit is obtained. Sometimes, indeed, the reverse is the case: the teeth do not touch, and the pins have to be adjusted to suit the want of contact.

After all the teeth have been ground to their places, and put on the pins to see that the bite is correct, they are dismounted and cleared from all trace of oil by washing with soap and warm water. Small pieces of soft wood or cotton-wool on a needle file, are then used to clean the tubes of all the paint or platinum detritus left in them. The plate is carefully pickled and sometimes polished or burnished.

As a rule, tube teeth are fitted to touch against each other on the plate, when the dental arch has to be restored, the molars and bicuspids being made to fit against each other laterally, to prevent food lodging between them.

The next step is to cement the teeth in position. They are carefully arranged in due order round the plate as it is laid on the work bench. The pins are nicked or notched with a sharp file or a sculptor, to give them a hold on the sulphur cement. The sulphur is laid ready in lump and in powder, a spirit lamp is lighted, and an old smooth-jawed pliers is selected to hold the plate, while the process of cementing is carried out. Sometimes a bit of tough paper or thin leather is used to hold the plate between the jaws of the pliers, to avoid scratching or bruising the gold. The teeth are placed half on the pins and cautiously warmed; powdered sulphur is then put over the open tubes in the teeth and melted. The teeth are now gently lowered down the pins towards the plate, the melted sulphur following in the tubes. Powdered sulphur is also placed along the necks of the teeth, so as to melt and flow on the plate. When a sufficient quantity is melted, the plate, held in the pliers, is quickly carried to the workman's apron, which is gathered in the hand, and the teeth are held in position on the plate till the sulphur sets.

Another method is as follows: when the teeth are ready to be fixed on, the upper end of each tube should be slightly counter-sunk and all bur removed. The free end of the pin should be slightly rounded towards the centre and also made quite smooth, and when the pins have been roughened, the teeth should be put *in situ*.

If sulphur in lump is used, it should be broken into small pieces about the size of canary seeds, and a piece should be placed on the end of each tube as it rests on the pin. The plate should then be heated over a spirit lamp, or by being placed on a hot iron, the temperature of which should be kept as equal as possible, but never allowed to rise too high to deprive the melted sulphur of its fluidity. If this be done with the ordinary skill which comes from a moderate amount of practice, and the pins and plate have been cleared from grease, the sulphur will flow down between the tube and the pins and under the teeth. When this has taken place, another lot of the small pieces of sulphur should be laid on the tops of the tubes, so that a fresh supply of sulphur may fill up any part away from which it has flowed too much. The whole should be cooled gradually, and during the cooling, slight equal pressure should be applied with a cloth in the left hand. This pressure insures the teeth being pressed home on the plate before the sulphur has set. If the work be done with care and patience, there will be little or no superfluous sulphur to clear away in the remaining finishing that may have to be done. To carry it out without "burning" the sulphur or cracking the teeth, needs a careful hand and a calm temperament.

Tube teeth are usually "sulphured on," but some dentists prefer to cement them on the pins with floss silk and mastic varnish. This is effected by winding some strands of floss silk round each pin, after it has been carefully "nicked" down its length and also across the end. The strand of silk is wound in such a way as to permit of the tooth being on end, so that the last turn comes on the top nick and is held between the top of the pin and the edge of the plate. With a wire or slender rod the adhesive mastic varnish is placed on the silk round the pin, and to avoid bursting the tooth, it is gently brought to its position without undue force.

"Sulphuring on" and "silking on" tube teeth are bits of workroom procedure that look easier to do than they are in reality; both require care, and the workman has a lively anxiety about the teeth and the risk of cracking them while doing such work.

When the teeth are cemented in position, the plate is cleaned and polished, and made ready for the patient by giving the last touches to the "bite."

With the very best corundum wheels tube work is certainly laborious, but the use of *carborundum* wheels ought to make it popular again, as they cut porcelain much more easily and rapidly than corundum ever did. There is also this to be said, that it is not every mechanical assistant who can do *artistic* and *sound tube work* such as was to be seen in my youth; vulcanite has, I fear, spoiled all that.

Gum teeth are in design similar to plate teeth, with a gum added in the form of a coloured surface above them. Plates are sometimes made with one or two gum teeth, in cases where much absorption has taken place, and where the patient's gums are shown in speaking or laughing.

Gum teeth are "backed," ground, fitted, and "waxed" to the plate, invested and soldered just as plate teeth are.

I have seen the entire arch in upper and lower edentulous cases made with gum teeth, where the fitting of the contiguous surfaces called for no mean skill on the part of the workman, in order to secure close joints, and at the same time to make a nice contour of the gum surface.

Gum blocks or "sections" have come into use very largely since the employment of vulcanite, and some dentists are very fond of using them. Should they touch the labial portion of the gum, they are ground with a wheel till the point of contact is fitted. The joints have to be most carefully made so as not to show a line of vulcanite between them. Personally, I do not admire gum blocks, as they are commonly used; and too often the coloured surfaces of the gum borders look dreadfully "made out" and artificial.

Patients, however, are to be found who like the artificial beauties of gum blocks; they must, therefore, sometimes be used, and a dentist with artistic powers can do very beautiful restorations with them when the blocks and the contours have been matched with skill. They are mounted by adding wax to attach them to a metal or wax plate, as in ordinary vulcanite work.

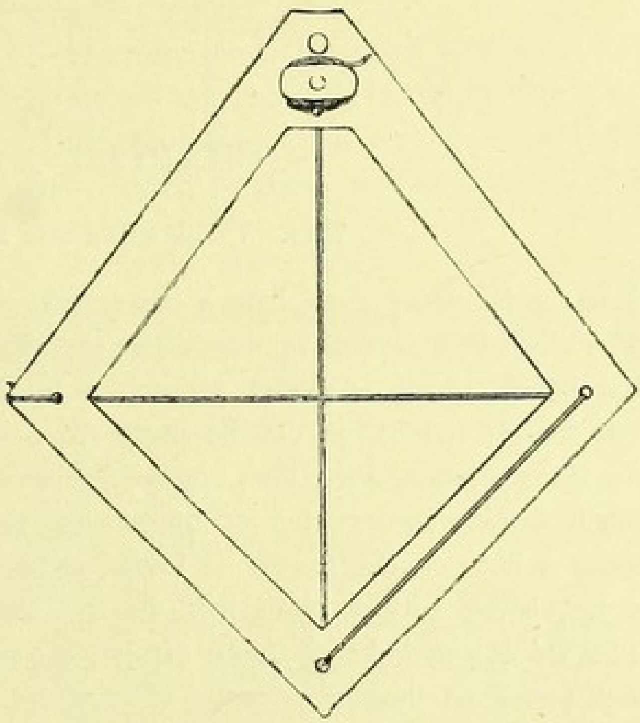
Much care has to be exercised in packing the flask, for fear of crushing the "section" by undue pressure in any direction, or of packing too tightly and causing the block to crack after it has been vulcanized to the plate. The investment is the same as in ordinary vulcanite work. Care must be taken not to allow the gum blocks to come in contact with the metal of the flask.

Vulcanite teeth resemble plate teeth in form, save that a portion of the lingual surface is left projecting below or above the pins to suit them for upper or lower dentures, as the case may be. They are of many forms and are mounted in wax, to correspond to the articulation of the jaws. The correctness of the central line ought to be confirmed before setting the teeth in position, and marked on the models by a saw cut or by a knife cut.

Plaster models for vulcanite work are sometimes cast out of position and are pared anyhow, the bite being cast without regard to the faithful exactness that ought to be shown in such work. Teeth mounted on models prepared in this way are apt to look quite wrong when tried in the mouth, and the cutting edges of both uppers and lowers may slope to one side of the mouth instead of being kept level. To meet this difficulty Mr. Kirby, of Bedford, has used for many years a tool which I figure, and which he calls "the dentist's square."

As may be seen from the illustration (Fig. 81), which is exactly half actual size, the "square" is a brass frame of diamond form, with holes drilled in it in such a way that a thread can be so placed as to form horizontal and perpendicular lines, which, being carried from the corners, intersect each other in the middle of the frame. It is plain that, if the frame is held with the perpendicular line opposite to the centre marked on the model by the workman, it will easily be seen what direction the horizontal line takes which represents the cutting edge of the teeth. Should it go to one side, as it may easily do when all the workman's attention is given to the plaster models, it can at once be corrected by reference to the square. In full sets, and in partial sets where the front teeth are lost, the use of this simple and accurate tool will be found a great boon to the careful and painstaking workman.

FIG. 81.



MR. AMOS KIRBY'S DENTIST'S SQUARE (HALF-SIZE).

I have to thank Mr. Kirby for his kindness in permitting me to bring such an admirable invention before the profession. It is, I believe, now figured for the first time, although Mr. Kirby has had it in use for a great many years. I use it, and find that it is a reliable help to accurate work.

CHAPTER XV.

THE VULCANIZER BENCH.

I HAVE, for many years, kept a bench set apart for vulcanizers (Fig. 82). The sheet-iron jackets in which the chambers rest are firmly screwed to the bench, which is placed at such a height from the floor that the interiors of the boilers can be easily seen.

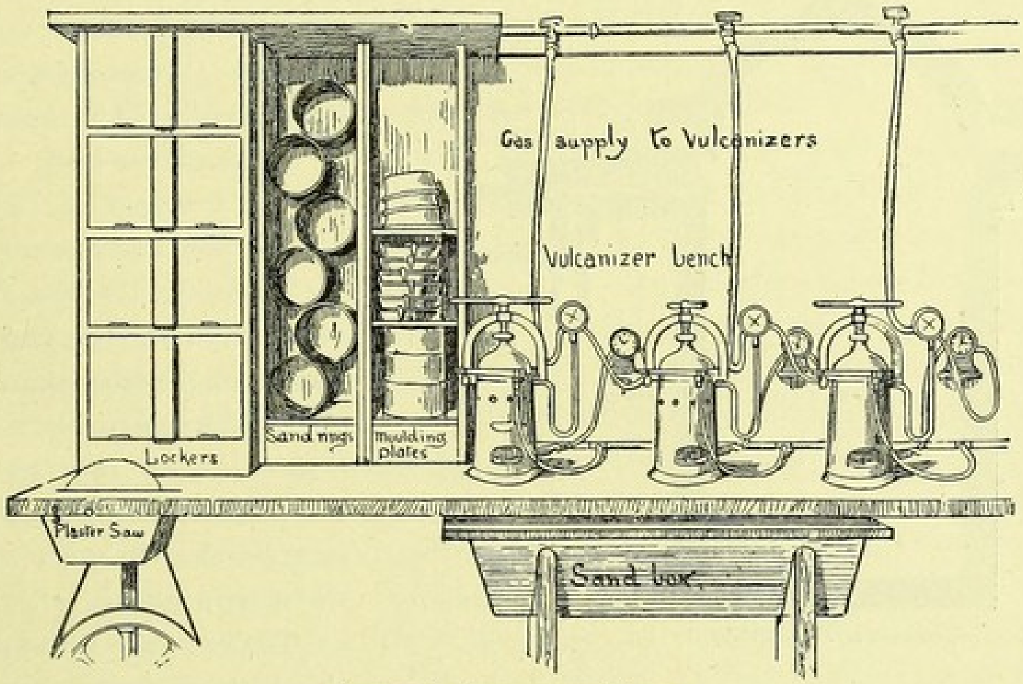
Many dentists keep their vulcanizers loose on a bench, which causes much trouble in screwing or unscrewing the covers, and also leads to many a burn on the fingers or hands, owing to the difficulty of securing a hot boiler with a cloth held in the hands while using a spanner. The vulcanizer which I use is of simple construction, cast in gun-metal and tested to bear a pressure of 250 lbs. to the square inch. The principal feature in it is the tapered joint, formed by the mouth of the boiler and the cover (Fig. 83). This joint is perfectly steam-tight, above any pressure needed for vulcanization, without a washer, and I have never known any leak in nine years' use, except when some plaster detritus has, by carelessness, been permitted to lodge between the "ground" surfaces of this steam-tight joint.

There is a screw-tap for blowing off steam external to the seat of the safety valve. If it is necessary to open the vulcanizer when full of steam, an india-rubber tube is first pushed over the nozzle of this tap before it is unscrewed. This india-rubber tube conducts the steam into a gas pipe, three-eighths of an inch in diameter, which is attached to the wall at the back of the bench. This steam waste-pipe slopes from the bench level to the floor, where it communicates with the external air. The fall in the course of the pipe avoids any chance of free water, from the steam condensed in the cold metal pipe, blocking the pipe and staying the rapid escape of the steam. This pipe is well worth the cost and trouble of fitting, as it prevents the nauseous smell of the sulphuretted steam filling the workroom—and, indeed, too often the dwelling-house as well—and removes a constant cause of rust to the iron or steel tools which are left exposed to the air of the workroom.

The vulcanizers are fitted with Fletcher's burners, and, last but not least, the unreliable thermometer has been discarded, and its place taken by Gartrell's "gas-regulating gauge."

My friend Mr. Gartrell, of Penzance, the inventor of this admirable contrivance, has most certainly earned the grateful thanks of our profession for the skilful way in which he has solved a very great problem. Mr. Gartrell's invaluable invention is one of those aids to hard-working

FIG. 82.



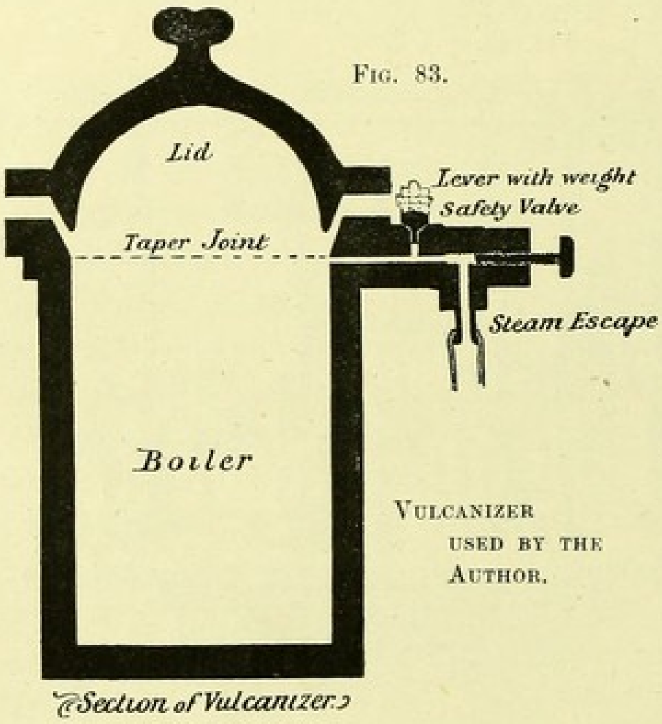
AUTHOR'S VULCANIZER BENCH.

and harassed folk which should be universally used, but I am sorry to know that a great many workrooms are still without it. The first cost seems to prove an insuperable objection to its use by the niggardly dentist, who will bear with equanimity the destruction of a vulcanite denture, which occurs when the misleading thermometer has not been watched, or when its tube is cracked, thus making its contents useless to the watcher, who does not know it in time to prevent the work being spoiled. The price of these gas-regulating gauges has been brought within the reach of most of us, and they are well worth their cost if only for their convenience and certainty in action during vulcanization.

It is not necessary to speak of the details of their construction, which have been published in other pages, but their principle is based on the law that steam pressure and degrees of heat, as indicated by a thermometer, bear an intimate relation to each other. These pressure gauges are attached to the vulcanizer by a syphon of iron or copper tube, which is kept filled with water.

As a supplement to Mr. Gartrell's gauge, another automatic instrument is added to the outfit of the vulcanizer in the form of an alarm clock, for cutting off the gas supply and extinguishing the flame of the burner, when the necessary time for complete vulcanization has expired. This alarm or automatic cut-off is usually arranged as an independent instrument.

Fig. 83.



Vulcanizer used by the Author.

There is no reason why the Gartrell gauge should not have an alarm clock attached to it, so that the clock face and the gauge disc could be seen by the workman at the same moment.

Ten years ago I placed this little clockwork problem before a clockmaker acquaintance of mine, who was to send me a working model of a suitable design within a fortnight. He has recently joined the majority without dealing with my little want. Mr. Gartrell informs me that he will now supply us with such a useful help to exact and orderly work. In the meantime a modification of a common alarm clock continues to do duty with all that regularity and precision which we often find in make-shift appliances, which not uncommonly last for many years.

I have also in use an alarm clock with a gas cut-off, supplied by a dental manufacturing company, with the gas tap placed on the top of the clock, which can be connected with india-rubber tubing with the gas supply on one side, and the gas burner under the boiler on the other. This form of clock can be set to act for any time, from fifteen minutes to twelve hours. A screw, in which a wire spring is caught, works by the aid of the alarm movement of the clock. When the spring comes to the end of the screw thread, it flies off, and shuts the tap controlling the gas supply. This clock is, however, made with a pendulum, which is not a sensible thing in such an instrument, when we remember how forgetful we sometimes are about trifles; a winding mainspring would be far better. The construction of the instrument is flimsy and out of proportion to the initial cost of the clock. The clock was disabled by a fall or similar mishap some time ago, and I had the greatest difficulty to get a clockmaker to mend it; he said it was mere rubbish, not worth the cost of mending. Surely it will be worth while for some good clockmaker to put a decent contrivance of the sort in our hands.

The flasks which I use with this vulcanizer are the invention of Mr. A. J. Watts, and were first made and tried in my workroom. They are made of cast gun-metal in two parts, and are strong and serviceable. They are shown in Fig. 85, Chapter XVI. In form they do not resemble any flask in the market, and have advantages not possessed by other designs which are much better known to the profession. They are made in two sizes, and so far as my experience of them has gone—now considerably over a decade—they have served the intentions of the designer in the most admirable way.

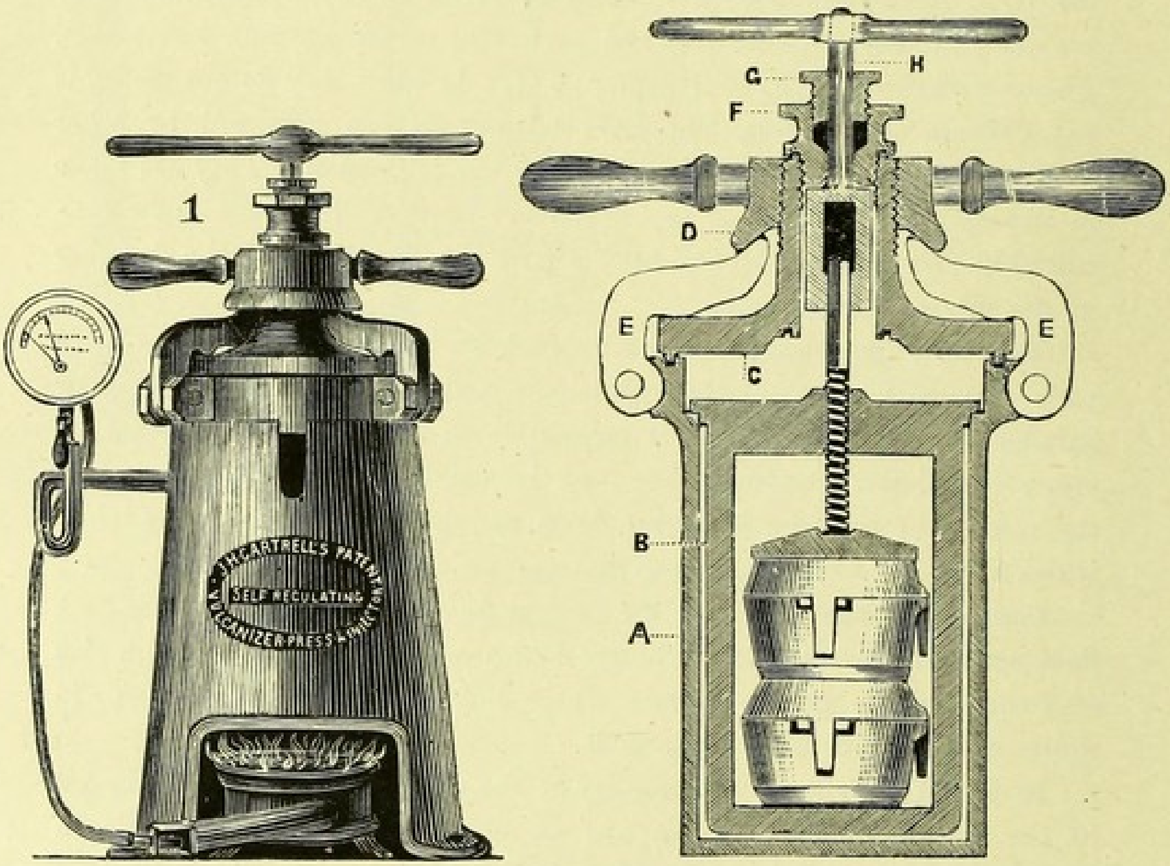
Most flasks designed for vulcanite work are unnecessarily made in three parts, and the junction of the middle part is almost universally effected by parallel action, which renders it impossible to negotiate any undercut, as either the plaster margin of the flask breaks, or the vulcanite placed in the margin of the case is folded down and held away from the surface which it is intended to conform to.

Casting the wax model of the denture in the reverse way in the flask does not alway get over the difficulty I mention; moreover, there is a risk of fracturing the plaster surface which holds the teeth in position, in squeezing the flask after packing it.

In Mr. Watts's flask the integrity of the plaster surfaces is safeguarded by the use of inclined planes, and an undercut can be safely held in position without fracturing the plaster edges during the closing together of the parts of the flask when it is finally packed. These inclined planes enable an undercut to be dealt with from more than one standpoint, and once the obstacle has been overcome, the slightest pressure brings the edges of the flask and the plaster surfaces together. The illustrations show the nature of this design, and also how a wax model of a denture may be cast as "on the model," or reversed, as may suit the needs of the case.

Mr. Gartrell many years ago designed a vulcanizer which enables the dentist to close the flasks in the vulcanizer, an illustration of which is here shown (Fig. 84). Mr. Gartrell informs me that 80 lbs. pressure is a favourable temperature for gently and accurately closing the flasks. The teeth are not misplaced by the pressure used, and the quality of the vulcanite is tough and elastic. If the washerless joint of the vulcanizer which I use were combined with Mr. Gartrell's plunger for closing the flasks, a most convenient form of vulcanizer would be placed at our disposal for this work.

Fig. 84.



Mr. Gartrell's Vulcanizer.

CHAPTER XVI.

VULCANITE WORK.

VULCANITE is a material in great demand in dentistry. Owing to the facility with which rubber can be moulded, it enables men of inferior mechanical skill to use it in the construction of dentures who never could do accurate work if metal alone were employed. The result has been that an unworthy kind of competition has been introduced into professional life by the specious representations of men whose whole aim is to deceive patients with a view to exacting fees ignobly earned.

One must not be led astray, however, by this apparent facility of execution to discard the sound methods of the older and more laborious modes of construction. Every case is not favourable for the employment of vulcanite in the form of a denture, especially where plates of small size are required and many teeth still remain in the mouth. The bulk of the material and its greater fragility than metal, even under the most favourable circumstances, do not call for its employment when compared with the greater strength and diminution in bulk which can be attained by the use of a gold plate.

The use of vulcanite dentures in edentulous cases is credited, by many observers both in the United Kingdom and in the United States of America, with being the chief cause of the progressive alveolar absorption to be observed in many mouths, owing, it is held, to the non-conducting properties of the vulcanite. The lack of response of vulcanite to the action of hot and cold foods in the mouth is not unfrequently a cause of complaint on the part of patients who have first worn metal plates and have afterwards, either owing to further dental losses or a desire to be economical, worn vulcanite plates.

Dr. L. P. Haskell, of Chicago, has many times during the past twenty years drawn special attention to this point, and also to the cases of sore mouths which are sometimes caused by the use of vulcanite that has not been properly indurated, owing to the employment by the dentist of too high a temperature for vulcanizing in order to save time.

My own memory of the well-marked alveolar ridges nearly always to be seen on casts of edentulous mouths when metal plates were the only kind in general use serves to support Dr. Haskell's contention that metal plates *are* necessary if the gums are to be kept in the most healthy condition, and the duration of the alveolar ridges is to be prolonged. Unfortunately, the plaster models that would have refreshed my memory of the past on this point have been thrown away during alterations in my house. My opinion therefore cannot have that weight which it would have were I able to show from living patients, the duration of whose artificial dentures would be known, examples of edentulous mouths, in which (*a*) metal plates had been worn, and (*b*) vulcanite plates had been worn, with the original condition of the alveolar ridges in each case, and their present condition.

Vulcanite is, however, of very great advantage in cases where teeth have been long lost, and where absorption of the alveoli has made changes that need much restoration in bulk in order to support the mineral teeth when the bite is opened to normal conditions. To reinforce the diminished powers of mastication and the function of speech, and to restore the natural expression of the patient's face by carrying the mineral teeth in suitable positions, are all purposes which vulcanite will admirably fulfil. Vulcanite, therefore, can be used either solely as a base plate in the construction of dentures, or in combination with metal plates made of gold, dental alloy, or aluminium. In combination with gold, vulcanite is most useful in cases where, although absorption of the alveoli has taken place to some extent, some teeth remain firm and in good condition, and consequently strength with little bulk is needed in the plate.

Dentures intended for the mandible, where incisor teeth and the canines and sometimes a bicuspid or two remain, can be best made by means of a combination of vulcanite and metal. In this region—partly from the movements of the tongue, partly from the narrow space available on which to rest the denture—strength, combined with absence of bulk, is a necessity, if we are to give the patient comfort in mastication and articulate speech.

Vulcanite has, however, one great drawback—its colour; for the very greatest advances that have been made in its preparation do not as yet include success in *colour*.

The " unrivalled " gum colours of the manufacturers are very far from the natural tone of the gum, and we are too often compelled to use a material that does not satisfy the dentist who has a cultivated eye and is a good judge of colour.

The results of some efforts to produce a more artistic result have been placed in our hands in the form of "Gears' shaded pink rubber" and "Walker's granular gum rubber." These rubbers are unfortunately liable to disintegration in wear, but if this defect could be overcome, they would add to our resources in many instances, for they are, I must say, an improvement, so far as shading is concerned, on the very best pink rubber which I have seen, whether solarized or not.

It has long been a cause of wonder to me that the manufacturers do not make a paler *coating* rubber for such work, as the dense and "heavy" colouring of the very best pink rubber is a long way removed from the natural colour of the gum, even if we leave out of question the shading or mottling of this surface, as we see it in the living mouth, which is a good example of "broken tone." That the *quality* of the vulcanite now made is most excellent, no one can deny; it shows much care on the part of the manufacturers, and a desire to keep ahead with all improvements in this material.

Vulcanite dentures are modelled on a plaster or cast-tin model of the mouth,—and the model of the intended denture, which is also known as the base-plate, is commonly made of beeswax, or beeswax reinforced with resin; or, as affording more rigid supports, hard paraffin. "Hard-bake," "*Crown Composition*," sheet-tin, or fusible metal is used for the base plate by many dentists. If beeswax alone is used, it cannot be left in the mouth for any length of time with advantage, as the natural warmth of the mouth, and the undermining action of the saliva, which penetrates between the mineral teeth and the wax plate and causes the teeth to drop off, gives the practitioner much anxiety as well as additional labour. Wax toughened with resin has as little stability of form as the beeswax alone, when used for prolonged trial in the mouth. It is therefore wiser to use some rigid form of plate like fusible metal or "Crown Composition," as a trial plate, if accurate work is to be constructed worthy of a skilful and intelligent dentist. From experiments which I have made, I think "Crown Composition" is as stable under conditions of "trying-in" as "Hard-bake," and it is much nicer looking and more easy to manipulate. Very nice thin plates can be made by its aid, especially for the mandible, in cases where much absorption has taken place, and where it is necessary to provide for the movement of the floor of the mouth in speaking and in swallowing.

"Hard-bake" is made by melting two parts of shellac by weight to one part of "Stent" in a saucepan, and stirring them together till the mass is sufficiently blended. The melted mass is poured on a stone slab to cool, and it can be rolled to a suitable thickness for making plates as soon as it has toughened.

As a preliminary to making the trial plate, the sheet of "Hard-bake" or of "Crown Composition" is cut to a suitable size for the case from a pattern. The piece cut to the pattern is warmed over a Bunsen burner or spirit flame, or dipped in hot water, to make it plastic; the plate is pressed on the plaster model, and the surplus material is cut away with scissors or a sharp knife. The plate is as accurately moulded as possible; this procedure can be aided by holding it while on the mould over a flame, taking care not to burn it. By firmly pressing the plate material from time to time where it needs close adaptation, and then cooling it to test the fit on the model, a well-fitting plate can be made.

Trial plates, made with "Hard-bake" or impression composition, have often to be stiffened with iron wire of about the same diameter as pin wire. The wire is bent with pliers to rest tolerably accurately upon the ridge of the trial plate, passed round the backs of any incisor or molar teeth that may be left standing, and brought across the curved part of the plate where it crosses the palate. The wire is heated in a flame, placed in the intended position, and embedded in the "Hard-bake." If rolled sheet tin is preferred, as in cases where the dentist may wish to reduplicate the rugæ, it is necessary to make dies and counter-dies from the plaster model. As in the case of gold plates, the tin has to be struck on the metal die to make it fit. The plate, of whatever material it is made, is tried in the mouth, and if the fit is found to be correct, the "bite" is taken by building on the alveolar ridge a sufficient quantity of wax to form a wall of the necessary depth to meet the teeth of the other jaw; the wax wall varies in width from three-eighths to five-eighths of an inch, according to the nature of the case and the way in which the teeth may meet it. It is desirable to leave the wax rather higher than close articulation will admit of, as it is necessary to have on the free surface sharp impressions of the crowns of the teeth of the upper or lower jaw, as the case may be.

It is a waste of time to build up a wax bite by *pressing* softened pieces of wax together one over another on the trial plate. If the wax block is not made homogeneous and solid, it is apt to separate in layers when the saliva in the mouth flows over it, and thus cause loss of valuable time.

The best way is to mould suitable bars of wax in hot water, and press them in the desired position on the plaster model. These wax blocks can be trimmed to shape with a warm knife, and thoroughly attached to the plate by warming the surfaces intended to be united.

In the case of metal trial plates, the surface intended to receive the wax is warmed and rubbed over with a ball of wax, which leaves a film on the surface. The wax blocks and the metal plate can then be united by heating the metal plate and placing the wax in position. If "Hard-bake" or "Crown Composition" is used as the trial plate or bite, it will be necessary to carry out these details while the trial plate is held on the model, else the heat of the melted wax will be apt to warp the plate.

When the bite is correctly taken, it is necessary to pare away the laminæ of wax, which tend to prevent the wax fitting on the model, after which the bite is chilled in cold water before casting it in plaster of Paris.

Bites taken with solid wax trial plates almost invariably go out of shape from the pressure of the upper or lower jaw. If they are brought into correct position on the plaster model, and set in due relation with the upper or lower model, it is quite usual to find that the bite is not correct if a denture is set up to suit these conditions.

It is, I fear, not an uncommon experience to work to a false bite. Such a mishap can only be avoided, in my opinion, by the use of rigid trial plates, as well as by particular care to ensure that the bite *is correct* before the patient leaves the chair.

The bite having been opened and pared to a convenient form, the teeth selected for the case are mounted in position on the trial plate with the aid of some melted wax. The teeth may have to be ground or fitted by removing some of their excessive length, and their position with respect to the bite examined from time to time, care being taken to keep to the "centre" as well as to the line of the cutting edge which was marked by the practitioner when the bite was in the patient's mouth.

During this process of modelling, it is better to work by degrees than by plastering on thick masses of wax. Time is lost, and the effect of the case is spoiled by any clumsiness in modelling the labial or buccal surfaces. If a denture is carefully and neatly modelled, a much better idea of its future appearance can be gained by the patient, as well as by the practitioner. A few quick deft puffs from the blow-pipe at the soldering lamp will leave the surfaces beautifully smooth without heating the teeth sufficiently to misplace them.

From a long experience I am of opinion that more pains should be taken in the modelling of the rims or edges of dentures than we usually see in practice. If the true line of contact is marked on the plaster model with a lead pencil by the practitioner, with the patient at hand to refer to, much trouble will be saved. The edges can be rounded and left an eighth of an inch thick, or even more in certain positions ; by this means a good finish is given to the denture, which, when used in the patient's mouth, is not likely to hurt. On the model I dare say a "feather edge" looks nicer to the mechanic than a rounded edge, but as the practitioner has always to file the former away owing to the discomfort which it causes by its sharpness, it is wiser to make the rim as nearly as possible at first of such a form that it can be worn by the patient. The wax model of the denture having been found to answer correctly to the needs of the patient, and any corrections made that may be necessary in articulation or appearance, it is now ready for moulding or flasking.

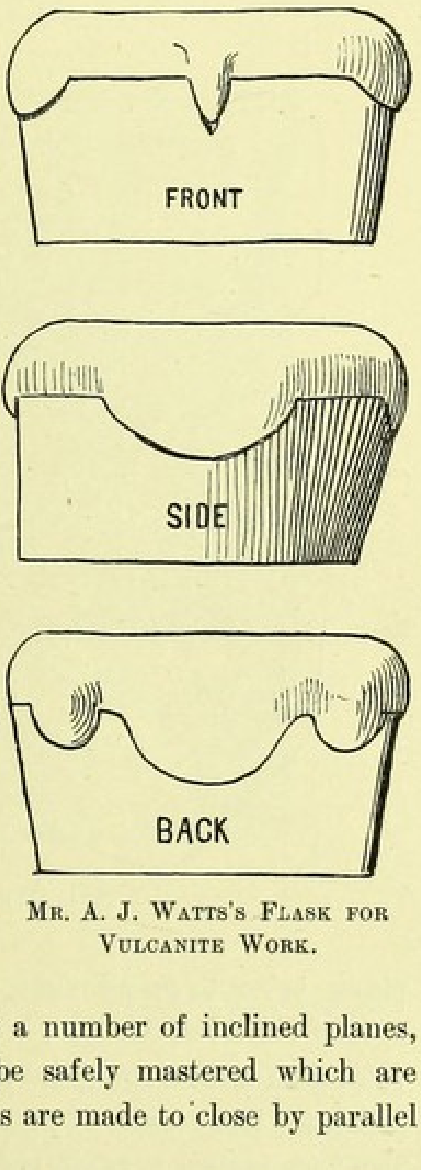
It should be carefully varnished on all the surfaces, except those of the teeth, with thin shellac or other suitable varnish. It may be necessary to varnish the wax and fusible metal or wax base plate a couple of times. The use of varnish in this way places at the service of the dentist a nice smooth mould, and when the vulcanite is taken out of the flask after removal from the boiler and cooled, it will not be found covered with the numerous little nodules of vulcanite which so many of us accept as a matter of course. Silicate of soda painted over the plaster surfaces of the mould—not on the teeth, however—also enables the dentist to secure a hard and smooth mould in the flask in which to pack the rubber.

Vulcanite flasks may be roughly divided into three classes: flasks made in two parts ; flasks made in three parts ; and flasks made in four parts. In two-part and three-part flasks the method of investment is identical, and two mixings of plaster of Paris are employed. In four-part flasks three mixings are needed, as in this form the teeth remain in the middle section of plaster. The model is held in the lower part, and the third section of plaster forms a plug which reduplicates the contour of the palate. Four-part flasks are not in constant use, owing to the risk of raising the bite should the flask fail to close accurately after the mould is packed with rubber. They are chiefly used where there is a difficulty of packing the unvulcanized rubber under the necks of the mineral teeth, and where there is a difficulty in placing the rubber in the curved space represented by the labial or buccal contours of the jaw.

In such cases many dentists prefer to paint these portions of the case before investment in the flask, with rubber dissolved in chloroform, and by slightly warming the cast fixing the necessary pieces of rubber in position. This is effected by cutting away the wax with a knife, and replacing it with rubber packed on the plaster model, after coating the latter with the adhesive solution which I have mentioned.

I have for nearly a decade used two-part flasks made of gun-metal (Fig. 85), already referred to in the preceding chapter as Mr. A. J. Watts's flask, which is designed to allow the workman to manœuvre the parts of the flask together, the parallel closure of the ordinary flasks being avoided.

Fig. 85.



Mr. A. J. Watts's Flask for Vulcanite Work.

It is also so constructed as to permit of a wax denture being invested with the teeth covered with plaster, and only the palate exposed, while the model of the denture remains in the lower portion of the flask, and the plaster of Paris cast in the upper portion produces the lingual contour of the palate. A wax denture can also be invested in it so that when the upper portion of the flask with the plaster mould in it is lifted off, the palatal surface of the inside of the denture is seen.

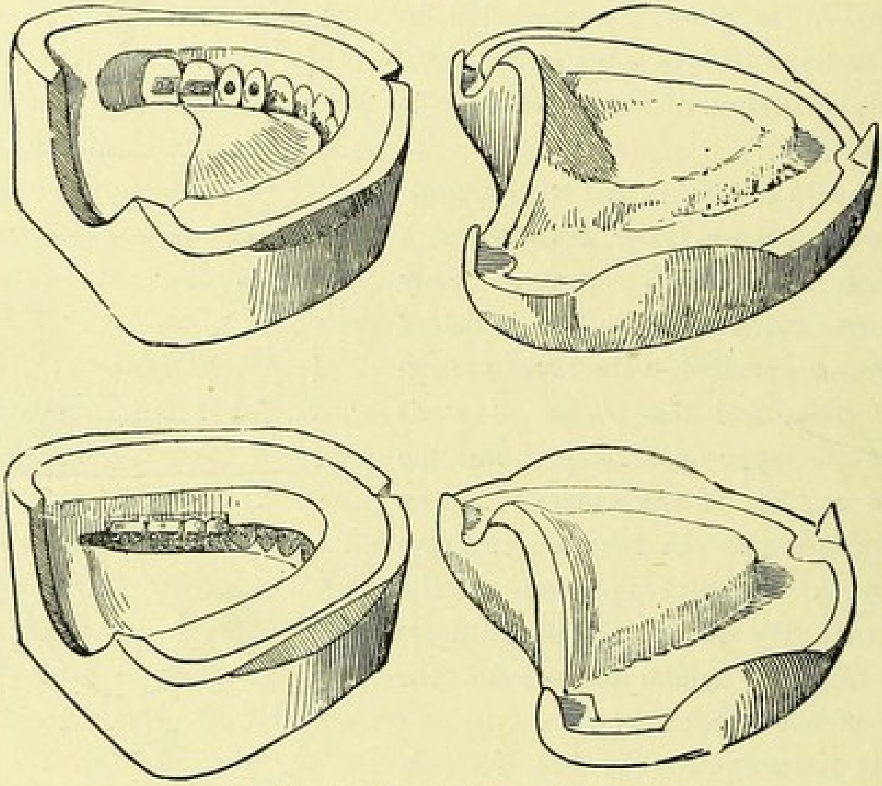
The illustrations (Fig. 86), I think, will clearly explain how wax dentures may be invested to suit the case, or the individual predilections of the workroom.

The closure of the flask is influenced by a number of inclined planes, so that with ordinary care undercuts can be safely mastered which are impossible to overcome where vulcanite flasks are made to close by parallel action alone.

The great value of this flask is its strength, its ease of adaptation to unusual surfaces in closing after the mould in it has been "packed," and its simplicity of form. After ten years' use I have not had occasion to wish to vary its form, as it has done with the greatest efficiency all the work I have wanted it for, and it has also met all the demands which the most exacting workman could require. Moreover the plaster margins do not fracture, as in flasks which are made to close by parallel action. In this flask I do not use a "firing" model, but invest the wax denture as it comes from the mouth.

The fusible metal plate used as a rigid support gives a sharp and accurate cast of the plaster model, so that if the case is invested, and the

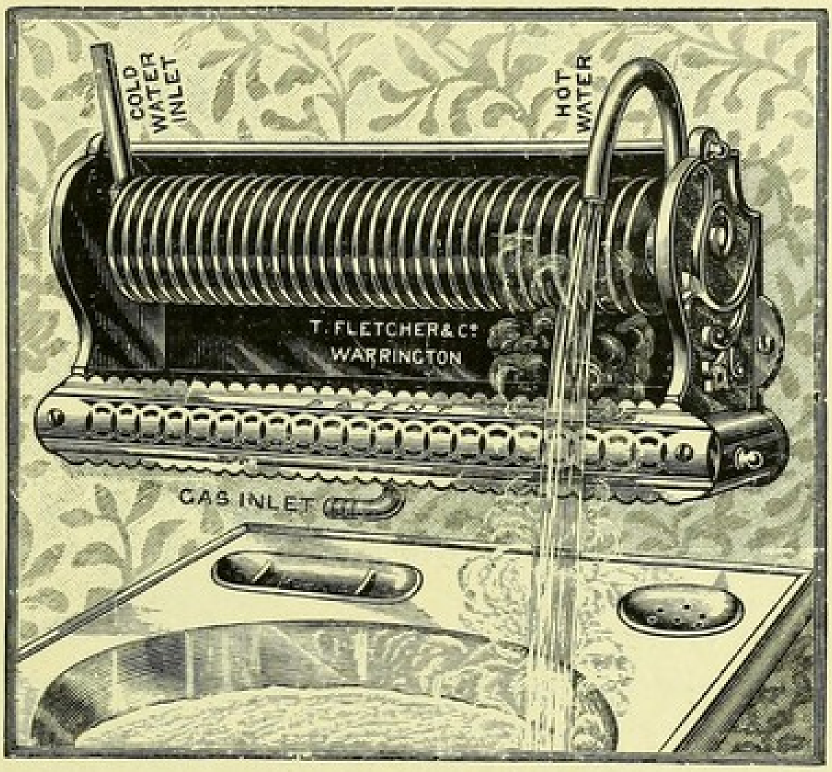
Fig. 86.



Mr. A. J. Watts's Flask Invested.

plaster is left to set all night, no one would know from its appearance, as it is removed from the flask after vulcanization, that the case had not been vulcanized on a "firing model." When the wax denture is invested, the flask with its contents is placed under a screw press till the plaster is set. The flask is then warmed and opened, and the wax and fusible metal are scalded out of the plaster mould, either with a kettle of boiling water or with the fine, steady stream of boiling water which is delivered by Fletcher's Instantaneous Water Heater (Fig. 87). During the process the plaster mould can be most conveniently held in a wire frame such as is shown in Fig. 88. The mould containing the teeth is packed with the selected rubber, cut into small pieces of half an inch long by a sixteenth wide for packing under teeth and in other difficult places ; larger pieces are packed in the more exposed surfaces, where freedom of access makes it easy to consolidate them in the mould. The flask is warmed from time to time till the moulded surfaces are all duly packed ; careful reference is also

Fig. 87.



Fletcher's Instantaneous Water Heater.

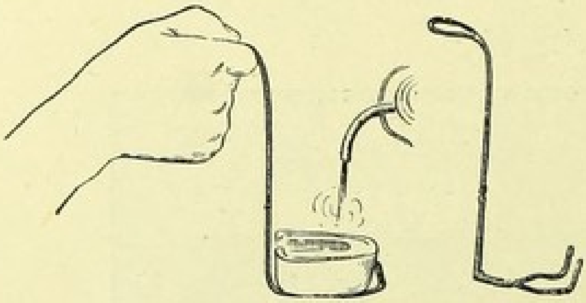
made from time to time to the model of the case, so that the vulcanite will not prove in excess in any portion.

By placing some of the thin cloth in which the rubber is packed over the surface of the mould, and by gently warming and closing the flask, the packed surface exposed to the eye should reproduce the characteristics of the mould.

The copper water-oven (page 66), designed by Fletcher, Russell and Co., of Warrington, is most useful for heating the rubber when cut into pieces for packing; the flask can also be warmed in its interior without any risk of expelling the mould, such as there is by putting the flask on a fire or other quick heater and generating steam from the water in the plaster.

The instruments used in packing are tweezers and a tool called "a packer," which is sometimes made from one blade of a broken dressing forceps. A broken scaler or excavator will also prove useful if the point is rounded and blunted, and half an inch of the end is bent to an angle of 120 degrees.

Fig. 88.



Wire Frame for Holding the Plaster Mould while Scalding Out the Wax and Fusible Metal.

It is well to pack softened rubber in a difficult position by always packing in one direction, till the rubber shows in another accessible part. If this be overlooked, a space may be left in the rubber, which will disfigure the case, and compel the workman to do the work over again.

Plenty of time should be given to the operation of packing a case, as sedulous attention will avoid the need of a second resort to the process of vulcanizing.

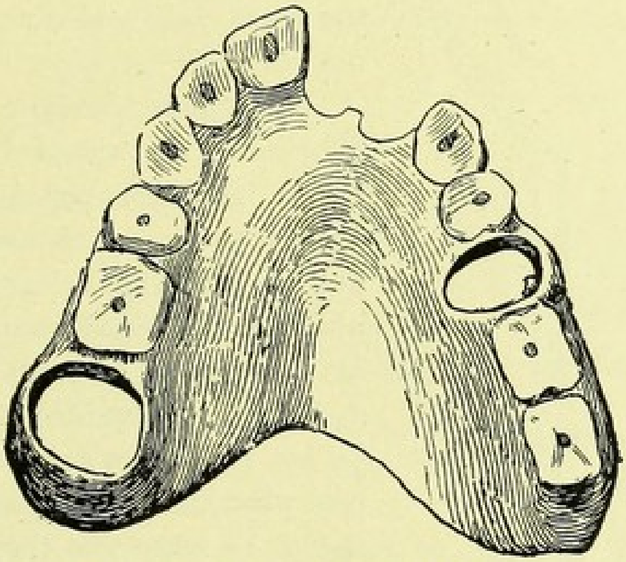
When the case is completely and accurately packed, channels may be cut in the plaster leading from the vulcanite to the flask. These channels form "gates" or overflow openings for the rubber, which may be found a little in excess of what is actually needed when the case is vulcanized. The final closure of the flask is now made, this being done by placing it in the clamp, which is screwed up sufficiently to hold the parts together. The flask with the clamp is then placed in the vulcanizer.

Tube teeth can be mounted in vulcanite in the following manner:—Suitable tube teeth are selected and fitted roughly to the trial plate on the model, with due regard to the bite; the tubes are then carefully cleaned and packed with rubber, after which the teeth can be mounted in wax on the trial plate. By proceeding thus, the workman has no anxiety about packing the tubes with rubber after the case has been invested in plaster in the vulcanite flask. Fig. 89 shows a denture of this construction.

When patients go to India or the Colonies, very strong masticating surfaces can be thus provided in the bicuspid and molar regions. Indeed, I can say I have never seen a tube bicuspid or molar fractured when used in this way. It relieves the practitioner of much anxiety concerning the unstable nature of platinum pins, though the teeth are somewhat more costly than pin teeth.

Vulcanite can be combined with a gold plate in cases where there is a comparatively open bite, and very strong and artistic work can be done

Fig. 89.



Vulcanite Denture mounted with Ash's Tube Teeth.

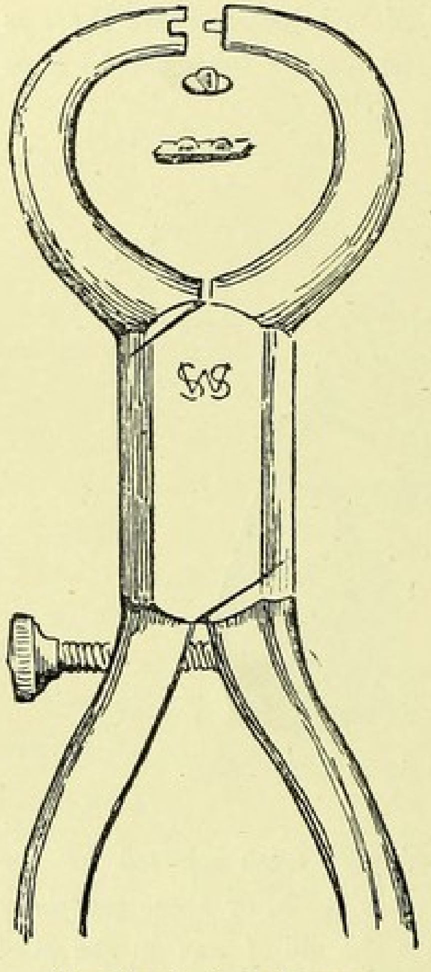
with these materials. For such a combined case teeth selected for the incisor region may be what are known as plate teeth, or those especially made for vulcanite. They are mounted with the aid of wax on the gold plate in the positions which they are intended to occupy, after grinding away portions of the teeth should they touch on the plate.

In the bicuspid and molar regions teeth should be selected which have some resemblance to the natural organs, as it is only in very close bites indeed that a row of short canines should be used to represent the natural teeth.

The case is carefully modelled to the bite and tried in the mouth of the patient, when any changes that may be necessary can be made, and the case vulcanized in the usual way. The attachment of the rubber to the plate is an important detail, which should be carefully designed.

Dome-headed gold pins are soldered at different places on or just inside the alveolar ridge, with such judgment that they will not be visible after the case is finished and adjusted, and at the same time will give the dentist every latitude in finding suitable positions for the teeth. Strips of gold bent in the form of cleats are also useful, if they are placed in positions likely to add to the strength of the case. Longer strips of gold, bent in a serpentine way, may be fitted by bending the crinkled strip of gold to fit the plate, and tacking the bends with solder where they touch the plate.

Fig. 90.



Dr. Peck's Loop Punch.

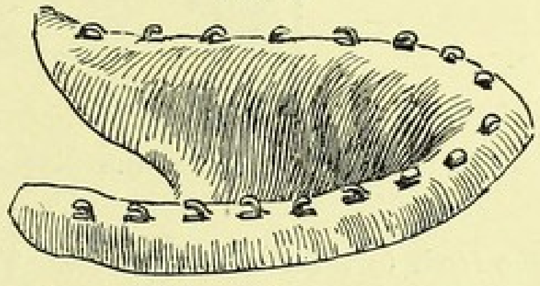
Wire drawn down to the thickness of spiral spring wire, and coiled on wire for an inch, then pulled out again and soldered to the plate, is also a neat, strong way of attaching vulcanite to a plate, which I have used many times. Care has to be taken to bring the wire so as to hold the vulcanite on the plate, and yet not to obstruct access to the platinum pins when the case is packed. Care has also to be taken that the position of the wire does not interfere with the setting of the teeth or their pins.

During the past eighteen months I have frequently made use of an invaluable tool, known as "Dr. Peck's Loop Punch" (Fig. 90), made by the S. S. White Dental Manufacturing Co., and Messrs. Justi & Son, of Philadelphia, U.S.A. This punch was invented to evade the difficulty of soldering aluminium. With its aid, loops can be made in metal plates as shown in Fig. 91, and the advantage is gained of actually stiffening a light gold plate, if the positions of the loops are chosen with judgment and the plate is held very loosely and delicately in the hand while punching. I have not had the fit of a plate injured or sprung by it, and the tool is made so as to be useful in a large proportion of plates, whether deep or shallow. These loops form a most admirable and satisfactory means of attachment, with less trouble and risk than is incurred in soldering pieces of gold to the plate.

The appearance of oblong spots of vulcanite on the palatal surface of the plate looks strange at first, but it does not interfere with the security of the vulcanite or the construction of the case. The illustration (Fig. 93) shows a swivel mounted on a strip of gold plate, and used in a case where the natural bicuspids remain in the mandible and spiral springs have to be worn. With the loop punch gold crowns can also be made to give strong masticating surfaces in close bites (Fig. 94).

I was shown in America in 1895, by an enthusiastic advocate of aluminium plates, a case which he had made and worn himself continually for two years. It did not show any signs of oxidation, erosion or destruction in any way to my eye, and the metal surfaces retained a beautiful polish, although my kind informant said he did not take particular care to polish the plate. He also informed me that his health had not suffered in any way from the action of the fluids of the mouth on the aluminium, which was strange if it *be* true that poisonous action does take place on the surface of the modern preparations of this metal. So far as cleanliness of surface was concerned, it showed a favourable contrast to many gold cases, which we see deeply bronzed with a coating of saliva that could easily be removed.

Fig. 91.

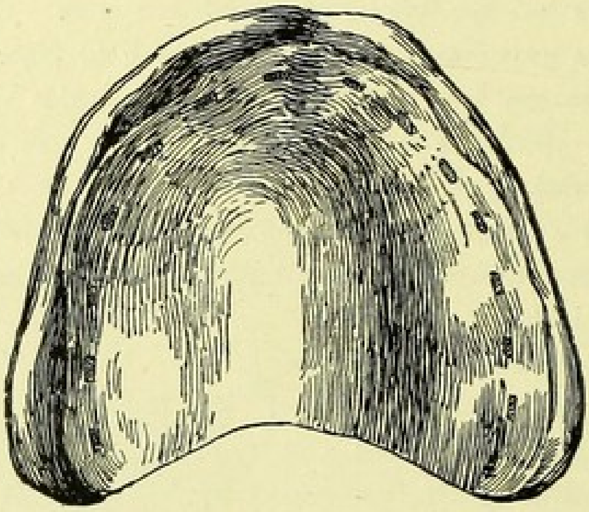


Loops on Metal Plate produced by Dr. Peck's Loop Punch.

Aluminium makes a good stiff plate, and its lightness enables the dentist to use a plate of substantial thickness without any discomfort to the patient in the form of weight. It is worked on a die as easily as gold or other sheet metal; it requires some care to anneal; a temperature that will brown a chip of pine wood, such as the wood of a household match, when held on the plate, will make it sufficiently soft for further striking in the die. Some workmen cover the aluminium plate with oil and hold it over a flame till the oil lights, but the result, I was told, is not so certain as by touching different parts of the plate when heated with bits of pine and singeing them by contact.

In the construction of a full set with spiral springs which I made for a patient during the past summer, I used aluminium plates and attached

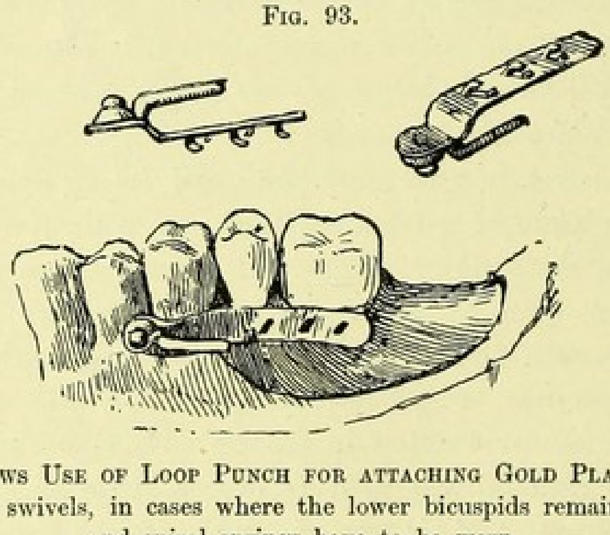
Fig. 92.



Palatine Surface of Fig. 91.

the teeth to them with vulcanite. The patient is a very gouty subject, with thin gums and wasted processes, and she expresses herself grateful for the absence of weight and of that sense of heat which are so commonly associated with full dentures mounted on vulcanite. She informs me that

Fig. 93.

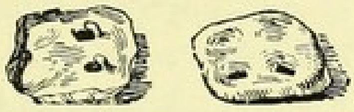


Shows Use of Loop Punch for attaching Gold Plates, designed to carry swivels, in cases where the lower bicuspids remain in the mandible and spiral springs have to be worn.

at times she notices a "taste," but is unable to say positively that it is caused by the aluminium plates, as she sometimes also experiences the same "taste" when she wears a duplicate set which is mounted on gold plates.

The response of aluminium plates to heat and cold is excellent, but they part with heat more slowly than gold plates. It is, therefore, necessary for patients who wear dentures mounted on aluminium, to be careful that soup and other hot foods of which they partake are not of such a temperature as to cause the aluminium to become unpleasantly heated.

Fig. 94.



Metal Crown looped with Dr. Peck's Punch.

A combination of aluminium plate and vulcanite attachments would be treated in the finishing processes much as a gold plate would be—care being taken all through the packing to retain the plate in its correct place on the cast, without letting any particles of plaster lift it from its bed, or any scraps of plaster drop into the spaces between the teeth and the plate.

There are many kinds or shades of rubber prepared for our use by the manufacturers, and the desirable qualities of toughness, elasticity, ease of packing, and certainty of vulcanization are carried to a high pitch of perfection.

There is, I fear, a little uncertainty in some of the directions for producing the best results with the vulcanizer. The thermometer is invariably mentioned, which, as most intelligent dentists know, is an unreliable instrument for registering the temperature of a vulcanizer, unless it is most carefully and assiduously watched and is excellent in quality.

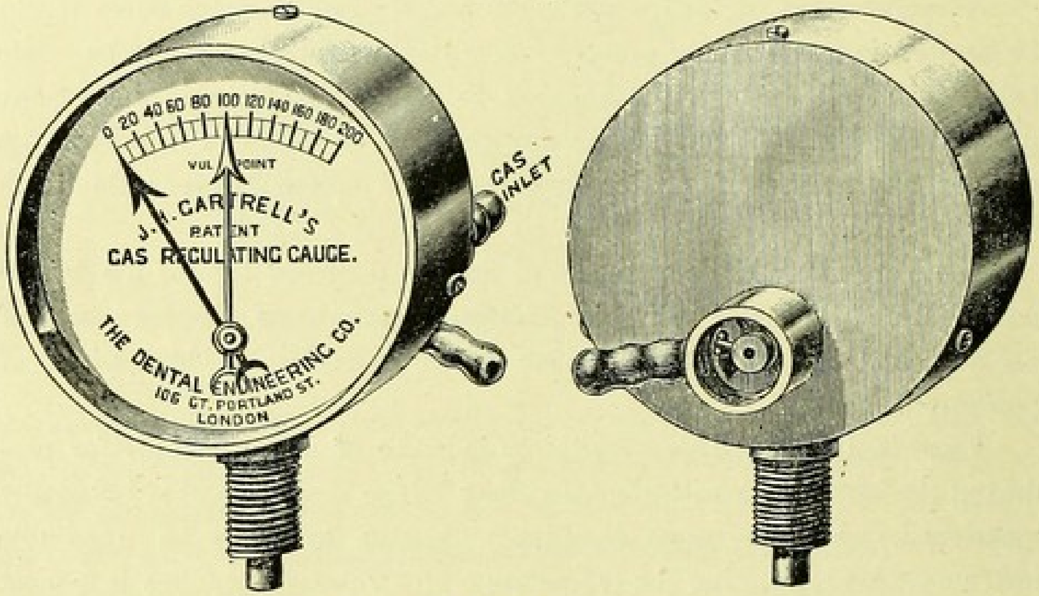
Mr. J. H. Gartrell's Gas Regulating Gauge (Fig. 95) gives an accurate reading; and excellent results will be obtained by treating the flasks when packed with rubber as follows: Heat the vulcanizer and pour into it sufficient hot water to form steam, then put in the flasks and secure the lid. Raise the pressure to 80 lbs. in from fifteen to twenty minutes, and carefully close the flasks if the vulcanizer in use is provided with a press for the purpose.

The pressure should be maintained at 80 lbs. for thirty minutes, then raised to 100 lbs., and kept at this pressure for another forty-five minutes. The steam is then allowed to escape, the vulcanizer is opened, and the flasks are cooled. Excellent tough vulcanite will be found when the cases are removed from the flasks.

When thick, bulky cases are to be vulcanized, not less than half an hour should be allowed for raising the pressure to 80 lbs. from the time of closing the lid. The more slowly the pressure is raised, the better are the results obtained, as when it is raised in a hurry the vulcanite will be found "burnt" or "porous."

Mr. Gartrell's Gauges have been in constant use for more than seventeen years all over the world. They have been severely tested over and over again, and compared with the very best thermometers under every possible condition of work. In no case has a vulcanizer exploded which has been fitted with a gauge.

Fig. 95.

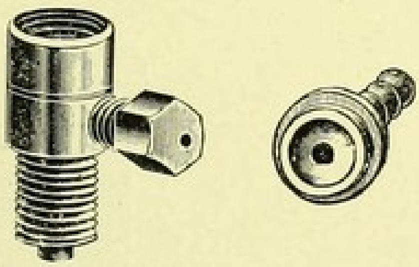


Mr. Gartrell's Gas Regulating Gauge.

A recent explosion, in which a vulcanizer was furnished with a thermometer, which wrecked a workroom, fortunately without injuring anyone, shows how unsafe the best thermometer may prove if it is unwatched and forgotten for even a very short time after the temperature has reached a given height. I am of opinion that the thermometer ought to be discarded as an instrument for registering the temperature of a boiler. I look upon it as a death-trap, owing to its want of gas-regulating power, and from having experienced the terror which a neglected thermometer inspires. On one occasion I had to crawl across the workroom floor to turn off the gas when the temperature of a cast-iron vulcanizer had been left unwatched on a windy day, and the wind pressure on the gas company's gasometers had rapidly run up the temperature to a dangerous point. The tap controlling the gas supply had an arm soldered to it which moved over a graduated quadrant, and the arm had been set at the usual place. After this experience, the gas was led to the burner under the vulcanizer through a pipe of small calibre, and this contrivance worked well until Mr. Gartrell's splendid invention reduced such risks to a minimum.

In the latest form of gauge Mr. Gartrell has introduced a copper disc safety valve (Fig. 96), which will work accurately, as it is not affected by the heat of the vulcanizer. It is placed between the pressure gauge and the syphon, and is not influenced by heat, as it would be if it were attached to the vulcanizer. With the ordinary safety valves or fusible metal plugs, a little grease or dirt may retard or postpone their action indefinitely. This gauge, when used in an intelligent way, is one of the greatest boons which a dentist can have in use on his vulcanizer, as it is impossible to burn a denture, a mishap which not infrequently takes place with the thermometer.

Fig. 96.



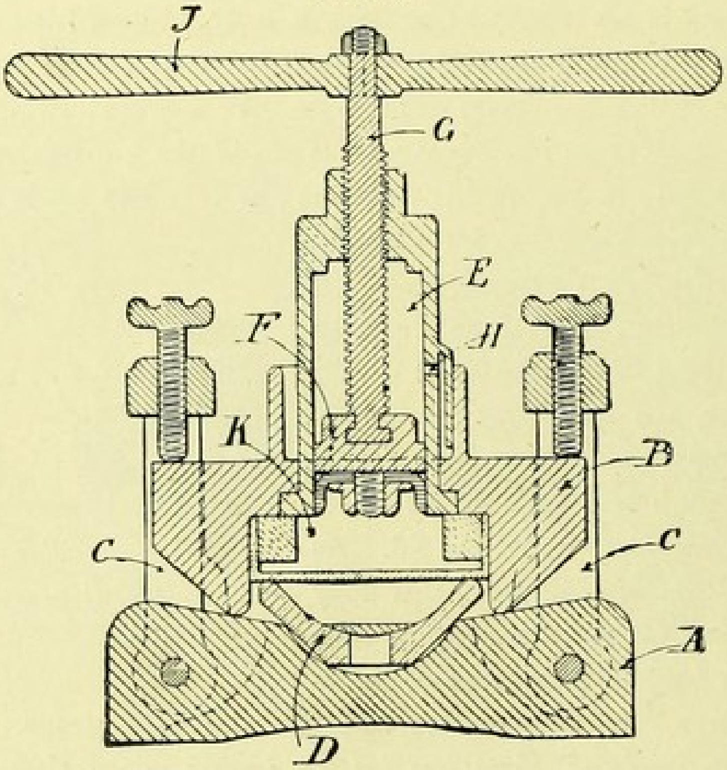
Mr. Gartrell's Copper Disc Safety Valve.

It is well, when getting up steam to the vulcanizing point, to let some of the vapour escape, and thus carry off the air which is imprisoned when the lid is closed, and which is driven to the upper part of the vulcanizer under the lid. As air is a bad conductor of heat, this body of air surrounding the thermometer tube may account for the divergence of registration between the thermometer and Mr. Gartrell's gauge. In many books, and in nearly all directions for use, freshly mixed plaster of Paris is recommended to be placed in the boiler for the purpose of supplying moisture for generating steam. There is no advantage to be gained by this procedure, for it adds to the consumption of plaster. A measure of boiling water, the amount of which can be determined by a few practical tests, will supply all the steam needed by a trustworthy vulcanizer.

There is an almost endless number of patterns of vulcanizers, and if I do not describe them at length, it is not because I do not appreciate their merits, but because I am satisfied with the simple form which is in use in my own workroom, a section of which is shown on page 148.

Vulcanite is much improved in quality by being "cooked" in contact with tin, either in the form of sheet pressed on the surface of the model by the help of the hydraulic or steam swager, or by the use of a tin model cast in the sand like a metal die. When this latter kind of metal model is made for use in the vulcanizer, as soon as the tin shows signs of cooling at the margins of the cast, the fluid metal of the casting is deftly thrown out, and leaves a metal shell on which to mould the rubber. This metal shell is filled with plaster and set in the lower part of the flask in the way in common use, and the wax model of the denture can be carefully fitted on

FIG. 97.



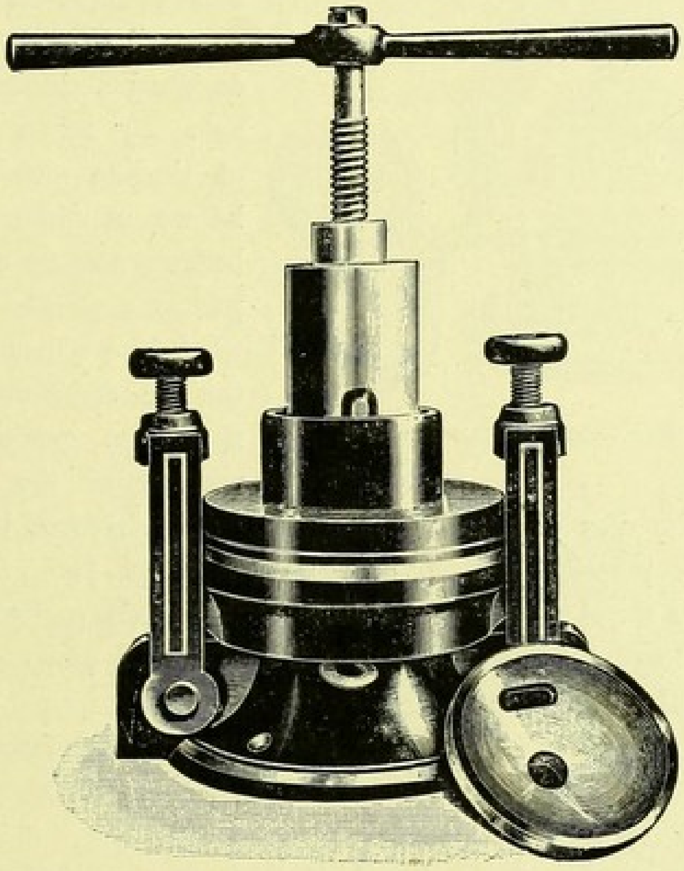
MR. GRUNDY'S NO. 1 HYDRAULIC SWAGER.

it and invested with the help of the upper part of the flask. The thinner this cast can be made, the better for readily enabling the dentist with a few judicious saw cuts and a pair of pliers to remove the metal from the inside of the denture when it has been removed in the flask from the vulcanizer, cooled and opened.

Black and whalebone rubber treated in this way, or vulcanized in a mould, or on a model coated with thin sheet tin, is rendered wonderfully tough as compared with an equal bulk of vulcanite treated on a plaster mould or in a plaster mould. The details of the palate come out wonderfully sharply defined, and if the cast is carefully finished, the vulcanite has a beautifully polished surface where it rested in contact with the tin.

I have had an opportunity of testing the "hydraulic swager" (Fig. 97) designed by Mr. Grundy, of Batley, and to those who do not make use of fusible metal plates, I would say that it will be found of use for making trial plates with which to test the accuracy of the model.

Fig. 98.

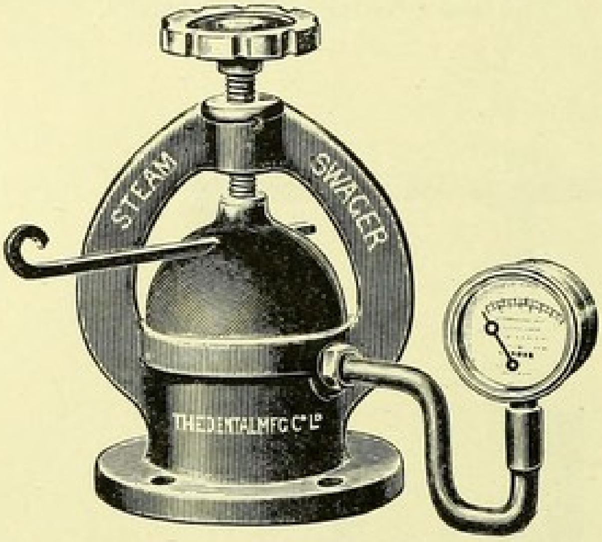


Mr. Grundy's No. 2 Hydraulic Swager—a Simpler Form than Fig. 97.

By uniting two or more plates together with wax, the metal plates made in this way can be used for taking bites. The apparatus is strongly and carefully made, with a pump and valve by which to produce the pressure by the aid of water on the rubber disc, which squeezes the sheet tin over the surface of a mould or into an impression taken from the mouth. To one practised in its manipulations the details to be observed offer no difficulty.

Since this type of hydraulic swager was brought prominently before the profession, Mr. Grundy has designed a simpler form (Fig. 98), which I have not used, but which, costing less than Fig. 97, does similar work with less trouble, and cannot easily be misunderstood by the ordinary dental assistant.

Fig. 99.



Mr. W. R. Humby's Steam Swager.

Mr. Humby, of London, has shown to the profession, from time to time, a "steam swager" (Fig. 99), which he designed a great many years ago. By means of a sheet of tin-like metal, commonly known as meter metal, held between the upper and lower part of a vessel, shaped somewhat like a bomb, a marble can be encapsuled with the metal, so powerful is the pressure of the steam when exerted on the disc of metal, which yields and stretches but does not tear. Models prepared and invested in the upper part of the swager can have this metal forced on to their surface with perfect fidelity, so that two or more thicknesses may be used for trial plates on which to mount mineral teeth.

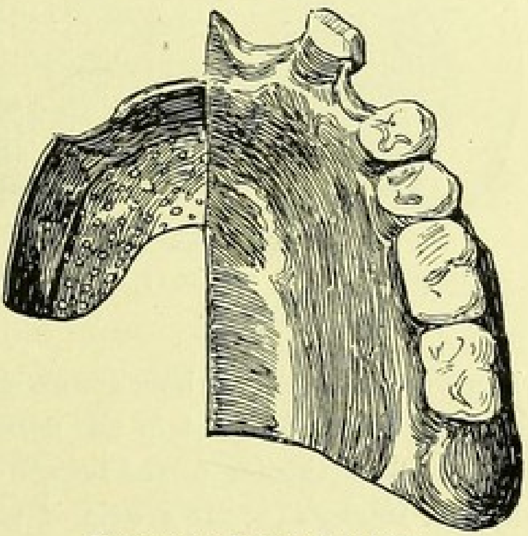
Mr. Charles H. Morley, of Derby, has for a number of years practised a method of strengthening vulcanite plates, the following description of which may prove of some interest to my readers:—

The plaster model of the mouth is made from an impression in the usual way, and from it a zinc die is cast in sand, and a counter-die of lead is made. A tin plate, of No. 8 or No. 10 Ash's gauge, is struck on the zinc die, of a size intended to represent the finished plate. This plate is tried in the mouth, and, if found to be a correct fit, is used to take the bite by means of wax blocks attached to it. The plaster bite or articulation is then made, and with its aid suitable pin or vulcanite teeth are mounted in the ordinary way on the tin plate, which, with the teeth in position, is tried in the mouth of the patient, to make quite certain that the bite and the position of the teeth are correct. The plate is now placed on the model, and plaster casts are made of the fronts of the teeth, in the form of sections or blocks, as in continuous-gum work, which articulate with the outside border of the model in grooves or pits cut in it for this purpose. The teeth are detached after the plaster blocks have thoroughly set, when the relative positions of the teeth and the model can be seen.

A copper plate, No. 3 Ash's gauge, is struck on the metal die, and on this a perforated gold or dental alloy plate of No. 6 or No. 7 gauge is struck. Over the perforated plate a tin plate of No. 8 or No. 10 gauge is struck. The perforated plate and the tin plate must be made smaller than the copper plate and of such a size that they will clear the pins of the teeth and lift out of the vulcanite flask afterwards. The perforated plate should extend from first molar to first molar on each side of the arch, and care should be taken to make it end between the pins of the first or second molars, not opposite to the approximal surfaces of the mineral teeth.

On the perforated plate, a strip of plain gold or dental alloy plate is soldered *at right angles* (Fig. 100), so that it will come under, or a little within, the pins of the teeth. At this stage the palatal surface of the plaster model is covered with the copper plate. The perforated plate is placed on the copper plate and covered with the tin plate. Wax may be used to join the surfaces of the plates together. The mineral teeth are now attached to the plates with wax in their correct positions by the aid of the plaster contour blocks already mentioned.

Fig. 100.

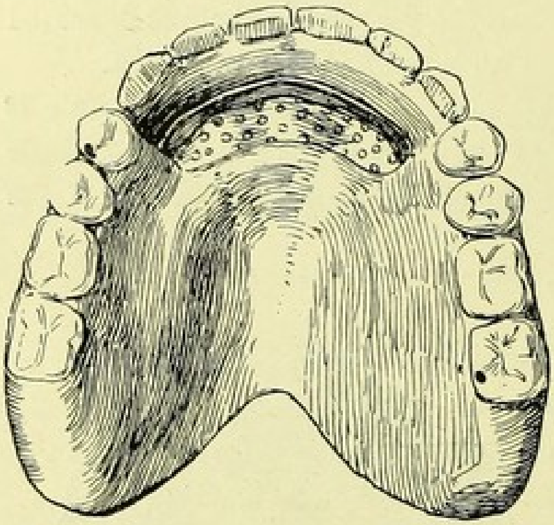


Vulcanite Upper Denture, with Part cut away to show Perforated Plate with Plain Plate soldered to it (Mr. Morley's Method).

The plates with the teeth are finished for placing in the vulcanite flask just as if a gold plate with rubber attachment was in process of construction. The triple plate carrying the mineral teeth is invested in a three-part flask, but some cases with teeth fitted on the gum can be fixed in a two-part flask. When the plaster has set, the flask must be warmed before it is opened. After it is opened the wax can be scalded out. Rubber is then packed under and between the teeth in the usual way. A piece of Ash's extra thin rubber for base—whalebone, or any other that may be desired—is now taken and cut to the pattern of the perforated plate and placed on the palatal surface of the plate. The perforated plate with the rubber attached is replaced on the surface of the model in the flask in its exact position. The tin plate is then placed upon the perforated plate, the flask is heated and gradually closed. The packing is very important, and at every step the greatest care need be used.

When the flask is opened, after all the foregoing details have been carried out, the perforated plate will be found in correct position on the model, and the space previously occupied by the copper plate replaced with rubber (Fig. 101). It should be borne in mind that if the copper and tin plates have been left full size, a three-part flask is necessary to allow of their removal, as well as to allow of packing from both sides where the plate turns over the ridge. The palate side should be packed first, then the flask should be closed with the tin plate in position, after which the plug section of the flask should be opened, the tin plate removed, and the packing of the rubber completed.

Fig. 101.



Mr. Morley's Angle Plate, with Vulcanite cut away to show Details.

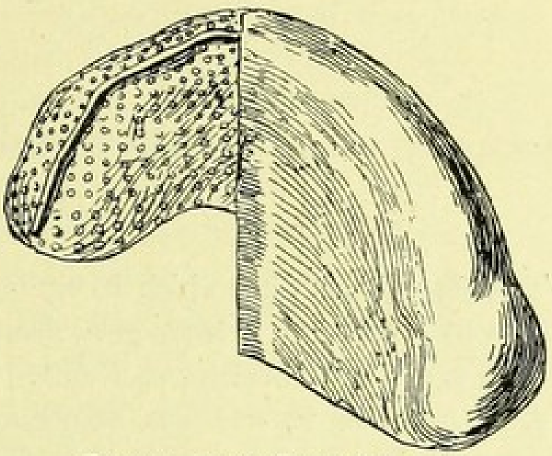
If all the details have been accurately carried out, the flask can be closed and the case vulcanized in the usual way.

For strengthening partial vulcanite uppers, it has been found convenient by Mr. Morley to strike a strip of plain gold or dental alloy plate, No. 8 gauge, one eighth or a quarter of an inch wide (Fig. 102). This strip should be laid round the labial edge of the perforated plate and perfectly soldered to it. A space the sixteenth of an inch wide is recommended to be left between the necks of the natural and mineral teeth, and the strip soldered on the plate.

In polishing these cases, great care must be taken not to expose the perforated plate by cutting away too much vulcanite.

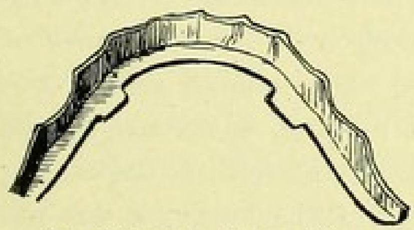
When angle-plates are made to strengthen the construction of vulcanite lower dentures, Mr. Brunton's two-part contour flask is required, as it opens at the end and draws out the angle-plate with the plug. To make an angle-plate for this purpose a plaster foundation is made upon the plaster model of the mandible. Care should be taken to keep the angle in the right position, with the line *true* in relation to the particular model as well as for the appearance of the finished work. It is also important to keep the lower portion of the angle-plate of uniform width, so as to maintain uniformity of strength. If the angle-plate should not be considered strong enough, it can be stiffened with gold solder run in the angle. A disc of metal is soldered to the edges of the two lugs shown in the illustration (Fig. 103) of the lower plate, for the purpose of holding the angle-plate in correct position in the plaster plug part of the flask during packing and vulcanizing. When the denture is removed from the flask, this disc can be cut away from the lugs, and the lugs can be filed down to the surface of the vulcanite, so that a neat clear line of edge of the plate is found. Before these angle-plates are packed, the dentist should be certain that the plug will draw out of the flask.

Fig. 102.



Dental Alloy Strip soldered at Right Angles on Perforated Plate (Mr. Morley's Method).

Fig. 103.



Mr. Morley's Angle-Plate for Strengthening Lower Dentures.

CHAPTER XVII.

SUCTION PLATES.

THE first suction plate which I ever saw was in 1856, when I was a small schoolboy. It was a large gold denture carrying plate teeth, and had been made in Philadelphia, U.S.A. My father replaced three broken plate teeth on it, and was deeply interested in the ingenious use of atmospheric pressure to retain it in position on the maxilla. The patient, a lady, had a typical maxilla for such a method of fixation, with a well-marked alveolar ridge covered with thick elastic gum. The gold plate was made to cover the labial and buccal surfaces of the alveolar process, and on the palatal surface had four chambers, two on each side of the middle line, about the size of kidney beans, projecting towards the tongue. The plate was beautifully made, and fitted the mouth like a glove. The lady had all her natural teeth still remaining in the mandible, but the use of plate teeth for the whole arch left the power of mastication imperfect. Her case was one of open bite, in which tube bicuspids and molars could have been used to great advantage on the denture,—but, made as it was, with the backs of the teeth at the cutting edges in close contact to the external surfaces of the lowers, it was not to be wondered at that the mineral teeth were, from time to time, bitten off by the natural teeth.

My father made many cases on the lines suggested by this denture,—but he was always careful when the bite was open to supply a masticating surface by using tube teeth. When the bite was close and plate teeth had to be used, he made up a masticating surface with pieces of gold, struck to fit the lower teeth and soldered to the plate. A year or two after this, he made a couple of dentures without any suction chamber, which were retained without difficulty, and, from time to time, as suitable cases presented themselves, "suction uppers" were made in various ways. Success in this kind of work depends upon the natural shape of the jaw, the intelligence of the patient, the excellence of the model, and the care and accuracy with which the details of construction are carried out.

I have seen many an excellent plate made on models cast from beeswax impressions, and many made from plaster impressions, for my father was skilful in taking impressions of the mouth with plaster of Paris, having used it for this purpose in the United States from 1837 to 1840. An intelligent patient is an important factor in successful treatment of this method of fixation. Without some kind of mental receptivity explanations of how to "keep up" the denture are often unavailing.

Sucking the air out of the barrel of a key, and letting it hang attached to the lip holding up the bunch; inverting a tumblerful of water with the aid of a card, a sheet of glass, or a small plate, and holding it bottom upwards without letting the water fall out, are modes of illustration which we may practise in vain to enlighten some dense patients. They look upon demonstrations of a natural law as mere conjuring tricks, and sometimes feebly re-assert with tears, "I can't keep it up."

Every edentulous maxilla is not favourable for this method of practice; discrimination has to be used in the selection of suitable cases. When the maxilla is hard and bony, although the form of the alveolar ridge may look favourable, being covered with but a thin and inelastic gum, great difficulty will be experienced even if there are a good many teeth remaining in the mandible. This type of case is sometimes scantily supplied with saliva, which appears to add to the difficulty.

Very flat palates, with a hard ridge or with bony nodules on the middle line, add much to the difficulties of the dentist if the gum be thin, no matter how excellent his model may be. In no class of dental work, therefore, is an accurate estimation of the thickness of the gum and its elasticity of more importance.

Suction can seldom be relied upon in palates of a hard, bony nature, covered with a thin fibrous gum, no matter how favourable they may be in *form*, unless the dentist's efforts are seconded by an intelligent patient possessing mechanical ideas, whose understanding of the nature of the case is apt. The situation of the suction chamber should be carefully chosen, as it is necessary to have a sufficient thickness of tissue to act as a valve when the air is sucked away from the chamber by the action of the tongue.

As stated in a previous chapter, the margins or rim of a denture should be most accurately drawn on the plaster model with a lead pencil, and the details modelled with sedulous care.

The movable attachments of the cheeks, the fraenum and the little muscular bands that infringe upon the gum, should all be noted, and room made for their action by dropping a little hard wax where necessary on the plaster model when modelling the plate. Sheaves or grooves can also be made for their action in the margin of the denture. An excess of material will defeat the success of this method of treatment by pressing on these movable parts and causing pain, as well as by offering a surface large enough for them to force the plate off the palate, the result being that air is let in between the palate and the plate, and the latter drops from its position.

Another type of case offers difficulties to the dentist, namely, where the upper teeth have to be replaced, and only the incisors and sometimes the first bicuspids remain in the mandible. The patient will only consent to the construction of an upper denture; he will not have the missing lower teeth replaced because "he has plenty of teeth for mastication." In such a case, when the lower teeth close on the upper denture, all the pressure naturally comes in front, the denture is tilted, air is let in between the palate and the denture, and the patient complains that "it drops," quite leaving out of account the unfavourable mechanical conditions for such work, to say nothing of the lower incisors having become elongated for want of occlusion.

There are many ways of constructing suction cases without chambers and with chambers; also with ridges projecting from the upper surface of the denture, placed where the gum is thickest between the middle line of the palate and the crest of the alveolar process, as so strongly recommended by the late Dr. Evans, of Paris.

By forming a ridge which projects from the inner margin of the rim of the denture, and runs continuously round the alveolar border and across the end of the palate, the idea is to convert the whole of the palatal, buccal, and labial surfaces of the denture into a large cell. The pressure of this ridge cuts off the inset of the air to the interior of the plate.

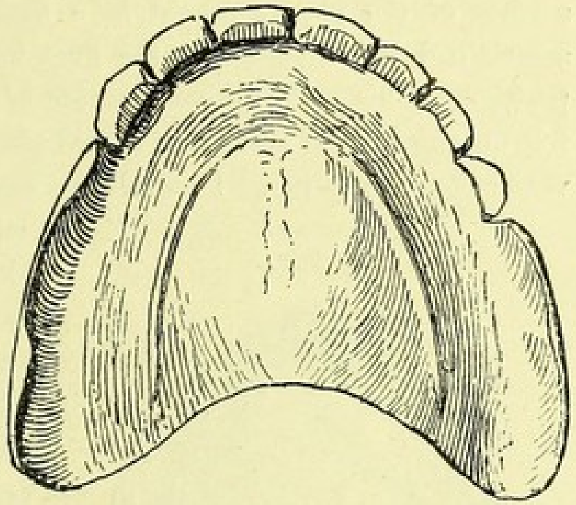
Cases without a chamber are most successful when the gum is soft and flabby on a symmetrically shaped maxilla.

Cases with chambers are commonly successful when there is a thick and elastic gum covering the bony structure of the maxilla, and where there is a normal bite.

I have seen cases made with projecting ridges in the palate (Fig. 104) which worked admirably, although, owing to absorption of the alveolar process or the closeness of the bite, the mineral teeth had to be ground to fit on the gum without any labial border to the plate.

There are strong differences of opinion as to whether the suction chamber should be deep or shallow, and made with rounded edges or with sharp square ones. For myself, I am inclined to recommend *rounded* edges as being more comfortable to patients, and because I have so often had to cut away a sharp square edge on account of the pain and irritation which it caused.

Fig. 104.



Denture with Projecting Ridge in the Palate.

Chambers can be moulded in wax on the surface of a model intended for sand casting, or by attaching a tin shape of suitable thickness to the model with sticking wax, after the metal model of the chamber has been correctly shaped and made to fit the place which it is intended to occupy. Care should be taken to bevel the surfaces of the model of the chamber, so that sand "drags" will not take place in moulding.

Suction chambers can also be made by cutting out a suitable shape from the plate, and soldering over the aperture a cell stamped out to fit on a specially prepared model. In some of these chambers the cell is larger in diameter than the aperture cut in the plate, and a border is left round the mouth of the chamber to give an overlap to the gum when it is sucked into the chamber. Sometimes the chamber is made by soldering a metal ring on the plate, and then cutting out the mouth of the chamber till it touches the inner edge of the ring. The chamber is completed by soldering a flat piece of gold on the ring.

The cases that I have seen in which sharp-edged chambers were in use were always a discomfort, from the irritation set up in the gum by the sharp edges of the mouth of the chamber. The discomfort was removed by rounding the sharp edges as much as possible. I have not been able to discover any superiority of adhesion in chambers made in this way, over those stamped in the plate by the use of the die.

I have made many successful cases where teeth remained in the jaw, as well as when they were absent, by soldering wire rings to the upper surface of a gold plate (Fig. 105), or by cutting a groove in the palatal surface of the plaster mould in a flask prepared for vulcanite, having ascertained beforehand that the gum was thick and pulpy at the chosen position. This makes a combination of chamber and ridge, which is not felt on the lingual surface of a gold plate, and I have found it to act in a very effective manner. I am always careful to mark the correct position with a lead pencil on the model, the patient being in the chair, after careful digital examination of the surface of the gum. These chambers may be made either elliptical or in the form of an ellipse much drawn out (Fig. 106), as may suit the peculiarities of the case.

Fig. 105.

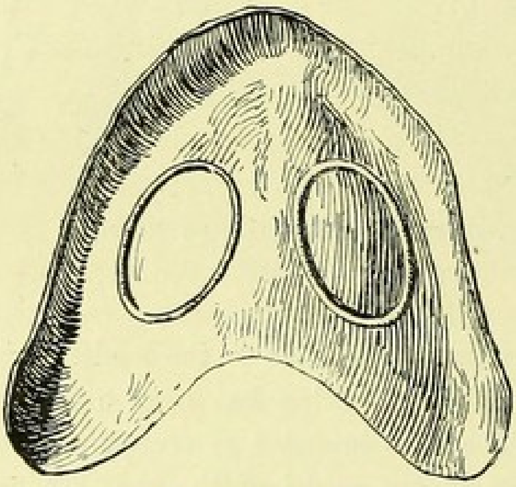


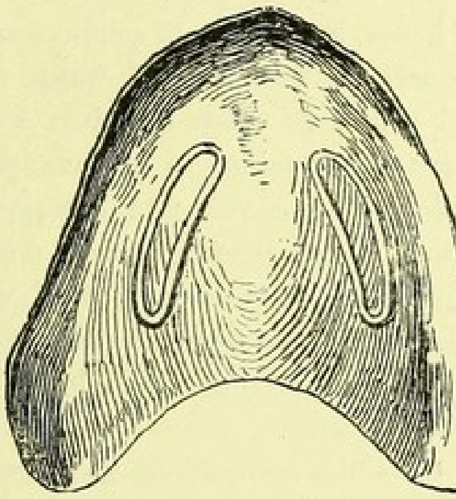
Plate with Wire Rings soldered on the Palatal Surface.

For some years past, suction discs have been much to the fore, but, despite the strenuous claims of their inventors, my experience of their use has not always been a gratifying one. If they depend on a valve, or on the sucker action of a leather or india-rubber washer, the practitioner has to keep them in repair or to renew them, as the vagaries of his patient may demand. Like many other domestic *contretemps*, the valve is either picked out or falls out at an inconvenient moment, and the patient rushes to the dentist for immediate relief. The very best of these valves seems to need renewal,—although, when they are freshly mounted, they seem to give "great satisfaction" from the firmness of their grip till the patient drinks some fluid.

I have seen many plates for the maxilla, carrying one or two teeth on the suction principle, in which the ordinary fastenings or bands were omitted. They are, however, seldom or never a success, from the habit which the patient acquires of playing with them with the tongue. The risk of swallowing one of these small plates is very great; and this type of suction denture should, I think, be looked upon as a mere mechanical curiosity, without practical use so far as speech or mastication is concerned.

During the past twenty-five years I have met with five cases of edentulous maxillæ, which caused much trouble to my patients and myself. They were, so far as contour of alveolar ridge may be taken as a criterion, most favourable cases for the construction of dentures to be kept in position by suction. They did not prove to be so, however,—for, in spite of the use of accurate impressions made with plaster of Paris, the denture would not remain in position. The palate in each case seemed to invite the dentist to place the suction chamber in the middle line,—but, despite every care, the denture would not "hold up."

Fig. 106.



Elliptical Suction Chambers on Palatal Surface.

The first case I saw with my father, and the patient declared he had been with five dentists, who all had failed to give him a suction case. The models were made in plaster impressions, and a wax plate was made to fit in order to test the accuracy of the patient's statement. The wax plate could not be made to retain its place. Trial was then made with a cast plaster of Paris plate with a highly-varnished surface, but it would not remain in position. A very close examination of the palate, which was a moderately deep one, showed a fold in the mucous membrane running from the soft palate into the hard palate, formed on the left side of the central line terminating on the alveolar process, which fold was about the width of a hair and about an eighth of an inch deep. Its course, which seemed to be somewhat that of the ordinary cleft palate, could be followed with a slender probe. This furrow or fold did not show as a whole on any of the impressions, except just where it entered the hard palate, and its appearance there was assumed to be an unusual form of drag. The furrow having been recognized, a suction denture was successfully made by modelling two small chambers where the gum was thick and pulpy, one on each side of the jaw. The chambers, which were about the size of haricot beans, were placed in the most judicious positions, where there was no risk of air entering them through the furrow which I have endeavoured to describe.

I have met with four cases since the one mentioned above, in which there had been a similar history of failure to secure adhesion of the denture to the jaw under apparently favourable conditions, so far as the nature of the gum and the shape of the alveolar border would serve to guide a practitioner. In all these cases a most careful examination of the plaster impression revealed traces of a similar furrow entering the hard palate, as already described, and running towards the front of the mouth on the left side.

I was led to try a combination of chamber and ridge in making dentures for them, two of which were gold and two vulcanite. In the gold plates, the ridge chambers were soldered on the upper surface, in positions ascertained to be suitable by careful digital examination of the palate. In the vulcanite dentures the ridge chambers were made by cutting a groove of a suitable depth and width, in the form of a long ellipse four times as long as it was wide, on each side of the palate. These cases were worn by the patients for years, and retained their position, through all the vicissitudes of speech and mastication, without trouble to the patients.

It would seem, from the narrow type of arch associated with these cases, as if the persons in whose maxilla this groove or gutter exists had narrowly escaped having a cleft palate.

All the four cases under notice had good support from the teeth remaining in the mandible, only two or three being missing in any of them, mostly in the bicuspid region.

I do not remember to have read of this peculiar groove or gutter in the maxilla as a cause of failure in the employment of suction dentures. It is well, therefore, by careful examination, to take care that such a condition is not overlooked when taking impressions of apparently favourable cases for the employment of suction plates.

I have, from time to time, made enquiry as to the recognition of this peculiarity on the part of others, but I have met with only one practitioner who had observed it, the late Mr. Thomas Grattan, of Belfast, who considered his own experience unique from having had as many as two such cases in a practice extending over many years.

CHAPTER XVIII.

THE EDENTULOUS MOUTH—BITE TAKING AND SPIRAL SPRINGS.

The mouths of toothless patients present many mechanical difficulties to the practitioner, when a denture has to be made to restore the impaired functions of speech and mastication. This is a subject that does not appear to interest writers on mechanical dentistry, and yet practitioners of ripe experience and sound practical knowledge occasionally tell of the anxieties which such work brings in its train.

It will be well to consider the types of edentulous mouths that present themselves to the practitioner, and to describe some of their peculiarities.

1. The symmetrical edentulous mouth is not so common as it deserves to be, so far as the dental practitioner's anxieties are concerned. This type is usually found with a well-marked alveolar ridge on the maxilla, and an equally well-marked alveolar ridge on the mandible.

The absorption of the alveoli having proceeded very equally and slowly after the loss of the natural teeth, a well-marked ridge is left well above the mylo-hyoid line, on which to rest the lower denture. The alveolar ridges on the maxilla and on the mandible are usually thickly covered with firm elastic gum tissue, so that, with ordinary care, excellent impressions can be taken of each jaw. The occlusion of the jaws is normal, *i.e.*, symmetrical. Dentures in such cases can generally be retained in the mouth without the aid of spiral springs.

Patients having this type of edentulous mouth can speak with a clear and resonant voice, and enjoy the pleasures of the table almost as well as when they had their natural teeth, if ordinary care is taken to articulate the mineral teeth on natural lines.

2. There is another type of symmetrical edentulous mouth, in which the maxilla possesses a well-marked alveolar ridge, covered with thick and elastic gum tissue. The mandible, however, has hardly a trace of the alveoli left, and the floor of the mouth rises and falls like the tide above the mylo-hyoid ridge on each side. The gum is very thin and sensitive

on the mandible, the occlusion of the jaws is normal. A lower denture for such a case should be designed with a view to floating above the mandible, while moored in position, by the aid of spiral springs attached to the upper denture.

This type of symmetrical toothless mouth is not an unmixed joy to the practitioner, for unless the greatest care is taken with the articulation and the setting of the swivels and springs, the lower denture slides forward and forms an ugly swelling below the lower lip, commonly giving this lip a spout-like appearance.

Fig. 107.

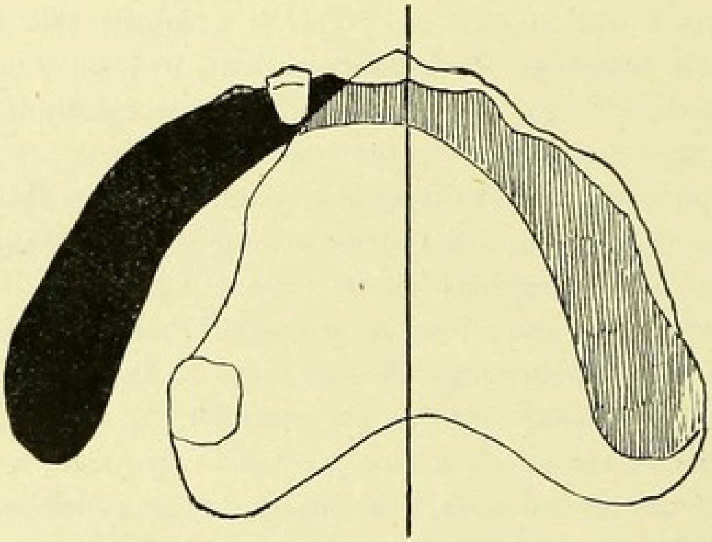


Diagram of "Eccentric" Bite.

3. The next type of edentulous mouth may be aptly termed "eccentric," from lack of normal relations between the maxilla and the mandible, the maxilla having moved from the middle line of the skull, so that the alveolar ridge of one side of it is commonly half an inch or more outside the alveolar ridge of the mandible beneath it (Figs. 107–109).

The maxilla is sometimes covered with firm thick elastic gum tissue, and sometimes with a soft, tender and vascular surface. The mandible is commonly but thinly covered with gum, and is easily fretted, if the absorption has gone so far as almost to expose the mylo-hyoid ridge, which can be readily felt with the finger through the thin gum. This type of case can often be recognized before the impressions of the mouth are taken, and before the mortifying experiences of failure in bite-making have begun, by careful study of the patient's features. A want of proportion and of symmetry can be observed in the face, and the nose is not uncommonly out of plumb. Sometimes one orbit will be found higher than the other.

When this disparity of proportion in the features of the patient is to be seen beforehand, a judicious practitioner anticipates unusual difficulties, and proceeds with more than ordinary caution in dealing with them. The bite in all such cases should be tested or confirmed, as it is waste of time to attempt to treat them without an exact bite. The denture for this type

FIG. 108.

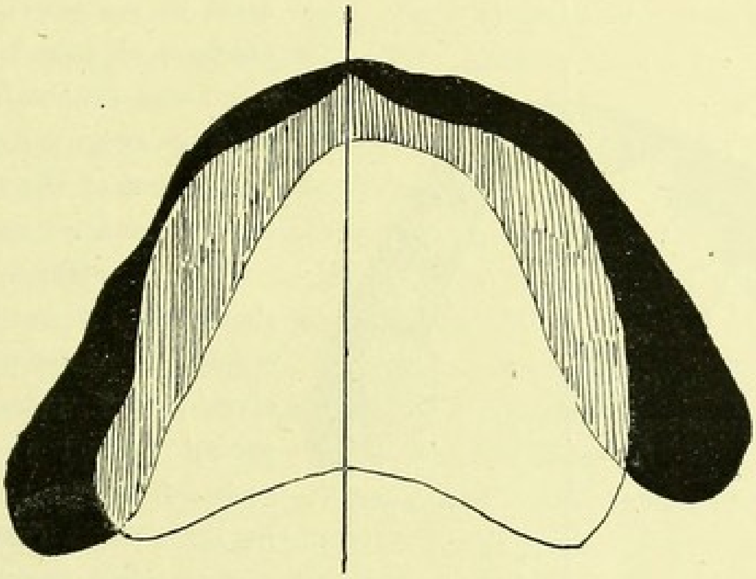


DIAGRAM OF "ECCENTRIC" BITE.

of mandible has often to be designed to float on the floor of the mouth, which rises and falls like a wave above the level of the mandible, while its action adds an additional difficulty by moving the denture out of position with or without the use of spiral springs.

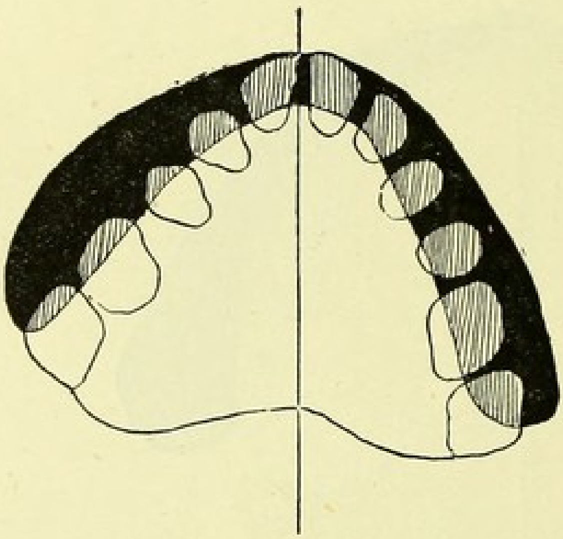
4. There is another class of this "eccentric" edentulous mouth, in which the maxilla is covered with a very soft and "spongy" gum over a rounded or flattened alveolar ridge. In the mandible, the alveoli are often to be found with a well-marked crest on one side, while on the other there is not the least trace of them left, and the floor of the mouth also rises above the gum surface of the absorbed side. This type, therefore, presents such complications as a very soft and yielding gum over the maxilla,

while on the mandible there is firm support on the alveolar ridge on one side and none on the other.

This variety of edentulous mouth is not uncommonly brought about by the foolish practice of padding an uncomfortable or ill-fitting lower denture with cotton-wool, or folds of linen or cotton fabric, on one side of the denture.

This practice is sometimes recommended to patients by dentists, and sometimes it is discovered by the patient himself, as a wonderful resource to make work that has never fitted, comfortable. The results in most cases are disastrous, so far as the preservation of the alveolar ridge is concerned. I have seen many cases in my practice where the outcome of this kind of treatment was lamentable, from the wasting away not only of the alveoli, but of the upper surface of the mandible itself.

Fig. 109.



"Eccentric" Bite.

In my opinion, the dentist should do all in his power to encourage preservation of the alveoli, and never permit a patient to pad a denture with such soft supports, as there can be little doubt that very rapid and complete absorption can be produced by this means. Indeed, I may say that the very worst cases of alveolar absorption I have ever seen were in the mouths of patients who had practised this treatment for a few weeks or a few months. It is seldom practised for *years*, owing to the fact that the discomfort to the patient is so great.

5. I have also noticed another type of symmetrical edentulous mouth, in which the maxilla is very much wasted and flattened, as well as the mandible. The gum in these cases is usually very thin in substance and of a pale colour. With all these complex problems to meet, it is little wonder to find, in many types of edentulous mouths, that a successful case is seldom seen without having to rely upon the much-derided spiral springs. In many of these cases, there is such a thin gum that "suction"

cannot be depended on in the upper, and is unavailable in the lower denture.

The intelligence of the patient often cannot be evoked to learn patiently how to keep the dentures in position by the aid of the cheeks and lips, or whatever adhesion can be established between the surface of the jaws and the dentures. To learn to keep two independent cases in the mouth at the same time, under such unfavourable conditions, is little short of a conjuring trick, and it is only the exceptional patient who will make any sustained effort to master such dental gymnastics. With the exception of the normal symmetrical edentulous mouth, all the types I have mentioned require the exercise of *care*,—nay, I may even say *great care*,—in the art of taking the articulation. My anxieties have been greatly lessened during the past five years, since I have used fusible metal in the form of plates, as recommended and practised by Mr. R. P. Lennox, of Cambridge, for the bases on which to shape the wax blocks. With the aid of fusible metal base plates in taking the articulation of the jaws, the dentist is saved many errors, as the metal prevents the wax or modelling composition going out of shape from the heat of the mouth.

I am in the habit of trying the wax bite on the mandible first of all, taking care that the fusible metal plate has no sharp edges to press into the gum and hurt the patient. A little care, when modelling the plate on the plaster model with wax, will avoid edges, so that only rounded surfaces rest on the gum before casting the fusible metal plate. It is sometimes necessary to file off edges, so that when the patient closes the jaws no pain will prevent the dentist from testing the accuracy of the plaster model by firmly pressing the metal plate with the bite on the gum. My practice is to look at the mouth attentively and pencil on the plaster model the extreme area to be occupied by the plate. On this area is modelled the wax plate, which is covered with impression material in a tray, which is cooled on the model with water and removed. The wax plate is removed, and a gate cut in the impression, if one has not been already modelled in wax. The impression is replaced on the model, and the melted fusible metal is poured into the space between the plaster model and the impression. If this procedure is carefully carried out and the metal is poured just before it cools, an excellent plate is the result, which can be used as a foundation on which to build up the wax used for taking the bite. When I have pared the mandible block to a suitable size, I introduce the fusible metal plate or wax block to try the fit on the maxilla. This is trimmed, if not found to fit right, till the patient's profile is found to be correct, and the lips are left soft and mobile-looking. Dentists are too apt, I fear, to overlook the natural mobility of the lips. Instead of remembering the expressiveness of the mouth, they make it fixed and stony in expression by distending it with an unnecessary amount of wax, which becomes stereotyped by the use of mineral teeth set out of their proper place by the "rule-of-thumb" assistant.

This lack of artistic feeling on the part of the dentist is much more noticed than dentists are aware of. I once had an amusing conversation with the husband of a patient of mine, in which he complained bitterly of the way his fashionable dentist had "built out" his mouth to ugly prognathous dimensions.

For many years past, my attention has been frequently drawn to the lack of expression in the faces of middle-aged people of both sexes. Instead of showing a mobile and expressive mouth, which years of experience spent in the cares and joys of life tend to produce, they have a fixed and wooden expression only worthy of the figure-head of a "Geordie" collier brig. The natural expression of these unfortunate individuals has been replaced by a *denture facies*, if I may venture to use such a term of description, which is quite false and artificial. In the United Kingdom a distended and rigid upper lip is too often seen,—while in the United States a tumour-like swelling below the lower lip is far too much in evidence on the faces of elderly patients. These disfigurements are due (1) to neglect in studying the profile of patients; (2) to the use of incorrect bites in the workroom; and (3) to the universal distrust, on the part of American dentists, of spiral springs.

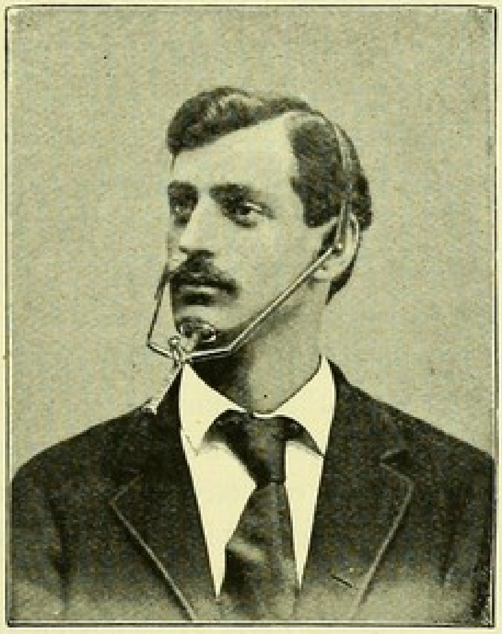
Having secured the expressive action of the lips and the articulation of the jaws, by getting the patient to swallow a few mouthfuls of cold water, I pin the wax bites together with wire staples pushed in with a pair of pliers; the "centre" is firmly marked on the wax as well as the level and direction of the lower lip. I should mention that the wax blocks are carefully pared to meet, so as to give, as far as possible, the natural level of the teeth. Some dentists mark an elliptical space showing the aperture of the mouth when the lips are half closed.

The perpendicular central line, and the horizontal line intersecting it corresponding to the cutting edges of the upper teeth, having been marked, the wax blocks, firmly fixed together, are removed from the mouth *en bloc*.

In my experience, the expression of the patient's face gives the practitioner an indication either that the bite is correct, or that it is absolutely wrong.

The wax blocks will be found to fit the plaster models correctly, as the fusible metal by its rigidity prevents the loss of shape commonly experienced when wax, or even "hard-bake," is used for this purpose. The bite is then cast as the practitioner may prefer, using an articulator, or the plaster tail bite, or the slab bite. It is waste of time to work with a false bite, and I can say positively that the use of fusible metal plates

FIG. 110.



GARRETSON'S ARTICULATING GUIDE.

used in this way saves the dentist and the mechanical assistant much loss of temper, inasmuch as they enable the dentist to secure a correct bite for the mechanical details which are to be carried out in the workroom. I for one shall always remember with gratitude the help afforded to the profession in this very troublesome process by Mr. Lennox.

Dr. C. F. Garretson, of Knoxville, Iowa, has invented an articulating guide which I have tested. It will be found of service with patients of vacillating disposition and a mental unreadiness to appreciate the importance of a correct bite, so far as their own future comfort is concerned.

The illustration (Fig. 110) shows the practical nature of this instrument. It is used by placing the rubber tips at the end of the frame in the ears, and drawing the leather band over the crown of the head, to such a position that it will not slip backward or forward. The tips should be held by the band firmly in the ears, when pressure is placed on the chin. It is a convenience to let the patient hold the left tip in the left ear, when the band is adjusted. The sliding bar is now pressed firmly against the chin, while the mouth is left slightly open, so that the condyles are pressed into the tempero-maxillary articulation.

If the pressure should be sufficient to cause pain when the mouth is closed, the spring can be lifted and the sliding bar shifted another notch. The patient should open and close the jaws many times ; as the mandible is retracted, the chin plate is moved till the dentist is satisfied that the condyles are in their sockets.

The patient can open and close the mouth, but the mandible *cannot be protruded.*

The bite can now be taken with wax plates or any other material the dentist is accustomed to work with.

The articulating guide can be removed from the patient's head by slipping the band off the pin that secures it in position.

It has been a fashion for some years past to deride the use of spiral springs attached to swivels, for connecting upper and lower dentures, to help to keep them in position in the mouth during speech, and during the more powerful action of the jaws in the function of mastication.

Books, journals, and speeches made at dental meetings loudly proclaim the "out-of-dateness" of using spiral springs in the mouth. To any one of a thoughtful and practical turn of mind this derision of an admirable invention, over one hundred years old, seems somewhat out of place. Many of us can see and hear patients labouring with dentures, which would prove useful and comfortable were they only fitted with springs.

I have often wondered that the dentists, who so emphatically condemn the use of springs, do not—by diagrams in their papers, or by the exhibition of casts of the mouths of their patients—show how dento-acrobatic feats can be taught to patients.

All dentists are not conventional in their ideas of treatment in such cases,—and yet how often do we find patients applying to another practitioner for aid, in a condition of discomfort that can be remedied by the use of spiral springs.

To me it would appear that many of the opponents of springs are unable to adjust them to the dentures, or the mouths of the patients. I have made very careful enquiries for years with respect to this subject, and I am of opinion that patients go from practitioner to practitioner, each of whom professes to remedy all kinds of difficulties "without the use of springs," only to have the same mechanical failure offered to them, the practical result to the patient being not efficient aid in mastication, but a mere collection of dentures.

All patients are not gifted with mechanical intelligence to retain large dentures comfortably in the mouth, without the aid of springs. I have learned, by long observation, that patients who *are* naturally clever with their fingers, are commonly deft with the use of artificial teeth in edentulous cases unsupported by the aid of springs, if the oral cavity is otherwise favourable to such treatment. I have observed that patients who *can* make anything well, be it needle-work, carpentry, or metal work, or who can execute any of the household arts, are far more easily satisfied than the bookish patients with a world of information, who are unable to construct anything but sentences in their querulous correspondence.

Patients able to play a musical instrument with expression and intelligence are, as a rule, favourable subjects for springless dentures—provided the alveolar ridges are favourable for such treatment.

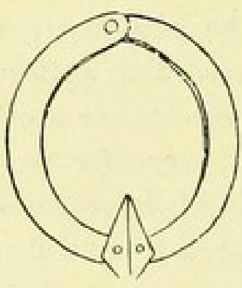
I have been through the hardly-earned experience of youthful enthusiasm, when I felt assured that springs were unnecessary. I am not blind, however, to the personal equation, that of two cases apparently offering the same type of loss of function, one can be successfully treated by the springless method, while the other cannot be treated without the help given by these useful, if somewhat capricious, servants.

I am persuaded that much of the discomfort and annoyance caused by the use of springs is due to the want of mechanical ability on the part of dentists and their assistants, as well as the confusion that exists in the professional mind as to the proper position of the swivels. Some practitioners place the swivels between the first molar and the bicuspid, others between the bicuspids, and others again with the lower swivels in advance of the position of those in the upper case, while there is a less numerous group who believe in having the upper swivels in advance of the lowers. All these methods conflict with one another, and with the ordinary conditions to be seen in edentulous mouths.

Is it a wonder, therefore, that the ordinary assistant looks upon the setting of springs or swivels as a tiresome task? I have no doubt there are workmen with natural skill and ability to whom such a problem is not difficult, but they are the skilled few who, with a quick, observant, and straight eye, can, without being able to explain their perceptions, grasp the nature of the difficulty, and set the swivels correctly in a rule-of-thumb way.

The usual way of placing swivels is to set them by the eye. This is an excellent way when the eye *is* trained and can work straight, especially if a compass or dividers is also used to test the equal position of each swivel with respect to the centre line of the *face*.

Fig. 111.



Mr. Kirby's Callipers for Setting Swivels.
One-third actual size.

That swivels should be placed as parallel as possible in dentures I am persuaded by experience, and far more attention should be given to the formation and shape of the spring chambers, so that the springs may be set to work on an equal plane, and on each side be kept from rubbing the inside of the patient's cheeks, as they do when they are set akimbo on the model, without any reference to their position or action in the mouth.

Springs should be so set as to take as large a curve as the case will conveniently permit of. If possible, then, the full length should be two inches, or two inches and one eighth. When a large curve cannot be used, the springs have to be shortened, else the bow becomes deformed into an elbow or angle, and the spring loses its elasticity or breaks.

The only instrument I have hitherto met with for the purpose of accurately selecting the position for swivels and springs, is a callipers made by Mr. Amos Kirby, of Bedford, which I have figured (Fig. 111). By their aid I have been greatly helped in many cases, during the past six years, since I had a pair made from a tracing taken from his instrument.

It is used by opening the limbs and placing the long side of one of the triangular feet on the centre line marked on the wax. The foot of the other limb is then adjusted till the long sides of the triangles are parallel at the spots where the swivels are to be placed. While the feet are thus in position a straight line can be marked on each side of the wax base plate, so that the bolts and swivels will stand parallel to each other and be of equal distance from the centre line of the finished denture.

Even with the aid of this excellent instrument, mistakes will occur in the workroom, and I have turned my attention to the treatment of this problem, with some success, if I may judge from the results with several patients, whose cases were out of the common, owing to the complete loss of alveolar substance on the mandible, and to their having various types of eccentric bite.

Some of these lower dentures may be truly said to float on the floor of the mouth, so great is the movement due to the loss of the support given by the alveolar ridge, by prolonged absorption, bringing the work into partial or complete contact with the floor of the mouth. They are held in position by spiral springs on the narrow pathway of gum left on the upper surface of the maxilla and mandible, during speech and mastication.

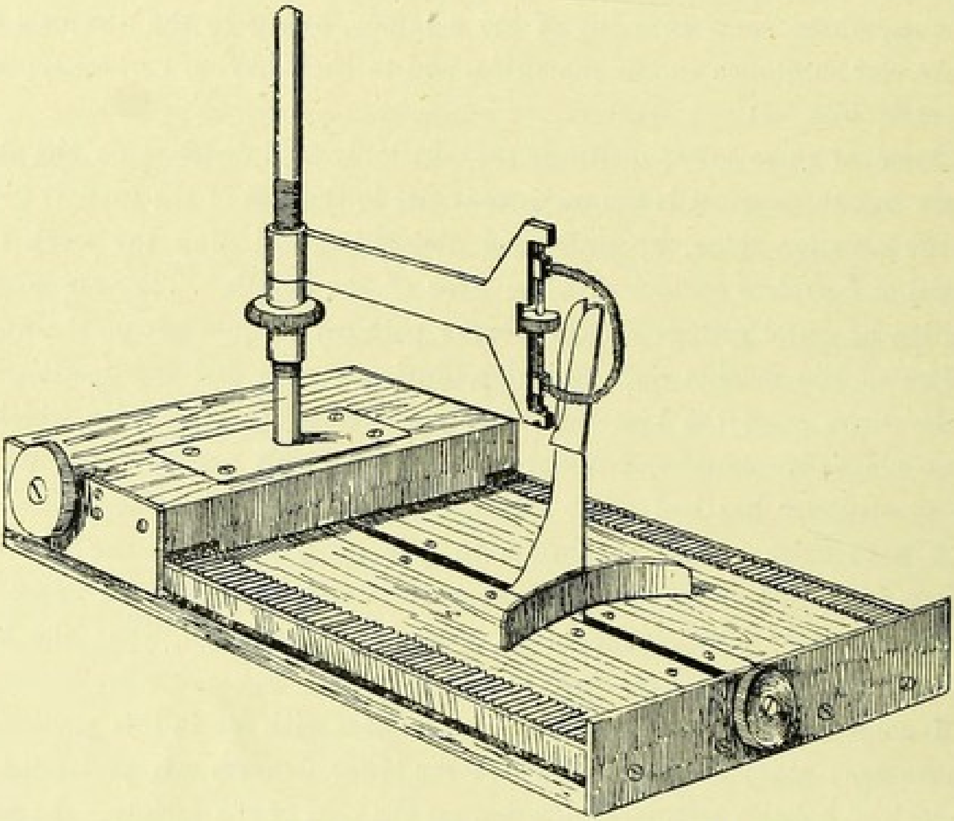
In these cases the bite was eccentric, a type of articulation which is by no means uncommon, but nevertheless a difficult one to treat, unless the practitioner has had great experience in dealing with them.

I have come to the conclusion that, in all edentulous cases in which springs form part of the dentures, the swivels and springs should be set up, or at least their position should be accurately determined, when the base plates are made, *before the teeth are mounted.*

I am aware that most workers do not agree with me in this particular. I have seen many instances in which the lower denture was protruded by the lack of balance and parallel action on the part of the springs. In some of these cases I was able to bring the lower denture into place by altering the position of the upper or lower swivels, as the case might be, and thus restore the articulation of the dentures. For some time past I have been able to treat some difficult cases of eccentric bite with success by deliberately providing for the swivels and springs in the design of the case before the teeth were mounted. This is not, as I have said, the usual way, but it is, I am persuaded, the right way, instead of leaving the matter to chance or the "rule of thumb" method after the work has been made and tried in the mouth.

In open bites the swivels may be as much as seven-eighths of an inch apart, and in close bites the narrowest curve can be selected that will prove useful in cases where the space for springs is much contracted. The size and shape of the spring chambers can also be arranged beforehand, and the chambers on the right and left sides of the dentures can be made to harmonise in plane in correct relation to the centre line of the face. This latter point is of great importance, as the workman is able at a glance to see how the deficiency in symmetry on one side of the denture can be

FIG. 112.



SWIVEL-SETTING TOOL DESIGNED BY THE AUTHOR—HALF SIZE.

brought as nearly as possible to resemble the bulk and direction of plane of the normal or unabsorbed side. I have no hesitation in saying that this most important detail in successful design and construction should be studied on the bite with and without wax blocks and without the teeth set in position on the trial plates, although I have little doubt that many of my brethren will not agree with me in this matter. They have never tried any other than the "rule of thumb" method, which I so much deprecate in practice, particularly when work has been constructed so as not to permit of any alteration or adjustment.

I have contrived a tool (Fig. 112) by which the proper situation of the swivel bolt may be found, as well as the largest bow that can be made by a spring two inches or two and one-eighth inches long.

The tool consists of a wooden base on which are placed the models of the mouth, so that an index finger will show the centre line of the face. An upright bar with sliding collar attached to the base carries a swinging arm, which can be raised or lowered as the adjustment may require. At the end of the swinging arm pins of metal are placed, which can be brought together or moved apart by means of a screw so as to show the size of the curves that can be made by a spring when its extremities are bent, placed on the pins and brought within a measured distance of each other. The positions of the swivel bolts and the available space for the springs can be easily ascertained by thus working from the centre line.

The swinging bar can also be lifted off the upright on which it moves and reversed, and the same angle can be carved out of the wax to correspond to that of the spring chamber that has been prepared. With this tool the swivels can be set in position first and the teeth mounted afterwards, with the certainty that perfect balance and parallel action have been secured before trying in the mouth. This latter detail is of great importance, for the workman should see at a glance how the deficiency in symmetry on one side of the jaw can be restored as nearly as possible to the bulk and direction of the normal or unabsorbed side. This important detail should be studied on the bite, with or without wax blocks, and without the teeth set in position on the trial plates.

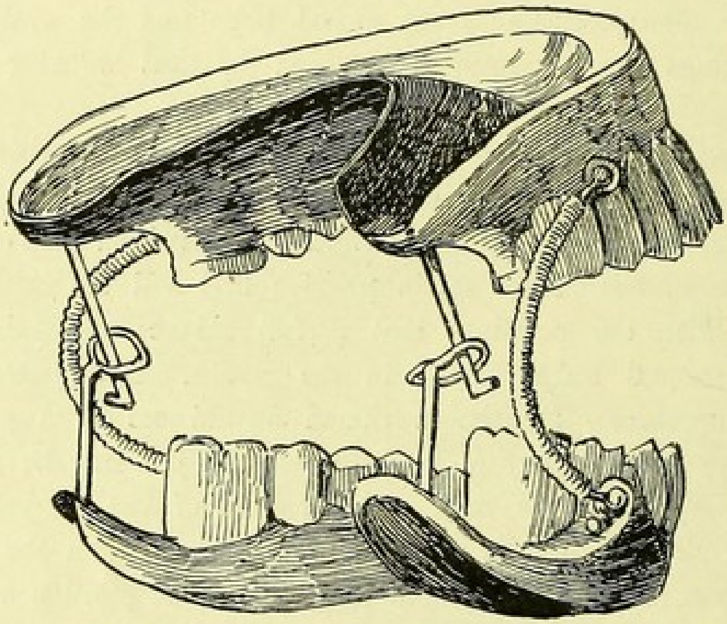
The nature of the curvature of the spring, and the space it will occupy, should thus be seen by the workman beforehand, and not left to "take its chance" after the case is finished, when the springs are tried in with the case for the first time in the mouth.

Springs should not be allowed to rest on the denture at the top or bottom of the spring chamber, when the teeth are in occlusion. Much discomfort is caused by the extra pressure caused in this way by springs pressing on the work. Whether springs will work in the position to which they are assigned by experienced dentists is too often a moot point without trial, and as "it is better to be sure than sorry," an instrument that will give help in determining, with some approach to precision, the position the swivels should occupy in a given case is much to be desired. I know of practitioners who have gone on for years without the slightest uneasiness as to the correct position of the springs and swivels they have "set up," till they found out by chance that patients had taken their mechanical troubles to another practitioner, who had altered the defective position to the satisfaction of the patient.

It is strange to see how incorrectly the position of swivels and springs is drawn in the text-books, even in the latest editions.

The tendency of lower dentures to slide forward on the mandible, in cases where the crest of the alveolar process has become absorbed, and where

Fig. 113.



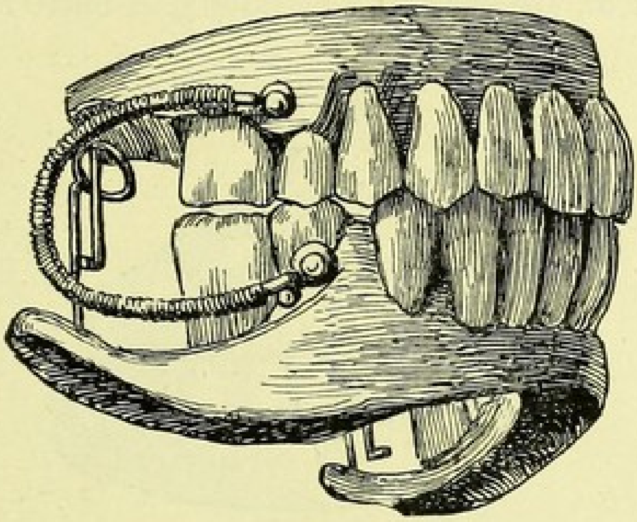
Shows Mr. Lennox's Contrivance for Retaining Lower Dentures in Position.

due care has not been exercised in placing the swivels parallel to each other, is sometimes very embarrassing to the dentist.

This forward movement is not only annoying to the patient, but is also a cause of great disfigurement to the mouth. The natural hollow lying between the contour of the lip and the chin is replaced by a tumour-like swelling, which gives a very coarse and ugly look to the mouth. Many worthy people, who are naturally of an amiable disposition, may thus be made to wear an expression or *facies* quite foreign to their natural disposition. In my opinion the forward movement of the lower denture is most frequently caused by the unequal disposition of the swivels. When the swivels and springs are not set parallel to each other, the act of closing the jaws compels the lower denture to slide forward, and the thrust given to the denture by the springs, as the mandible closes, pushes it out of place in a forward position. Sometimes the want of symmetry in the position of the springs causes either the lower or the upper denture to be swung to one side as well as thrust forward, and very great personal disfigurement is the result.

Mr. R. P. Lennox, of Cambridge, describes a case under his care, in which much discomfort was given to the patient by the forward movement

Fig. 114.



Shows Mr. Lennox's Contrivance, with the Wire shortened on the Right Side of the Upper Denture to Prevent the Hook being hidden by the Spring.

of the lower denture. The illustrations (Figs. 113, 114) show a contrivance that he applied to overcome the movement, which has been worn with success by the patient for several years.

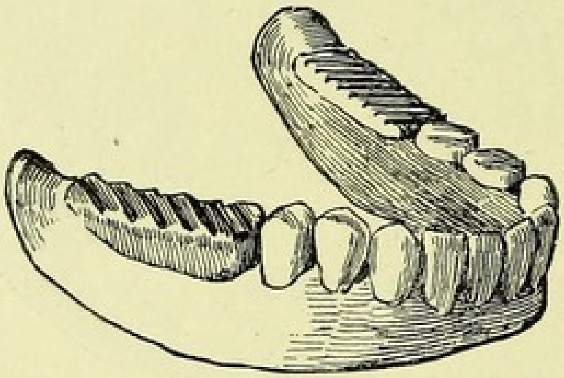
The two figures are drawn from a set of teeth which were fitted with the contrivance merely for the purpose of illustration; they do not represent the dentures worn by the patient. In illustration (Fig. 114) the length of the hooked wire attached to the right side of the upper denture has been shortened in order to make its action intelligible. If it had been drawn of normal length, the hook would have been covered by the spring and thus rendered invisible. The natural position of the hook when the teeth occlude can be seen on the left side of the denture.

These hooked wires pass through oval loops of wire attached to the lower denture, and thus permit of all the actions of the jaw in mastication, while at the same time they retain the denture in proper position.

Many practitioners do not use springs ; they look upon them as very undesirable encumbrances, and prefer to keep upper and lower dentures independent of attachment to each other. Cases no doubt present themselves in which this can be successfully done, but it not unfrequently happens that the lower denture has to be *weighted* in order to assist its stability in the mouth.

The illustration (Fig. 115) shows a method of *weighting* lower dentures, by means of metal blocks used in the molar region, designed by Mr. Amos Kirby, of Bedford, who employed it for many years before he retired from practice.

Fig. 115.



Weighted Lower Denture as Constructed by Mr. Amos Kirby.

The blocks are made of an alloy of platinum, silver, and tin, which is of a sufficiently heavy specific gravity for such use, and does not tarnish in the mouth. The notches or grooves on the upper surface are made to run diagonally and in the opposite direction to similar grooves made on the upper denture, so that a very smooth and effective triturating action can be carried out without dislodging the dentures.

Lower dentures constructed in this way can be made to weigh one ounce troy, or even more, without causing any discomfort to the patient. I have recently seen a weighted lower vulcanite denture, designed by Mr. Goodman, of Taunton, in which he employed gold filings, fifteen pennyweights being added between the layers of vulcanite, during the packing of the case in the flask.

I have on three or four occasions added to the weight of a lower vulcanite denture by striking up a No. 6 gold plate (Ash's gauge), large enough to cover the area of the alveolar process of the mandible, which did not call for much alteration of form in subsequent adjustment, and soldering to its upper surface, at right angles, a thick bar of platinum, somewhat inside the ridge, so as not to interfere with the mounting of the mineral teeth. This formed a very strong base plate on which to mount the teeth, and the weight, when complete with the vulcanite, was about one ounce and a quarter troy. Two of these cases have been in daily use over fifteen years, and retain their position in the mouth without any trouble to the patients.

CHAPTER XIX.

REMOVABLE BRIDGE WORK.

At the annual meeting of the Western Counties Branch of the British Dental Association—held in Plymouth, under the presidency of Mr. F. H. Balkwill, on the 27th July, 1888—my friend, Mr. J. H. Gartrell, of Penzance, showed publicly, for the first time, his designs of removable bridges, which he had then been making for some years. Very great interest was taken in them and in his demonstrations by the members attending the meeting.

The annual general meeting of the British Dental Association, which I organized in Dublin, was held in August, 1888. The models and designs which attracted so much attention at Plymouth, were again shown to a large body of members and visitors in Dublin.

Mr. Gartrell was kind enough at a later date, at his home, to show me several ingenious ways by which not only small bridges, but also large dentures can be securely retained in the mouth.

The following illustrations show very clearly some of his methods of dealing with cases of the kind; but his invention is not intended to apply to every case where teeth have been lost. His methods can be modified to suit the peculiarities of cases that do not fall within the range of the illustrations.

In August, 1889, Mr. Gartrell, by special invitation, again showed further examples of his methods of making removable bridges, at the annual general meeting of the British Dental Association at Brighton. He showed them also in Paris the following week, just after the Brighton meeting.

The following extracts, taken from the *Dental Cosmos*, Vol. 32, page 230, will, perhaps, interest the reader, and will clearly establish Mr. Gartrell's right to this invention, which has been appropriated by another dentist :—

"International Dental Congress,
"Paris, August, 1889.

"Dr. Gartrell, of Penzance, England, presented his new process of bridge-work, which is certainly very ingenious, and deserves to be carefully considered. The object of this process is to be able to easily remove the bridge at any time in case of accident or otherwise.

"It consists in fixing a gold metal bar, three millimetres in height and one in breadth, at its two extremities to the neighbouring teeth. On this bar, which is permanently fixed, is adapted the bridge-work, which closely fits the bar and prevents it from moving about, while the patient can remove the plate at any time, if necessary, without the slightest difficulty."

An American dentist afterwards appropriated Mr. Gartrell's methods, and had them printed in the *Dental Cosmos* as his own. I, therefore, wish to point out that this design was first brought forward and practised by Mr. Gartrell, and that I had myself the opportunity of seeing in the mouths of several of his patients, in the year 1888, similar bars, on which removable bridges had been successfully made and worn for from three to five years *before* 1888.

When the following appeared in the *Dental Cosmos*, in Vol. 32, page 439, we rubbed our eyes and wondered if we had only dreamed that we had seen Mr. Gartrell's removable bridges at Plymouth and Dublin in 1888, and at Brighton and Paris in 1889 :—

"FIRST DISTRICT DENTAL SOCIETY, STATE OF NEW YORK.

"Dr. H. A. Parr, of New York, illustrated his improved method of attaching artificial dentures, whereby one or more teeth may be securely held in position in the mouth, and conveniently introduced or removed. It can be locked in place with comfort to the wearer, even though a number of stumps or natural teeth remain in the mouth. In diverging or converging teeth it is particularly applicable. Fig. 1 represents the superior part of the mouth, with a number of teeth remaining in the jaw, and the locking device applied. Fig. 2 is a perspective view of the denture adapted to be fitted to the locking device. The natural teeth or roots are first fitted with a gold cap ; then a flat bar, rectangular in cross-section, made of platinum and iridium, is soldered to the sides of the caps, reaching either from tooth to tooth or only a part of the distance, and made to be in contact at one longitudinal edge with the gum. Fig. 1 shows the bars attached to the crowns. In Fig. 2 may be seen channels to correspond with the number and positions of the lock-bars. These channels are of a width and depth only to receive the bars, and the plate is held in position by contact with the walls of the channels. The work can be done in rubber or celluloid, and when there are only a few stumps or teeth left."

The attention of the editor of the *Dental Cosmos* was drawn to the foregoing extract by Mr. Harry Baldwin, M.R.C.S., L.D.S. ; and I here quote Mr. Baldwin's letter, which will be found on page 164 of Vol. 33, 1891 :—

"To the Editor of the *Dental Cosmos*.

"Sir,—Your letter of the 17th to hand, and in answer to your request contained therein to restate my remarks which I made five months ago, on the authorship of the removable bridge-work, described and figured in the June, 1890, number of the *Cosmos*, page 439, I have to say that the invention is that of Mr. Gartrell, of Penzance, England (see page 230, March, 1890, *Cosmos*), and is in no way attributable to Dr. H. A. Parr, of New York. Dr. Parr learned this bridge-work from Mr. Gartrell's demonstrations at the annual meeting of the British Dental Association in Brighton, August, 1889, and in Paris, a week later, at the International Dental Congress.—I am, yours truly,

"H. BALDWIN, M.R.C.S., L.D.S.

"37, Cavendish Square, London, W.,
"*November 28th*, 1890."

Mr. Gartrell is so inventive and original in his methods, and his character is so well known amongst his dental brethren to be that of an honourable, high-minded man, most generous in imparting his information or experience to others, that it is with pain I take the following extract from a foot note on page 268 of the fifth edition of *A Practical Treatise of Artificial Crown and Bridge-work*, by George Evans:—

"In England the method is designated the 'Gartrell Bridge,' having been introduced there by Dr. Gartrell, an American dentist, formerly of New York, now practising in Penzance, England."

Mr. J. H. Gartrell was born in Cornwall, not far from Prussia Cove, in Mount's Bay, and left Penzance for Canada in September, 1856. He became a pupil of his cousin, Mr. John Leggs, who is still in practice in Ottawa, Canada. Before leaving Canada Mr. Gartrell obtained the L.D.S. of Toronto, *sine curriculo.*

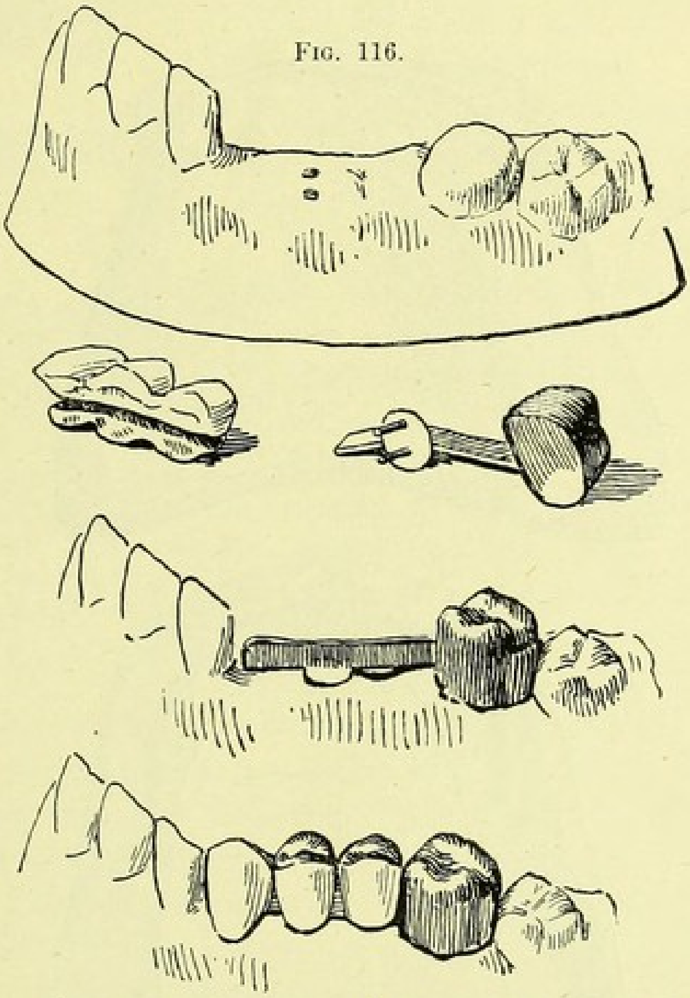
In 1859 Mr. Gartrell went to New York, and became an assistant to Dr. Peck, of East 28th Street. After Dr. Peck's death he carried on the practice for the widow of Dr. Peck till 1865. During this time Mr. Gartrell had frequent access to Dr. John Allen's laboratory, which was then managed by Mr. (now Dr.) Close, who gave Mr. Gartrell instructions in continuous-gum work without any fee, and with every encouragement to pursue it.

Mr. Gartrell has been working at continuous-gum ever since, so that in the following pages—see Chapter XXIII. on Continuous-Gum Work—the reader will find information respecting the most recent advances which he has made in this beautiful process.

It will thus be seen that Mr. Gartrell learned his dentistry in Toronto, and afterwards practised in New York; but how it is that he is claimed as an American doctor, as well as a dentist, puzzles Mr. Gartrell himself, while, at the same time, all credit for his admirable invention is taken from him.

Work of this kind needs patient skill and a practical acquaintance with all the details of the antiseptic treatment of the roots and teeth that may be used as supports. The illustrations (Fig. 116) show all the

Fig. 116.

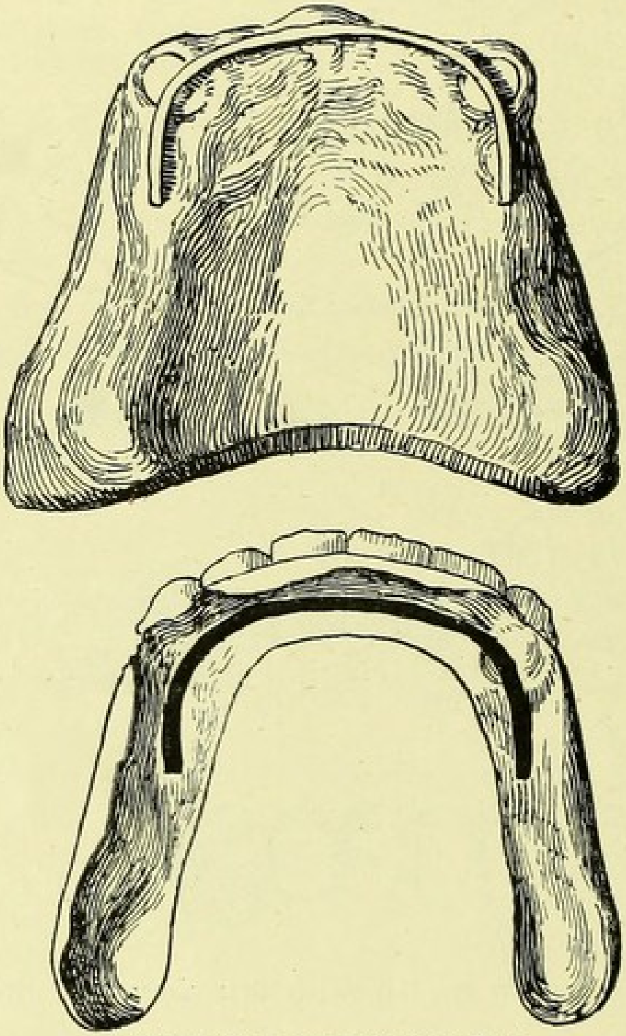


Shows Details of Mr. Gartrell's Removable Bridge-Work.

practical details of the construction of a case of Mr. Gartrell's removable bridge-work. I wish to direct attention to the bend in the bar and the slot in the bridge that fits it, as a bend or angle in such a position adds mechanically to the stability of the bridge.

I have seen other bars made by Mr. Gartrell, which had a bend or angle, a good example of which is seen in the upper case with the curved bar which is illustrated in Fig. 117. The bar was anchored in two firm canine roots, and the patient, an aged lady, wore the vulcanite denture made to fit the bar for some eight years—till, in fact, death claimed her. This type of removable bridge seems to me to have a future before it in suitable cases, which may come under the dentist's notice. I have, myself, been shown by Mr. Gartrell a couple of such cases in Penzance.

Fig. 117.

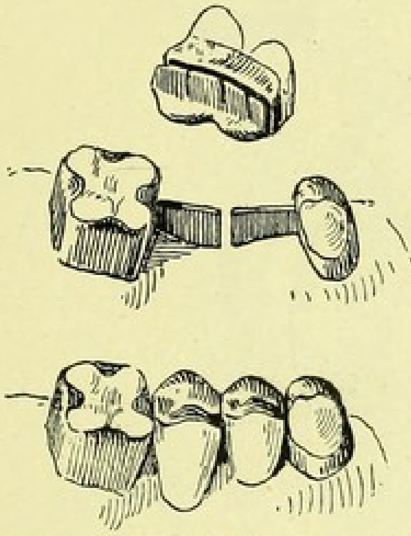


Upper Case with Curved Bar.

The illustrations (Fig. 118) show another variation of Mr. Gartrell's methods, with a molar and bicuspid crown banded to carry the bars which are attached to them.

I here figure two dentures (Fig. 119) which I made for patients who wished to take advantage of one of Mr. Gartrell's methods of holding a denture on the maxilla. Such split bars, applied to suitable roots, will last for years. By taking advantage of the modern advances that have been made in construction by Mr. R. P. Lennox and others, such work has a useful career before it. One of the bridges in question has been in constant use for eight years, with only one mishap to the cement in the anchorage, and the other is still in use after five years of hard daily wear.

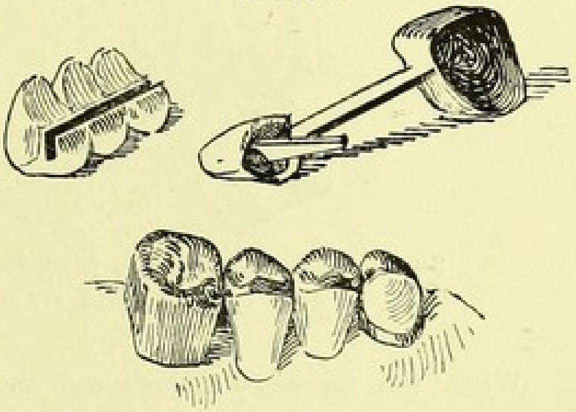
Fig. 118.



Shows Removable Bridge of Two Teeth, Molar and Bicuspid, banded, with Bars attached to them for receiving the Bridge; also the Bridge fixed in position.

Given a case with healthy roots of sound tissue, with close articulation, and where conspicuous fastenings cannot be used, the modifications which I have made in Mr. Gartrell's methods appear to be very useful. In the first one I speak of, the patient showed her gums in speaking and laughing. With the number of healthy roots which were still left in the maxilla, it was impossible to construct a suction case that would resist all the shocks of speaking and eating, and yet leave the patient without anxiety as to the stability of the case under all circumstances. I, therefore, made the small split bars figured on the model (Fig. 120), which were cemented into the roots of the bicuspids. On these split bars were fitted small gold boxes or slots, which were attached to the bridge to ensure its retention in position under a strong pull. The split bars were soldered to the root anchorages, so as to present no difficulty in placing the bridge in the mouth or of removing it at will. Care was taken, before fitting the teeth, to solder on the plate blocks of gold and platinum to occlude with the lower teeth. The pin teeth were then fitted and brought into correct

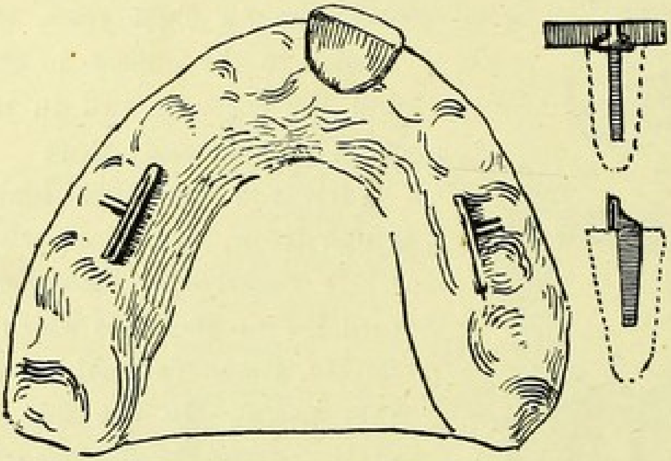
Fig. 119.



Shows Details of Removable Bridge of Three Teeth.

relation with the lower teeth and the gold plate, the case was tried in the mouth, and the teeth were pushed into their intended positions

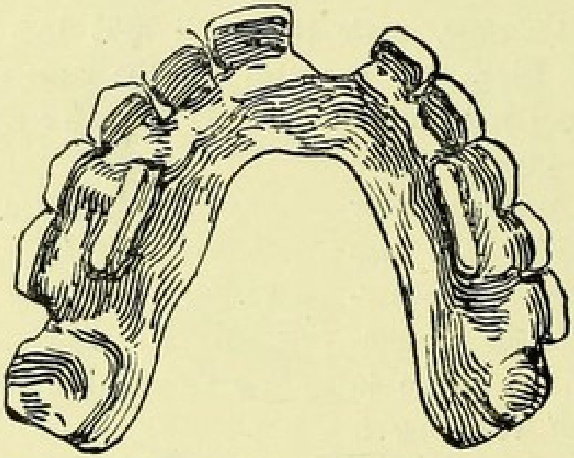
Fig. 120.



Shows Small Split Bars cemented into the Roots of the Bicuspids.

on the roots and the gum with a wooden handle which had a notch in the end of it. The denture was now removed from the mouth, invested, soldered, and polished in the usual way.

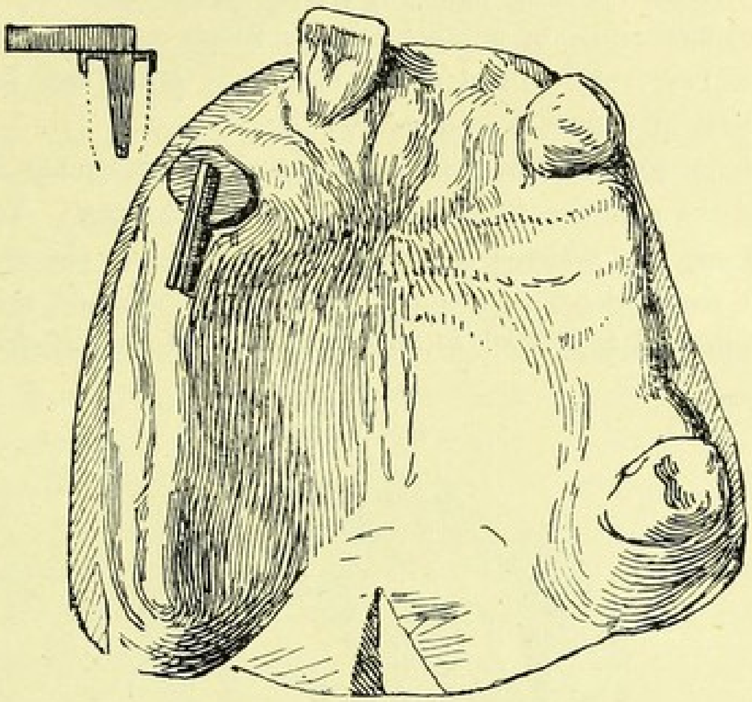
Fig. 121.



Shows Removable Bridge, with Small Gold Boxes or Slots, which tightly fit on the Bars.

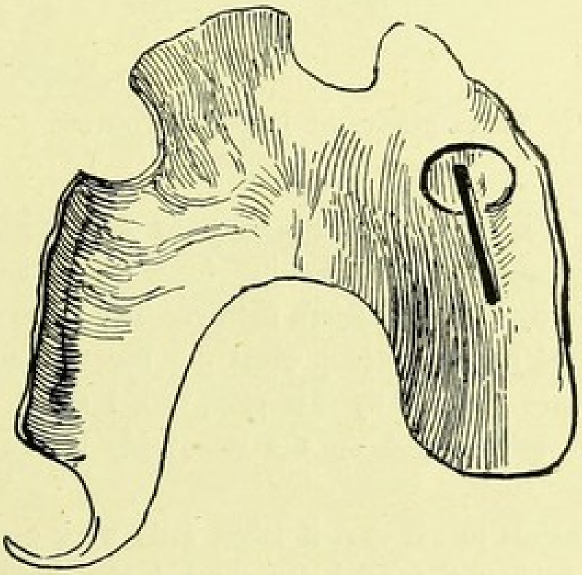
When the necessary adjustment and fitting had been done in the mouth, the split bars were slightly opened, and the denture went home on the maxilla with a snap, fitting quite solidly without any motion

Fig. 122.



Shows Split Bar secured to Root of Canine.

Fig. 123.



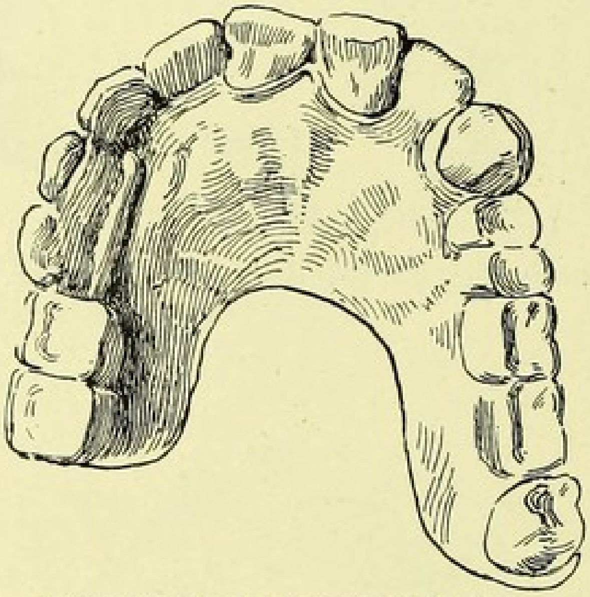
Shows Palatine Surface of Case (Fig. 122), with Gartrell Box or Slot on Plate to fit on Split Bar.

(Fig. 121). When it had to be removed for cleaning, it required some effort and careful handling to lift it off its supports.

I show illustrations of another case, in which only one split bar was used (Figs. 122, 123). In this case anchorage could best be obtained from the root of a firm, strong canine.

A platinum post was made to fit the canal of this canine, and on the free end of the root was fitted a cap attached to the post. To the post, collar, and cap was soldered a split bar. On this bar was fitted a gold slot, which was soldered to the gold plate (Fig. 122), and the necessary teeth were ground and fitted to suit the nature of the articulation.

Fig. 124.



Shows Removable Bridge in Position.

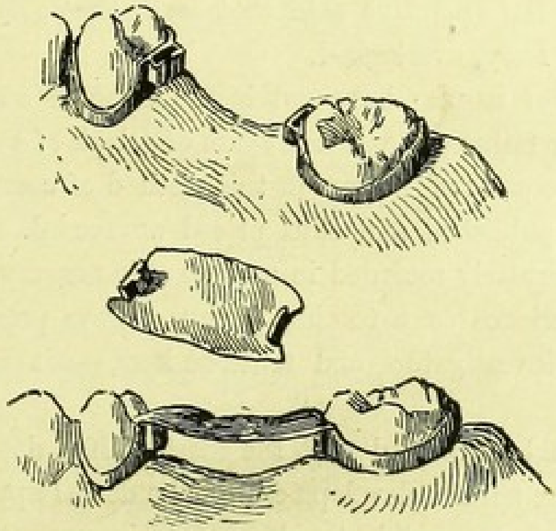
The denture (Fig. 124) has been worn by my patient for nearly six years, and the canine root is loosening from absorption of the socket, which is a peculiarity of my patient's family. The value of the anchorage was fully explained to the patient when the bar was made. The large plate, held in secure position by this plan, will, I think, show that cases can be advantageously treated on the removable bridge designs of Mr. Gartrell.

It, therefore, seems to me that if large, solid work can be treated thus as a removable bridge, the need for fixed bridges must be somewhat exaggerated in many instances. To my mind removable bridges offer all the advantages of fixed bridges, with the added attraction that they do not call for the destruction of valuable teeth as abutments, such as the use of fixed bridges too often entails, as we commonly see them designed.

The duration of the ordinary fixed bridge in the United States is placed, I was told, at from three to five years. The removable bridges which I have described have lasted a longer time than this, and were not, in my opinion, much more difficult to construct. Moreover, the patients have worn them with comfort, and have thus probably been spared an immense amount of suffering that I have often heard described as "torture," lasting for months, which some fixed dentures would have given them.

Fig. 125 shows details of a bridge constructed by Mr. Charles Rippon, of Dewsbury, and exhibited by him at a recent meeting of the Midland branch of the British Dental Association, held at Rochdale. The bridge was removable, and was held and strutted between a molar and bicuspid, in sockets attached to bands of gold which encircled the living teeth. The action of the bite did not cause any movement of the bridge, or of the teeth which sustained it.

FIG. 125.



SHOWS MR. CHARLES RIPPON'S CASE OF REMOVABLE BRIDGE WORK.

CHAPTER XX.

FIXED BRIDGE WORK.

In the whole scope of dentistry, no subject provokes greater conflict of opinion amongst the profession than the subject of Fixed Bridge Work. The conservative dentist will have none of it, while the enthusiastic worker who moves with the times "is fascinated with it," although he has had many lamentable failures, for which handsome fees have been paid. It is also one of the few subjects discussed amongst us that seems to have completely eluded the accurate and trustworthy application of statistics, as pointed out by Mr. R. P. Lennox. One cannot but notice, when reading the elaborate details of bridge-work procedure, in articles and books published upon the subject by those who advocate it as the highest manifestation of the operative skill that is in them, how completely the failures are, shall I say, overlooked.

There are few of us who have not learnt some of our best lessons in dentistry from our failures,—and it savours of a lack of candour, to say the least of it, that the cases of failure in this method of constructing artificial dentures are not published and thus placed on record.

Failures are regularly recorded in medicine, in surgery, and in science; the value of experience as a teacher is thus always present to the minds of men who *are* investigators and truth-seekers,—not mere opportunists or quacks.

It is hardly to be expected that the most skilful dentist can improve upon nature in her normal development of the dental apparatus. At first sight it would seem impossible to place a strain upon the natural roots which they were never designed to bear, such as is applied when a rigid and unresting form of force like a fixed bridge is anchored to them.

It should be remembered that in the operation of extraction most of the teeth are dislocated *outwards*, before they are removed from their sockets, and it is owing to the strain which bridges exercise in this direction that the work so signally fails; the roots cannot stand the strain put upon them. The swinging, triturating, and lateral action of the mandible is in many cases more than a match for the most talented "dental engineer"; the fixed bridge not infrequently becomes gradually loosened, and is thus less useful in the mouth than a properly designed plate would be in such cases.

An intelligent investigator, seeking the truth on this subject, will notice that in a large number of bridges the masticating surfaces of the artificial substitutes are made with rudimentary cusps; in some instances they are even reduced to mere planes. The actual amount of masticating surface is also deliberately reduced much below that originally possessed by the patient.

It is likewise remarkable how little lateral shock many forms of bridges are able to withstand for any length of time. I therefore think it can no more be proved that bridge-work is of universal application in the construction of artificial dentures than it has been proved that gold is of universal application for filling cavities in the natural teeth.

It is difficult for me to write dogmatically on this subject, as my experience in the use and construction of bridges is small. I have, however, had opportunities of examining bridges which have broken away from their anchorages in the mouths of patients and have been relegated to the waistcoat pocket.

The construction of these bridges left nothing to be desired for workmanship, but the rapid absorption of the root or roots to which they were attached, together with the disappearance of the external wall of the alveolar process, seems to me to point out that something more than "ideal" workmanship is wanted, before a patient can be said to have received a *quid pro quo* for the expense and suffering which are too commonly associated with the treatment of such cases.

Dr. George Evans, in his book on "Artificial Crown and Bridge Work" (fifth edition), sets forth the claims *in favour of* bridge-work in the following language (pp. 145-146):

"First.—The perfect replacement of lost teeth by artificial ones, and without the use of a plate.

"Second.—The absence of any mechanical contrivance to interfere with the tongue in articulation.

"Third.—The natural teeth are not abraded by the presence of clasps, the functions of the sense of taste are more perfectly performed, and a healthy condition of the tissues preserved, because the gums and palate are not covered over with a plate.

"Fourth.—The solidity and immovability of the denture at all times both in speech and mastication.

"Fifth.—The weight of the denture, and the strain of mastication, are proportionately distributed on the natural teeth, which are better suited to sustain them than the contiguous alveolar surfaces.

"Sixth.—Its special adaptation to the replacement of single teeth, or of a small number, where bridge-work is usually superior to any other device.

"Seventh.—While all operations performed for the restoration of lost teeth, like other remedial operations, are temporary rather than permanent in their results, bridge-work as regards permanency takes equal rank with any other procedure.

"The following, on the other hand, are *objections* raised against bridge-work :—

"First.—It fails to restore the contour of the soft tissues above the bridge, as artificial gums cannot properly, in most cases, be used in this style of work.

"Second.—The slots bevelled under the artificial teeth, called self-cleansing spaces, fill with particles of food.

"Third.—The speech and comfort of the wearer are often affected by these self-cleansing slots under the front teeth.

"Fourth.—The teeth employed as abutments are usually irreparably destroyed by the process of crowning.

"Fifth.—If an extensive bridge is made of gold, being immovable it is impossible to keep it perfectly clean, as the metal will tarnish in parts out of reach of the brush, and will gather offensive matter on its surface and in its interstices.

"Sixth.—In cases where it becomes necessary to temporarily remove the bridge for the purpose of repair, or because of disease in the teeth which support it, the operation is difficult, and the bridge is usually injured so as to unfit it for re-insertion.

"Seventh.—The teeth which support the bridge are required to bear more force and pressure than nature intended—where the piece is large many times more—and, the bridge being permanently attached, at no time can any rest be given the abutments or the contiguous parts by its temporary removal. Thus a piece of bridge-work of fourteen teeth supported by caps or crowns on four natural ones, each one of the natural teeth may have to bear more than three times the strain, in supporting the weight of the denture and the force of mastication, that was intended.

"The ultimate result is evident to any one who is experienced in dental practice ; and unless the anatomical conditions are most favourable, the usefulness and durability of such work is decidedly limited in character, considering the time, trouble, and great expense attending it.

"Such are the *objections* which have been put forth against bridge-work ; and yet, whatever may be urged against it, its *advantages* have won from a majority of the profession, including many accepted authorities, an enthusiastic, almost a sensational indorsement: some practitioners even going so far as to proclaim it the only true method for the insertion of artificial teeth.

"Judged impartially, bridge-work has many advantages when practised by experts who properly construct and apply it.

"Without doubt it has been and is still abused. Bridges have been inserted where the support was insufficient, or the construction was wrong in principle or faulty from lack of skill. More than this, bridge-work has been passing through the experimental period, when failures are apt to appear more prominently than successes. The chronicles of dental literature, however, in this respect offer only a repetition of the historical difficulties that attend all new departures in the arts."

Mr. Charles S. Tomes, in his "Manual of Dental Surgery," says (pp. 708, 709) : "With regard to bridge-work, there are not, as in the case of crowns, a great many places in which it is the best thing to be done ; still, there are just a few ; this word of warning is the more needed, as nothing in modern dentistry has been so abused as bridge-work. The implantation of teeth in the jaws is in man, as also in animals, very closely proportionate to the strain which comes upon them in mastication, and is not greatly in excess of their necessities, even making due allowance for the fact that we cook and soften a great deal of our food.

"When, then, as is too frequently done, a bridge carrying quite a number of teeth is fixed upon two or three roots or complete teeth, these unfortunate teeth have to bear all the strain, which in the normal mouth would be distributed over the roots of many teeth ; and not only that, but the remoter parts of the bridge, when bitten upon, may exercise a strong lever action, thus trebling or quadrupling the strain upon the attachment above that which would occur were the support underneath the force applied.

"The natural and inevitable result is that they either become very painful or absolutely come out ; and I have removed many a bridge, teeth and all, for which the patient had paid a fabulous fee but a year or so previously.

"When, therefore, considering the question of resorting to a bridge or to some other appliance, the first thing is to consider how the strains will come, and whether it is reasonable to expect the teeth which have to bear them to do so. And it should be borne in mind that the roots of a dead tooth are apt to be already below a normal standard of health, and that it is therefore better, so far as this mechanical matter of strain goes, to cap over a live tooth than a dead one.

"It must be remembered that a tooth will bear considerable and repeated applications of force in a vertical direction, and but to a very limited extent in lateral directions, the ordinary excursions of the jaw in mastication not tending to displace teeth laterally, except to a very short distance. An excellent example of the inability to tolerate lateral thrusts is seen when the back teeth have been lost, and the lower incisors strike upon the backs of the upper teeth,—a condition which speedily results in their being loosened.

"Hence it is necessary to carefully consider the directions in which force applied to the bridge will act upon the teeth which serve as its attachments, lest we be subjecting them to strains which will destroy them ; and it is never reasonable to insert in the form of bridge-work a large number of teeth to be carried on two or three roots or entire teeth. This practically amounts to a condemnation of large bridges, except where a good many teeth or very sound roots remain. But for some few selected cases small bridges serve a very useful purpose ; removable bridges, such as those designed by Mr. Gartrell, are, in cases that lend themselves to their application, to be preferred to fixed bridges, as they admit of complete cleanliness, a result which is oftentimes hardly attainable with the fixed bridge. And it need hardly be said that the employment of a bridge is quite unjustifiable where the patient's teeth are loosening.

"I was lately consulted in a case where bridges had been inserted less than a year previously which were already failing from this cause ; and it was obvious from the depth of the crowns on the molars and bicuspids that the teeth used for attachment had already gone far on their way towards coming out at the time when the bridges were inserted. It is hardly possible to suppose that the practitioner who inserted them can have done so with any other view than securing of a large fee ; one of the bridges had no opposing teeth whatever, so that it could hardly have been expected to be of any use to the victimised patient."

Mr. R. P. Lennox, of Cambridge, in his recent work on *Some Methods and Appliances in Operative and Mechanical Dentistry*, has obligingly furnished us with the statistics relating to two fixed bridges which he and his partner inserted. He points out how the first case was lost by the failure of the two upper lateral roots to support a bridge of the four incisors ; the central roots had been lost before the treatment of the case was undertaken. "The second bridge after six months' wear was knocked out by the handle of a mangle, and is therefore only interesting, from the statistical point of view, in this, that the patient declared she liked the bridge and was sorry to lose it."

Mr. J. Charters Birch, of Leeds, has studied bridge-work very closely for more than seven years, as carried out by the best exponents of this kind of dentistry. His own experience of a large fixed bridge in his own mouth and of the construction of over eighty bridges during the time mentioned leads him to speak highly of the work.

The following are his conclusions with regard to some of the precautions to be observed, in order to arrive at successful results *in well selected cases* : (1) The suitability of the case for bridge-work ; (2) the position which the bridge will occupy ; (3) the probable duration of the bridge, and whether its future will be affected by the decay, or loss of, or accident to any of the remaining or opposing teeth in the mouth.

All these considerations apply with much force (*a*) to the loss of a bicuspid or molar in the jaw carrying the bridge, as such a loss will often so change the nature of the articulation as to cause too much stress upon one particular tooth, which may result in periostitis ; (*b*) to the loss of opposing teeth ; and (*c*) to the tilting forward of adjacent teeth. In other cases the result of loss or accident may be a thrusting of the bridge in or out of line sufficiently far to produce absorption of the alveolar process, which in time would render the bridge loose and useless.

The condition of the roots to which the dentist intends to anchor the bridge in the mouth is therefore one of momentous interest, as is also the question whether they are suitable for crowning, or sufficient in number and of the needful stability to support the rigid stress of a bridge. Patients not infrequently expect the dentist to make use of roots which have been covered by a plate for years, and can only be felt by the use of a probe. Sometimes the condition of such roots is deplorable, owing not only to the septic condition of the canals, but also to the ragged edges on them, which cause irritation of the gum tissue. Roots like these should be irrigated with a syringe filled with hot water, and dried with an Evans' root-dryer. Overhanging gum can be readily removed by a few applications of ethylate of sodium, carried to place on some cotton-wool; the treatment should be continued until the surfaces of the roots are exposed.

To treat the canals,—a suitable probe, moistened and coated with powdered permanganate of potash, should, if possible, be passed up the full length of the canal. Before the probe is withdrawn, the canal and pulp cavity should be explored, in order to ascertain whether the foramen at the apex of the root is enlarged or not, or if the side of the root is perforated. In withdrawing the probe as much of the permanganate of potash as possible should be left in the cavity. The canal should then be syringed with a 20 per cent. solution of peroxide of hydrogen, full strength. The chemical combination will cause an effervescence which will actively drive all *débris* out of the root and disinfect and sterilise the canal. This treatment should, if necessary, be repeated several times, until the clean probe is found to be free from all septic odour when removed from the canal.

If the root is a suitable one, the canal should be dried, and a removable dressing, charged with some powerful antiseptic, placed close to the foramen.

Roots covered with gum are best filled with gutta-percha, which will dislodge the overhanging gum. Before the gutta-percha cools, a tinned tack of sufficient length should be warmed, and its head covered with gutta-percha, then gently but firmly pushed into the root-canal so as to make the gutta-percha expand over the surface of the root. The smallest size wood screws, as used for fine cabinet work, or the tapering screws made by Mr. Lennox's method with the ends flattened and curved, or dental alloy pins guarded with a disc soldered on, will also be found useful in this detail of treatment. In the course of from two to four days the root surfaces will be seen quite clearly and found free from irritation or tenderness.

Roots have a value according to their length. A long root may be made to last for years by means of support suitably applied. Short roots, on the other hand, will be found only too often to yield nothing but disappointment.

It is therefore a necessity in bridge-work to ascertain beforehand the character of the roots in the mouth, so as to be able to decide upon their value. This is where experience comes in. Doubtless the X rays will be found of value in some cases in which without them it is sometimes impossible to obtain the exact information needed for such work. The roots that can be used as supports should be treated antiseptically. When they are brought into a healthy condition, dowel-pins or posts can be fitted to some of them, and collars to others, in the following manner: An impression is taken in plaster of Paris, with the dowel-pins and collars set in position. When the plaster has set and the impression is removed from the mouth, it is carefully examined. Should any of the dowel-pins or collars be found to be loose, they are secured in position with a little wax. The method of securing them is to run a thin layer of wax round the inside of each, which admits of their being easily removed from the model by heat. The melted wax will leave a slight space between each collar and root, which permits of the collar being removed without injuring the model. The collars can be kept exact in fit by filling them, as they stand on the plaster impression, with melted fusible metal, such as is used by Dr. Melotte. To ensure their retention in correct position, guide points should be made on them. Before the collars are filled, pipe-clay tempered with glycerine should be built round them where the fusible metal is not wanted to run. Before the metal is poured, the inside of the collars should be painted with whiting; this gives them a surface which will part from the fusible metal.

The melted metal is poured into the collars prepared for it, and before cooling, a tinned tack is pressed head downwards in each collar. When the metal has cooled, the clay is removed from the impression, and metal castings fitting the collars will be found in the impression, each provided with a spike for securing attachment to the plaster model. All traces of clay are then removed from the impression, and the fusible metal cores are cast *in situ* in the impression, so that the collars can be put on and taken off without any risk of injuring the model, such as would exist if it were made entirely of plaster. Copper tubes are fitted on the dowel-pins before the impression is cast in plaster. When the model has set and can be drawn, a metal lining will be found in each canal for the dowel-pins or posts, and metal roots for the collars which are to be made into crowns. Should the model prove satisfactory, the plaster in the labial region above the dowel-pins is cut away till the end of the dowel-pins or their copper sockets can be reached, in order to allow the workman to prise each dowel-pin pivot out of its copper socket, so that in completing the bridge it can be lifted off the model, when it is ready to be invested for soldering.

The dowel-pins are generally fitted with gold or platinum discs, which are most carefully adapted to the end of the root and soldered to the pin. Close adaptation can be obtained by the aid of a handle shod with india-rubber of the thickness of a pencil, in the middle of which a hole is made to take the free end of the dowel-pin. Pressure applied by the hand, or with a light tap on the end of the handle with a hammer, will cause the thin disc of gold to adapt itself to the surface which it is intended to fit. A similar handle charged with impression composition will also be found of use, as the pressure applied by it to the end of the root, with the thin metal surface between the root and the impression, will make an excellent fit. After due preparation, the porcelain teeth are fitted to the model, backed, positioned, invested and soldered. The investment is made of marble-dust and plaster.

An impression is taken of the antagonizing teeth with clay tempered with glycerine, as before mentioned, in a suitable tray, around which a section of large rubber tubing is placed. Fusible metal to form the die is now poured into the impression ; this gives a sharp reproduction of the surfaces of the teeth to which the bridge has to be built. The metal cast is cooled, painted with whiting, surrounded with a rubber ring, and melted Melotte's metal, which has a lower melting-point than fusible metal, is poured on the die at as low a temperature as possible ; this forms the counter-die. The die and counter-die thus made will give the masticating surfaces of the teeth, between which the gold can be struck which is to form the crowns for the collars.

The crowns and dowel-pins, made as described, should be fitted in the mouth, and a plaster impression taken of them in position. The impression should then be cast, and the crowns and dowel-pins accurately adjusted to the bite. The dowel-pins are attached to each other on the model with hard wax. The teeth are removed from the model and invested, the investment is allowed to set, after which the wax can be scalded out. The gold and solder are placed in position in the investment, which is heated to redness when the soldering is done. The investment is allowed to cool, and the work is removed from it. The crowns are next attached by wax to the dowel-pins. Pin teeth are fitted in such a way that they do not touch the gum, in order that a space may be left for cleaning away any food which may lodge between the gum and the tooth. The articulating surfaces of the teeth thus used to bridge across spaces are made of pure gold, in the same way as the masticating surfaces of the crowns.

The metal articulating surface, having been made, is placed in position, attached to the teeth in wax, and adjusted to the bite. The completed bridge is carefully lifted off the model, a piece of tobacco pipe stem is fitted across from molar to molar, or bicuspid to bicuspid, and invested with the bridge, in order to prevent as much as possible the warping of the bridge during soldering. When the bridge is soldered, it should be allowed to cool very slowly in the investment. When it is cold, the investment may be removed, the bridge pickled in acid, finished, tested on the model, and then heavily gilded to give it a coating of pure gold all over. Bridges are cemented in position by various cements of the oxyphosphate of zinc type, but there is little doubt that their existence is prolonged if gutta-percha is used instead of cement. The reason is a simple one: the gutta-percha acts as a buffer on and in the roots, and allows some "play" between the roots in the alveoli, and the crowns and dowel-pins which are attached to or anchored in them.

All the bridges which I have seen, that have come to an untimely end, were *immovably* cemented in the roots. Many of us remember crowns which have lasted for twenty-five years or longer in the mouth that were fixed in position with gutta-percha or mastic cement. The advantages of allowing for "buffer" or "play" movement, when anchoring bridges, seems to have been largely overlooked in the books and papers on the subject.

The illustrations of bridge-work given in the American books and journals appear to me, despite their wonderfully elaborated details, and the precision and care with which they are engraved, to be wanting in the little irregularities and "accidents," as a painter would say, which speak so graphically of the *vraisemblance* that we naturally expect to find in books written by eminent authorities.

Are these beautifully symmetrical designs made on models for illustration, or are they actually taken from cases in practice, and do they represent bridges which have been worn in the mouth for a number of years? The intelligent inquirer is usually left in the dark as to the time which it takes to treat the roots, and to construct a bridge; also as to the average duration of a bridge, under all conditions, in an ordinary mouth.

More information is required than we at present possess on the subject of fixed bridge-work, but it seems almost impossible to obtain it. If the conditions were always equal, no doubt the knowledge required would ere this have been on record. I am fully aware that one root may be thoroughly and successfully treated in ten minutes, while another may take several hours and yield less satisfactory results; but, notwithstanding this, I cannot help expressing a hope that my brother practitioners, who make bridge-work a specialty, will fully and candidly place before us the results of their labours, with all the details of their cases, be they failures or successes, for it is only by honest interchange of thought and experience that real progress can be made.

CHAPTER XXI.

FUSIBLE METAL.

I AM so much impressed with the value of this material, that I think it may be of interest if I recount some of its advantages and uses in dentistry.

I have to thank Mr. R. P. Lennox, of Cambridge, for many hints that will be found in this chapter, as well as for so admirably bringing before us the uses of a material little employed by dentists, in the valuable paper which he read, and the demonstration which he gave, at the London meeting of the British Dental Association, in August, 1891.

Fusible metal will be found useful for the following purposes :—(1) For making plates for the maxilla or the mandible, on which to build or model the wax bite ; (2) for use as a rigid support when setting mineral teeth in position with wax, in cases intended for vulcanite dentures ; (3) for making dowel crowns ; (4) for making a mandrel with which to construct gold crowns ; (5) for mending a vulcanite denture with speed, when a tooth has been broken out of the vulcanite ; (6) for making an interdental splint in a case of fractured mandible ; (7) for making dies with natural teeth for striking up crowns ; (8) for making slab bites.

Care is needed in using fusible metal in these different ways. A few experiments will show how valuable to the practitioner the use of the metal is in carrying out accurate work,—in bite-taking, for instance, which is often faulty by ordinary methods.

A plaster model is used, as in all ordinary routine, on which a wax plate of the desired thickness is made, of such a size as may be suitable to the case in hand. At a convenient position a piece of wax, half an inch wide and as thick as three sheets of wax, is added to the plate, with which to form a "gate" or entrance for the melted metal.

It is well, when modelling the wax plates, to avoid undercuts on the labial surface of the model. The fusible metal casts so accurately that the model is easily damaged if great care is not taken in humouring and lifting the plate from the plaster surface. The wax plate is wetted and covered with Crown composition, which has been previously softened in hot water. It should be not less than a quarter of an inch thick. The composition is allowed to cool, and, when hard, the wax plate is removed from the composition. The composition is replaced on the model after the plaster surface of the model has been well rubbed with French chalk, and slightly warmed before the fusible metal is poured. The fusible metal is then melted in a suitable vessel, and quickly poured into the gate left between the plaster surface of the model and the composition, which communicates with the space forming the mould. The fusible metal is allowed to cool. It is then carefully removed from the plaster model, and the sharp edges are removed or trimmed with a hot copper or steel tool, or with a file. Neglect to remove these sharp edges causes great discomfort to a patient when the plate is tried in the mouth. A little care spent in modelling the wax plate will be repaid by the perfection of detail of the fusible metal plate when it is used to fit in the mouth.

On the fusible metal plate can be built the necessary amount of wax with which to articulate with the natural teeth still remaining in the opposing jaw of the patient, and to take the bite,—or the wax can be made to fit to a similar block of wax which has been fitted to the opposing jaw. It is of great value to the practitioner to have, not only an accurate, but a rigid plate fitting the model with which to take the bite; and there is no difficulty about this, as such a plate is so easily and simply made.

In the case of vulcanite work, fusible metal in the form of a plate is invaluable, as it not only most accurately and sharply reduplicates the surface of the plaster model, but affords an excellent base to which the mineral teeth can be attached with wax. When such a case is tried in a patient's mouth, the work does not go out of shape, as it often does when the whole of the proposed denture is modelled in any kind of wax. The sharp relief given by the fusible metal to the plaster surface does away with the need of investing a plaster model on which to vulcanize the case.

This metal is most helpful in making dowel crowns by Mr. Lennox's method, which is referred to in another place. The impression is taken with Crown composition, in a tray that permits the direction of the canal to be correctly indicated, with a wire post fitting the canal in the root. The impression is cooled in the mouth, the guide pin is withdrawn from the root, and the impression from the mouth. A thin sheet of wax is softened and laid in the impression. The surface of the wax is wetted, and filled up with warm composition in a soft state to make a lid to the impression. The wax is removed, and the lid of composition is replaced on the impression. Fusible metal is then poured in between the surfaces of the mould thus formed by the impression and the lid. The wax should be so fitted that a thin casting is made, because, when large masses of the fusible are cast, they are apt to become very granular on cooling. Making a cast for dowel crowns in this way has the advantage of not losing any time waiting for the usual plaster cast to set; and the valuable parts of the cast, especially those representing the canal and the root-face, are not easily injured during the process of fitting.

In making gold crowns fusible metal forms an excellent mandrel for shaping the ferrule which is to embrace the root. A ferrule is made from a thin strip of copper, in the form of a portion of a flat ring, by folding it round the root to be crowned, care being taken to place the shortest curve next the gum. The ends of the copper strip are grasped with a pair of pliers, and they are drawn together until the lower edge fits the form of the root a little above the gum. This ferrule is soldered at the joint, placed on the root, and filled with wax. An impression is taken in Crown composition, and, on being removed from the mouth, the ferrule is filled with wax. A brass pin, cut in half, is thrust head downwards into the wax towards the buccal surface of the ferrule, and a model is cast in plaster in this impression in the usual way. The model is drawn, and the ferrule being left in due position on the model, the wax is removed from it, thus exposing the brass pin. A small hollow is cut on the plaster surface within the ferrule on the lingual side.

The mandrel can now be made by melting fusible metal into the copper band on the model, and, with a little pressure, holding the fusible metal in the matrix till it cools. The brass pin is of use as an aid in handling the mandrel,—and the depression cut on the plaster, being filled with fusible metal, forms a guide with the brass pin in replacing the mandrel in its correct position on the model. The mandrel offers a ready method of determining the depth of the gold which is to encircle the root, and also the shape of the gum festoon.

In the work of mending broken vulcanite plates, where a tooth has been broken out, a dovetail is cut in the vulcanite where the tooth has been damaged, and a couple of undercuts are made at each side of the dovetail. The tooth is held in position, and fusible metal is melted into the dovetail with a hot steel tool. The melted metal is squeezed into position by pressure applied with the finger and thumb, and, when cold, scraped and polished.

An additional pin tooth can be added by preparing the vulcanite plate and fitting the tooth into due position with wax. The plate and tooth are invested in plaster, the wax being left exposed. When the plaster has set, the wax is scalded out, and melted fusible metal is poured into the space in the investment.

Natural teeth can be used as punches for stamping up the cusped surfaces of gold crowns. The punches, which are made of a size to fit into a steel handle, are produced by planting a natural tooth crown downwards in impression composition, placing a brass ring over it and filling up the ring with fusible metal. The piece of gold is stamped into shape, with the aid of a hammer, on a lump of beeswax.

This use of fusible metal will be more fully referred to (in the following Chapter) under the subject of crowns.

Mr. Fenn-Cole, of Ipswich, has used fusible metal for making interdental splints, in cases of fracture of the mandible,—and so has Mr. Lennox.

Impressions are taken of the maxilla and the mandible, which are cast in plaster in the usual way. The cast of the mandible is sawn across, through the site of the fracture, and the teeth of the separated parts of the cast are brought into correct occlusion with the teeth in the cast of the maxilla. The plaster parts of the cast of the mandible are then united with plaster, and thus brought into normal position. When the plaster is thoroughly set, a suitable splint is modelled on the surfaces of the teeth of the cast of the mandible. This can be rapidly and easily done by rubbing the surface of the plaster teeth with French chalk, and pressing a sheet of Crown composition of suitable thickness on the model till it fits.

This model of the proposed splint can be trimmed with a knife, or filed with a wood rasp or vulcanite file, till its surfaces and edges are of suitable dimensions, and agree with the teeth in the maxilla. The model of the splint is invested on the model with plaster, or with Crown composition sufficiently thick. The model of the proposed splint is removed, the parts of the mould are brought together, and suitable "gates" are made through which to pour the melted metal. Fusible metal is now poured in and allowed to cool. If due care is taken in the casting, as well as in the moulding of the splint, the result will be excellent.

The fusible metal splint, when cold, is carefully removed from the mould, and thoroughly polished and finished, to make it comfortable in wear. It will be found to fit the patient's teeth correctly, and the fracture will be reduced as soon as the splint is placed in the position which it is intended to occupy. The splint can be removed if necessary for cleaning, or it can be kept *in situ* till the fractured surfaces of the mandible have united.

Any one who has seen such an accident treated with the speed and skill *with which I saw* Mr. Lennox deal with a fracture a few years ago will have cause to wonder if *surgeons* do not learn to make fusible metal splints, when the existence of the metal is brought to their notice through the columns of the medical journals. Such splints will enable them to give sufferers speedy and effective relief, and should lead them to abandon the crude insecurity of the four-tailed bandage, supplemented or not as it may be with gutta-percha splints inaccurately moulded to the chin.

A patient with a tolerably good supply of upper and lower teeth, who is suffering from fractured mandible, can be placed in a greater condition of comfort by this method than is attainable by any other kind of treatment. Amongst other advantages which it offers is that of immediate restoration of the powers of mastication. This method of treating fractured mandible does not appear to be practised in the United States,—interdental splints made of vulcanite, costing far more time and labour, being the favourite kind in use.

Mr. Lennox's method of fixing a splint is to drill holes through it on either side of a fracture in such a way that pins passed through them will pass between adjacent teeth, and, becoming wedged there, hold the splint down.

CHAPTER XXII.

CROWNS AND FURNACES.

THE value of crown work seems to have passed beyond dispute, and of the methods of making crowns there is no end. Although the literature on the subject is voluminous, it involves no little trouble to avoid complexity of construction of a crown on the one hand, and inefficiency of result on the other, if one is guided by some of the modern books which rank as text-books. Broadly speaking, crowns may be divided into two classes, the first of which may be described as dowel-pin crowns, and the second as collar crowns.

1. The dowel-pins, which have for many years been known as "pivots" in the United Kingdom, are secured to the mineral or porcelain crowns, and the free ends are set in the roots of the teeth on which the crowns are mounted. The pins are made in a variety of forms: round, triangular, square, feathered, &c., some of which are split lengthwise for a certain distance. Dowel-pins are commonly called "posts" by American writers.

Of the various forms, the round pin is the strongest and most generally used, as it is easy to proportion its strength to the size of a root-canal; moreover, the substance or strength of a root which is to be crowned need not be reduced to any serious extent in preparing it to receive the pins. The following are some of the advantages of the round pin:

It possesses the greatest strength in a given bulk; it is easy to make with standard wire of ascertained tensile strength; it can be removed from the canal in case of fracture by means of a trephine used in the dental engine, or with a pair of pliers which has slender jaws. If a broken pin cannot be extracted, a new one can be placed in the root by cautiously drilling a fresh hole on either side of the broken pin. It necessitates the removal of only a small amount of tissue for the pin to fit the root-canal. The only disadvantage of the round pin is its tendency to allow the crown to rotate, owing to the crown usually being constructed to rest on a plane surface. This can be avoided by making the end of the root convex, or by cutting a bevel on the root on which the labial end of the crown is to be fitted. Rotation can also be prevented on a root prepared with a plane surface by cutting a dimple or hollow in a suitable place and punching the plate of metal forming the cap to fit the spot. The addition of a short length of wire soldered to the dowel-pin, with a pit cut in the root-canal to receive it, will not only greatly strengthen the pin at its weakest place, but also prevent rotation. Square, or triangular, or feathered pins do not possess any advantages over a round pin except that they cannot rotate.

Split pins are weaker than solid pins, and are mostly used in tubes or sockets, such as the tube designed by Mr. F. H. Balkwill, of Plymouth, which is screwed into the root. Feathered or wedge-shaped pins do not always resist vibration in the form of strains or blows from antagonizing teeth, and when they are made of soft platinum they easily bend. The pin of the Logan crown is a good example of this type of pin. Tubes of gold or platinum have also been used for many years past as dowel-pins. These various kinds of pins and tubes are all used in the incisor and canine regions. For bicuspid teeth, the roots of which are flattened and sometimes bifurcated, a flattened pin is generally used, which can be split and bent if necessary at the end, so as to enter each root. Round pins, which can be screwed into one or more of the roots so as to form a support, are best for molars.

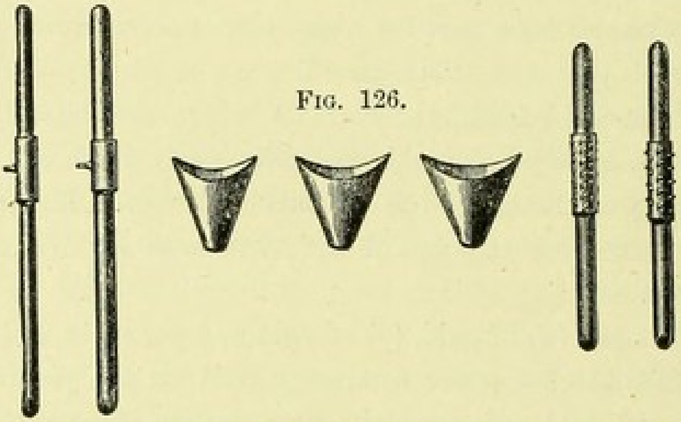
Crowns are made (*a*) of gold, (*b*) of gold and porcelain, or (*c*) entirely of porcelain. All-gold crowns are commonly used on the roots of bicuspids and molars; and gold and porcelain, or porcelain alone, on the roots of incisors and canines. Porcelain crowns are sometimes banded to roots as an additional means of security to the dowel-pin. Crowns without any pin can, in some cases, be placed on weak lateral incisor roots by means of a well-fitting collar, which form of attachment will retain its position for years.

Tube-teeth have long been used by British dentists as crowns, and splendid work has been done in the past with this form of crown. I have seen in the past many tube-teeth used for this purpose made by Mr. R. H. Moore, F.R.C.S.I., of Dublin, which looked most natural in the patients' mouths, and which had done service for from twenty to thirty-five years. The details of mounting one of these teeth are simple, but it requires a skilful hand to carry them out in the perfect way for which my friend, Mr. Moore, has been noted.

I here give a brief description of his method:

The root of the tooth to be crowned is cut down level with the gum, and bevelled so as to avoid rotation of the crown ; the canal is cleaned out and drilled with a suitable drill, so that the gold pin will fit the canal as well as the tube in the teeth ; the pin is cut to the required length, and the tooth is tried on it in the mouth. The tooth is ground little by little till it fits into the position desired, both as to length and projection. Sometimes the part of the pin which projects from the root has to be bent at an angle to the part in the root-canal in order to bring the tube-tooth crown into correct alignment with the neighbouring teeth. The correct position having been gained by fitting the pin and grinding the tooth, the pin is cemented into the tube-tooth crown with soft solder or sulphur cement, or with mastic varnish and floss silk. The free end of the pin is then cemented in the root with mastic and silk.

Fig. 126.

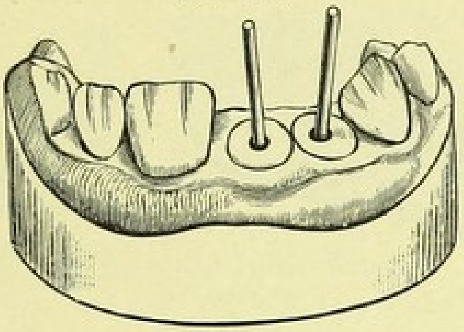


Mr. R. P. Lennox's Measuring Posts, Conical Caps, and Root-Canal Posts with Roughened Copper Tubes shown on them.

Crowns are also made with a tube that does not pass completely through the mineral, and this apparently minor detail in structure adds greatly to their strength. A further advantage which these crowns possess is that, when the patient laughs, the end of the pin is not seen, as is the case when ordinary tube-teeth are used. Crowns are likewise made with backed pin teeth soldered on a gold plate that is made to fit the root, to which the dowel-pin is soldered before it is cemented in the root. This is a very favourite form of crown with many dentists, owing to the ease with which the mineral part can be ground to fit about the gum and made to take any desired position before the soldering is done. The large choice at our disposal in the varieties of form and colour of plate or pin teeth also adds to its favour and permits of easy repair in case of need.

If an accurate impression of the alveoli and teeth is a necessary preliminary to making a plate, an accurate impression of the end of the root or roots is still more so in the case of crowns. In the hands of the most skilful, this proceeding, as conducted in the ordinary way, causes much disappointment and, at times, mortification. Owing to the direction of the pins which are fixed in the root-canals or of the neighbouring teeth, even the best impression material does not enable the operator always to secure an impression free from "drags."

Fig. 127.



Shows the Direction of Two Root-Canals (Lennox).

Mr. R. P. Lennox, of Cambridge, has solved this difficulty by means of a very simple invention (Fig. 126). This invention renders it quite easy to take at one time a first-rate impression of one or more roots in front of the mouth, which shows the depth and direction of the enlarged canals in the roots, and the angle at which the pins which are to support the crowns are to be set (Fig. 127).

It consists of a small cone-shaped cap (Fig. 128), which covers the end of the root and through which a post passes of a size to fit the prepared root-canal.

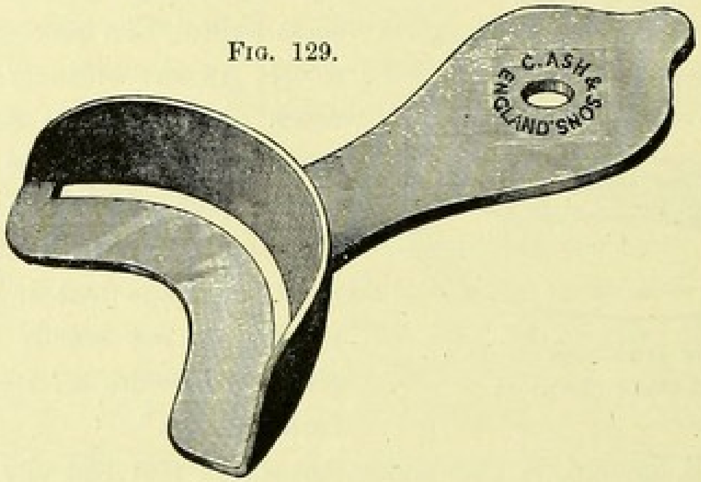
This cap is filled with Crown Composition, the post is passed through the middle of it, and the cap with the composition is cooled. The impression surface, which is left cone-shaped in form, is heated, the post is passed into the root-canal, and the softened impression material held in the cap is pressed on to the end of the root. The gum is pushed away from the root by the excess of impression material, as well as by the mouth of the metal cap, so that a very sharp impression will be found inside the cap, often indeed showing the markings of the file or stump wheel which has been used to reduce the end of the root. The post and cap are then removed, and any excess of composition is trimmed away. After

Fig. 128.

Conical Cap charged with Impression Composition, with Root-Canal Post passed through the Middle of the Composition (Lennox).

this is done, the post and cap are replaced, and an impression of the mouth is taken in Crown Composition by means of a "tray with a slot running round the bottom at its outer edge" (Fig. 129).

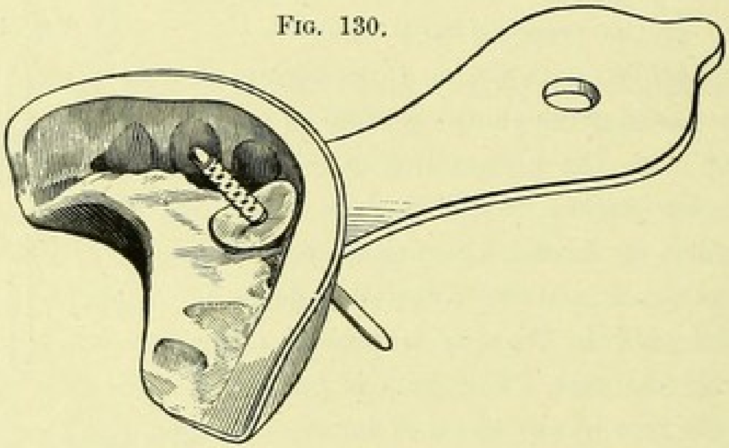
Fig. 129.



Impression Tray with Slot in Front of Floor.

As the tray is placed and adjusted in the mouth, the post enters the composition and is directed towards the slot in front of the tray, through which it passes as shown in Fig. 130. To hasten the setting of

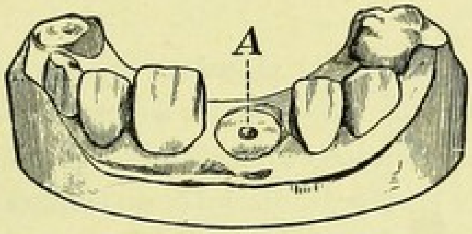
Fig. 130.



Shows Impression, with Post and Cap in Position and Roughened Tube Fixed on the Post.

the composition, cold water is applied to the tray by means of a syringe. The post is first removed from the tray, and then the impression is withdrawn from the mouth. The metal cap will be found in the impression, showing the exact shape and position of the face of the root. The impression is now prepared for the plaster of Paris cast.

Fig. 131.



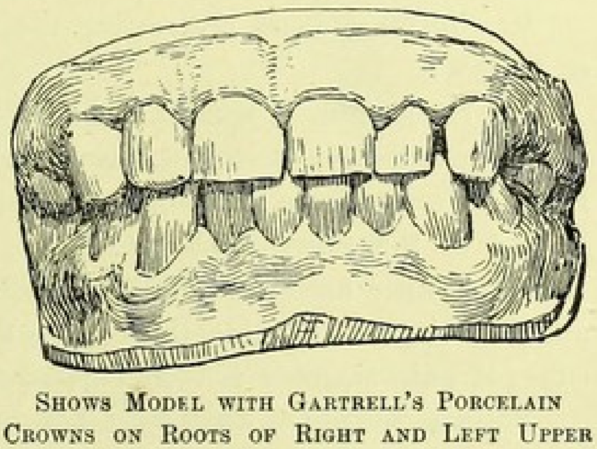
Model with Copper Tube in Root-Canal *A*.

Before this is made the post is replaced in the metal cap in the impression tray, and secured to the outside of the tray with a drop of wax. A short piece of roughened copper tube drawn to fit the post is then pushed on it, as shown in the above illustration (Fig. 130), till it reaches the impression of the root face. The model is now cast. When the plaster has set, the post is withdrawn and leaves behind it in the model the copper tube (A, Fig. 131), which forms a root-canal of an enduring kind, altogether superior to a plaster of Paris root-canal, inasmuch as it cannot readily be damaged, however much fitting is done in it.

I have seen a model made in this way by Mr. Lennox, containing five posts with their accompanying root surfaces, which, for accuracy and completeness, is far in advance of any model of the kind which I have ever seen. I have used these metal caps myself for some time, and I have been able with their aid to take accurate impressions of roots on which I have set crowns, made in Mr. Gartrell's Crown Furnace with his platinum wedge-shaped pins and mineral body. Fig. 132 represents one such case.

Mr. Lennox has indeed solved a problem in such a simple way by means of the plaster models which can be obtained in the manner described, that accurate work will be found as easy, *to those who care to do it*, as the most simple routine known to the dental mechanic.

Fig. 132.



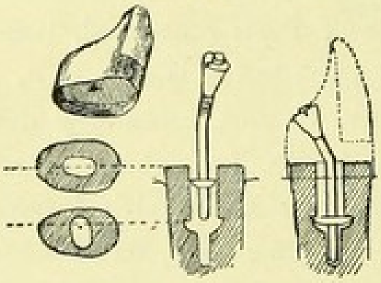
Shows Model with Gartrell's Porcelain Crowns on Roots of Right and Left Upper Canines and Right Upper Lateral.

In many cases it is a great boon to patients if a temporary crown be set on the root prepared for a permanent dowel-pin crown till the details of construction of the latter are completed. This can mostly be effected by using a diatoric tooth, which matches the lost crown, provided with a suitable pin, made of hard-drawn German silver wire, vulcanized in it. Some dentists are so considerate as to keep a supply of these teeth ready prepared for such cases, and thus please their patients in a matter in which a little kindness is warmly appreciated.

Mr. William Helyar, of Bristol, has most kindly placed at my service an ingenious design for a gold and porcelain crown to be secured in a canine root in the maxilla with a view of affording support to a denture.

The illustrations (Fig. 133) show very clearly the pin with an elliptical collar on it, and also a screw nut made in the form of a cone. The pin is pushed as far as it is intended to go into the root-canal, which has been prepared for its reception and rotated, when the little plate on it will be found to lock in the recess prepared for it. The porcelain-faced crown is placed on the bent part of the pin, and the nut is screwed on the upper part with a turnscrew made for the purpose, till the crown and denture are thoroughly secured in position (Fig. 134).

Fig. 133.



Mr. Helyar's Crown and Anchorage for Canines, for Supporting Dentures.

As an example of dental engineering, this novel crown possesses unusual interest amongst crowns.

I am indebted to Mr. S. G. Reeves, of Dublin, for placing at my disposal the new form of crowns shown in Figs. 136, 137, which he demonstrated at the Annual General Meeting of the British Dental Association, held in Dublin, August, 1897.

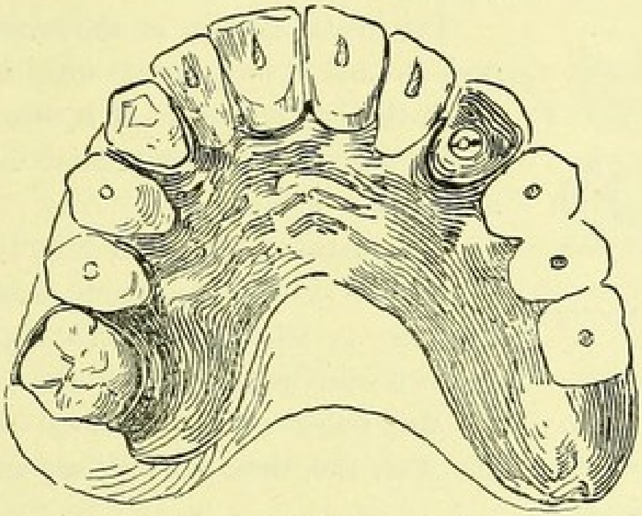
Mr. Reeves' method of treating the root which is to be crowned is as follows:

The rubber-dam is applied, and after the removal of the pulp, which has previously been destroyed, the chamber is thoroughly cleansed and made perfectly square or oblong with suitable burs. Easy access is thus secured to the nerve-canals, which are cleansed and enlarged with a Morey or other nerve-canal drill, sterilized with aromatic sulphuric acid and hot air, and filled to the apex with fossiline and iodoform. The enlarged pulp chamber is then temporarily filled with gutta-percha.

Nothing further is done for a few days, the patient being instructed to return at once should any pain or tenderness arise during the interval.

Assuming that the treatment is successful and that the root and surrounding parts are found to be in a healthy condition at the next visit, the

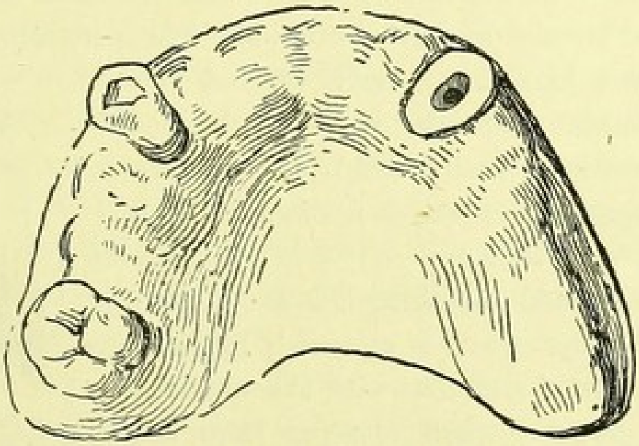
FIG. 134.



TUBE DENTURE, SUPPORTED BY MR. HELYAR'S CROWN AND ANCHORAGE.

external portion of the root above the gum is shaped to a suitable form, the temporary gutta-percha filling is removed, and, if necessary, the square or oblong-shaped opening in the pulp chamber is enlarged.

FIG. 135.

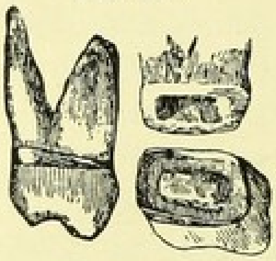


MODEL OF FOREGOING CASE, WITH DENTURE AND CROWN REMOVED.

The porcelain crown is prepared in the following manner:

A piece of *soft* platinum plate is accurately fitted into the square or oblong opening in the pulp chamber and on the prepared surface of the root, a ferrule of platinum is made to encircle the neck, the ferrule and soft platinum plate are attached to each other with hard wax, tried thus united in position, removed, invested and soldered together with pure gold.

Fig. 136.



Platinum and Porcelain Crown designed by Mr. S. G. Reeves.

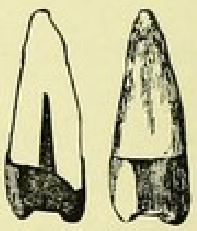
This metal portion of the crown is placed in position and driven home with a mallet, after which the bite is taken. It is then removed from the mouth, and the articulation is registered by means of a plaster bite.

The platinum cup (see Fig. 136), which fits the square or oblong opening made in the pulp chamber, is filled with Ash's high-fusing body, which is also built up inside the collar and fused in Mr. Dall's crown furnace. To produce a naturally shaped crown like Fig. 136, three lots of body and three firings are usually necessary.

When the crown is completed, it is tried in the mouth. If it be found too long for the articulation, the excess is ground away, and the crown is again fired to restore the glazed surface of the mineral body. If it be too short, more body is added and fused in the furnace. To protect the enlarged pulp chamber from moisture, the rubber-dam is applied before the crown is fixed in position.

Fig. 137 shows a combined platinum and porcelain crown designed by Mr. Reeves for the roots of bicuspids. The porcelain part consists entirely of Ash's high-fusing body without the use of a pin-tooth. Pin-teeth are easily broken in exposed positions, and should an accident happen to a pin-tooth crown, it is often difficult to replace it.

Fig. 137.



Porcelain-Faced Platinum Crown designed by Mr. S. G. Reeves.

Mr. Reeves' method of making it is as follows :

A platinum collar crown is accurately fitted to the root and made to articulate with the opposing teeth. This crown is then removed from the mouth, and two or three transverse cuts are made across its labial surface with a piercing saw in such a way as to leave a proper collar to fit the root. The lower sections of platinum are bent into the hollow of the crown,—the metal portion of the cusp being preserved unchanged in shape,—and form a rectangular chamber in which Ash's high-fusing body is placed and fused in Dall's crown furnace. This body forms a suitable base on which to model the porcelain face of the crown to proper shape. Due allowance must, of course, be made for shrinkage of the body in firing.

Such a crown faithfully made will resist a much greater strain than ordinary pin-teeth, such as are generally used for crowns; it can also be made more artistic in form by a dentist who can model well and has a cultivated eye for form. If a post is likely to be of advantage in the root to be crowned, it can be soldered in position before the body is added and fused. Mr. Reeves finds this class of crown most admirable for bicuspid roots.

Thanks to the experiments of Fletcher, Gartrell, Dall, Downie and others, the making of porcelain crowns has become comparatively easy, and the process certainly lends itself to artistic treatment in suitable cases. The usual method of making a crown is to fit a platinum pin into the root and to solder to it a thin disc of platinum, which can be made to fit the surface of the root by the aid of a suitable mallet, or with some impression material placed on the end of a handle and pressed on the root, or with a piece of stiff india-rubber fixed on a handle like a pencil. The rubber should have a hole in it long enough to receive the pin while the rubber is pressed on the platinum disc on the face of the root. The pin and cap having been made to fit the root, a suitable tooth is soldered to the pin with pure gold. Mineral body is then built on and about the pin to the desired contour, placed in a suitable furnace and fired. Sometimes two applications of body may be necessary, but this is not much trouble, as each application can be fired in a few minutes in the modern furnaces. When completed, the crown is allowed to cool down very gradually, and, assuming that all is right, it will be found to resemble a natural crown as nearly as any dowel-pin crown which can be constructed by any other mode. The crown can be set in the root for which it is intended with gutta-percha or any cement the dentist may think most suitable.

For making porcelain crowns and small bridges, several new forms of furnaces are at present attracting attention, and they all have particular merits of their own which appeal to the dentist, whether he is accomplished in the making of crowns or not. Messrs. C. Ash & Sons have a powerful furnace of this class which I have illustrated in the Appendix. Mr. Wm. Dall, of Glasgow, has also designed a simple crown furnace, which, as shown at work by him, leaves nothing to be desired for ease of working and certainty of results. He has lately introduced a novel feature in the form of a magnifying lens set in the door of the furnace, by means of which the firing of the body or enamel can be watched with comfort and safety. The details of construction are shown in the illustrations given in the Appendix. I wish we were all as skilful in working Mr. Dall's furnace as he is in demonstrating its capabilities.

2. Collar-crowns of all gold are seldom used in the front of the mouth in British practice. They are conspicuously common in America, but in my opinion do not by any means add beauty to the faces of those who wear them. They are best used on bicuspid or molar roots in positions which are inconspicuous. Collar-crowns of all gold, and of gold faced with porcelain, are commonly made by constructing a band or collar to fit round the root which is to be crowned. The band having been made of suitable depth, a gold cap is struck to resemble the cusps of the normal tooth. This gold cap is filed and fitted to the collar and soldered to it so as to form a hollow crown, which is filled with a suitable cement and pressed firmly on the root, care having been taken all through the process of making the crown to secure a good bite with the antagonizing teeth.

The best and most accurate method that I am acquainted with of making collar-crowns for bicuspids and molars is that invented by Mr. R. P. Lennox, of Cambridge, in which a fusible metal "mandrel for shaping the ferrule or collar" is used on the plaster model. Mr. Lennox has so fully and accurately described and illustrated the method in Chapter III., and also on pages 92 to 99, of his excellent little book on *Some Methods and Appliances in Operative and Mechanical Dentistry*, that I must refer the reader to it for details. I have not only seen the work done, but I have also been able to carry it out myself without any trouble, beyond that required in making any delicate object with skill. The subject of artificial crowns is a large one, and I recommend those who are interested in it and who desire further information to consult *A Practical Treatise on Artificial Crown and Bridge Work*, by George Evans, and the numerous descriptive circulars issued by the dental depôts.

CHAPTER XXIII.

CONTINUOUS-GUM WORK.

Before entering on a description of the latest improvements that have been made in this beautiful process, I must ask my readers to remember how uncertain and disappointing it was in results, until within the past few years.

Mr. F. H. Balkwill, in his work on *Mechanical Dentistry in Gold and Vulcanite*, devotes Chapter XIII. to this subject, and I take the liberty of including it in my book, because it will serve to remind us how great the difficulties were in the past, owing chiefly to the use of fire-clay muffles. Having experienced some of the mortifications so well described by my friend Mr. Balkwill, I cannot do better than place the lessons which he learned in the hands of my readers. He says :

"The idea of being able to make continuous porcelain gum work has always exercised a sort of fascination for me, and I think the feeling is pretty general. When a pupil in the workroom, I remember that we had an inclination in the same way, and some extraordinary blocks I helped to make there. One which we considered a great success we showed with pride to a medical friend who came in, when he burst out laughing. This so cooled our ardour that I think it was the last we tried.

"Many dentists have had furnaces fitted up, but they have, I think, with few exceptions, abandoned the work. This shows that it is an ideal, and as a matter of fact no material has approached porcelain as a natural imitation of the gum.

"The use of gum blocks is restricted and inconvenient in some ways. We require to be able to adapt the teeth to the bite, or appearance, individually, and the fact of having to move them in blocks is a serious disadvantage. What we want is to arrange the teeth and add the gum afterwards. It is to this aim that my efforts have been directed. When Mr. Fletcher brought out a gas furnace for the purpose, my thoughts were directed to the subject, as I thought that the easy application of the means of heat would make the process practicable.

"I therefore determined, about two years ago (1878), to make a few experiments, and procured some of the materials as supplied by the Americans for the purpose. Messrs. Lemale and Co. were also kind enough to supply me with some of their own body and gum, and not only so, but Mr. Fawsett, of their firm, with a kindness it is a pleasure to acknowledge, took much trouble in giving me information when I met with any difficulty, and also sent me several different gums to experiment with.

"The first experiment was in a furnace which we used to melt our gold with, a blacksmith's forge-bellows, and a coke fire. Two blocks, one of American gum, the other of Lemale's, were placed in a muffle, which was covered over with coke, and a white heat kept up for half an hour.

"Lemale's gum had disappeared, the American was fairly fused. Convinced by this experiment that heat would melt the gum, I procured Fletcher's furnace, and having a set on hand which was very suitable for it, arranged the teeth for the work.

"To try the gas furnace first, a small block was put in, but although heat enough to fuse this was got, the colour was quite spoilt, and it was some time before I found out that the cause of this was the construction of the muffle, which allowed the entrance of burnt gas. The slightest entrance of this I have since found always fatal.

"If a muffle cracks so as to admit the entrance of gas, the best way is to fill up the crack with a little body. After this defect was remedied, the pressure of the gas, or the direction of the wind, varied so, that I could not get heat sufficient, and failure was the result. As the set could not wait, it was sent out in the usual way.

"After some further experience I had some success, sufficient to send out a couple of suction vulcanite uppers with all the eight teeth in a continuous block, but the process was very tedious. After the block was set up, it had to be gradually put further and further into the furnace, taking three or four hours to reach the hottest place, and then to be kept there half an hour; then as the material contracted in fusing, cracks took place; these had to be filled up after the piece was cooled down, and the process repeated, so that it took at least two days to make a block. One block, which was otherwise tolerably successful, was spoiled by using water for the gum which had been exposed in the workroom all night, and had presumably absorbed gas products, as the fresh gum was spoilt in colour.

"The slightest amount of over-heat I found spoilt English teeth, first bleaching them, and then causing them to melt and lose shape. In this respect I found Ash's teeth stood better than Lemale's, but neither of them are to compare to American teeth in refractiveness.

"But the difficulty which finally compelled me to abandon Fletcher's gas furnace was the impossibility of sufficiently annealing the pieces. The draught of cold air, which took the place of the flame after the gas was turned out, made nearly all the pieces inclined to craze; and, indeed, this difficulty I have not quite got over yet, although I think the means of doing so are sufficiently evident. One very curious cause of crazing occurred. Having run short of the American body, I tried some American gum over Lemale's body, but Lemale's body melts at a lower temperature than the American gum, so that, remaining melted after the gum was hardened, its contraction at a different time had caused the American gum to crack in all directions.

"A few months ago an article by Mr. Fletcher drew my attention to the subject again, and I determined to make a few experiments with his injector furnace. The first experiment was made by placing a small muffle upright in the furnace and making a lid or brim to it by surrounding it with plaster and sand, so as to rest on the edge of the furnace, allowing vents as rays all round.

"I found a great convenience in working this, that the state of the work is easily seen, and the heat attained was quite sufficient, and I suggested this form to Mr. Fletcher, who had a furnace made to meet the suggestion. I found this furnace hardly give heat enough, the muffle being too large and shallow for the power of the flame; but the greatest cause of difficulty is, that the burnt gas naturally rises, surrounds the mouth of the muffle, and so gasses the work.

"My next trial was to enter a small muffle in the injector furnace opposite the injector, bringing the muffle through the furnace so as to touch the side next to the injector, but keeping it off the bottom so that the flame can play all around the muffle. I find in this little furnace that all the heat required can be obtained, about thirty-five minutes being all that is required to do the American gum, or twenty-five Lemale's.

"After many experiments, I have found it best not to dry and slowly heat the blocks, but to place them at once, whilst wet, in the furnace and heat up quickly—*i.e.*, in ten minutes. The reason I cannot tell. I suggest that the steam going out through the surface of the gum keeps this cool the longest, so that the interior begins to contract first, but certainly I have had much less trouble with the blocks when placed in wet and quickly heated up than when carefully dried and slowly heated up, the cracking and curling up being in this case often very disappointing. This I consider one great step gained ; instead of taking nearly all day after the block is made in slowly drying and heating, it can be done at once in thirty-five minutes. When there are more than three or four teeth, I have found no certain cure for its cracking in contracting, and to ensure the cracks being small, and coming in convenient places so that you may successfully fill them up in the second treating, I think it expedient to divide the gum with a knife whilst moist on each side of the laterals in an upper block of eight teeth. Even when a block of eight teeth is safely made and mounted in vulcanite, the inherent weakness of its shape is such that the mere handling in polishing is almost sure to cause flaws to appear. These, however, do not interfere with its strength, as from the number of pins in the teeth there is a superabundance of retaining power, and for strength the piece depends upon the vulcanite ; nor will they be visible in wear, although they may appear as blemishes to the work in hand. I do not, however, propose the work generally for such large pieces, but rather imagine it may prove serviceable for the four incisor teeth, above or below, when these have to be replaced between natural canines where there is much recession of gum. The want of power to do this adequately for a young patient has often been felt by myself, and therefore, no doubt, by others.

"Two other precautions have to be noticed before describing how a block is made. In the first place, as the whole block will contract in the fire, the teeth must be set rather farther apart than they are wished to be in the finished piece ; and, secondly, the gum and body become viscid whilst contracting, and draw the teeth out of their hold in the plaster. To meet the latter difficulty, two methods may be adopted : either twist fine platina wire loops around the pins of the teeth before investing them, so as to give them a firmer hold in the investment, or allow a slight ledge of plaster to come just over their edges in front. The first plan is rather troublesome to do ; the latter has the disadvantage that the plaster sticks to the tooth when hot, and rather spoils the polish. I will now describe the method of making a block. First mount the teeth on a wax trial-plate, either to a correct bite or to the mouth, according to usual practice, only do not allow the wax to come up about the pins behind the teeth. To fix them to the trial plate, drop sufficient wax on them in front, but allow a little wax to project through between the divisions between the teeth, so as to strengthen the block, as the body is to take the place of the wax. Having mounted the teeth in the wax to the positions it is desired they should occupy, place the piece on the model and cut away all the wax behind the teeth except just so much as holds the teeth together and what covers the gum in front. The teeth and wax together now represent the desired block. Make an investment of equal parts silver-sand and plaster, and set it so that the front teeth shall be horizontal and uppermost, and with a little plaster only continue the investment a little over the edges of the teeth. When set, boil out the wax, and the teeth are retained ready for the application of the body. The body is to be mixed with perfectly clean water, and the whole mould filled and modelled up to the fulness it is wished the future gum to be. A layer of gum is then to be added of about the thickness of a fourpenny-bit over the body, divisions made on each side of the lateral to control the cracking, and the piece placed at the far end of the muffle with the gum farthest in. Heat up slowly for five minutes, then put on full power so as to get to a white heat in ten minutes. Ten to fifteen minutes of moderate white heat is sufficient for Lemale's gum, and twenty to twenty-five minutes for the American. To gauge the heat is a nice point. No doubt eyes differ, but I find if I lose the outline of the piece in the heat, there is danger of the gum running away altogether. Stop up the injection hole of the furnace with a small crucible and the escape by overturning the chimney, and give two hours for cooling. Then fill up the cracks with fresh body and gum and repeat the process."

Turning from the past to the present, it is pleasing to find that continuous-gum work is being brought year by year more surely within the range of every-day practice, owing to the improved methods of construction which have been introduced by men who have devoted their time and attention to this ideal form of denture. Dr. L. P. Haskell, of Chicago, contends that: "This work, after nearly fifty years' use, has no peer as a full denture. Nothing ever made approaches it as the strongest, most desirable, most natural in appearance, most healthy to the oral tissues, and most cleanly when properly made."

This utterance, by such an eminent authority, tells in brief the advantages which this class of work places in the hands of the dentist possessed of enthusiasm. Among British dentists, no one has done more to make the details of construction of this beautiful work more practical and certain than Mr. J. H. Gartrell, of Penzance, in the Duchy of Cornwall.

A native of a county whose sons are to be found wherever mining or metallurgy is profitably carried on, gifted with a power of designing and inventing apparatus, endowed with inexhaustible patience in the construction of it, and animated by an enthusiasm for experiment which no failure can discourage, it is not to be wondered at that Mr. Gartrell has made the manufacture of continuous-gum work a practical success in the hands of the intelligent dentist. Mr. Gartrell learned this process in the workroom of Dr. Allen, in New York, in 1863, as carried out by Dr. Allen's assistant, Dr. Close. The process, as described in the latest text-book, has remained unchanged since 1863. Mr. Gartrell has left this beaten track, and has so completely changed the apparatus and process, as to bring continuous-gum work within the powers of the ordinary dental workroom mechanic. So successful has his method become, that his pupils and assistants, and many dentists in the United Kingdom, are working by it without any difficulty.

So far as my own experiments with Mr. Gartrell's furnace, shown on page 248, have informed me, there is no serious rival to it as yet, not even any of those now in the market which are heated by the electric current.

In the autumn of 1895, I had the pleasure of seeing Dr. Custer, of Ohio, demonstrate the fusing of continuous-gum with an electric furnace of his own invention, at a meeting in Philadelphia. So far electricity has not become a necessity of modern life with us in the British Isles, even in large cities, and Mr. Gartrell's furnace can be used wherever petroleum can be purchased, and a town water supply can be obtained, yielding a pressure of forty pounds to the square inch.

Mr. Gartrell has introduced into his apparatus several valuable improvements which I shall endeavour to place before the reader. I cannot speak too warmly of the generous way in which he has placed his long experience in continuous-gum work at my service, for the benefit of the profession. Even if I do not describe or advocate other methods, I feel that I am giving my readers information which is not only new and original, but which I have obtained from Mr. Gartrell by correspondence, and by a personal visit to Penzance to see his methods.

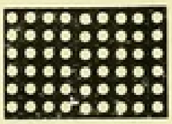
Fig. 138.

Mr. Gartrell's Die Metal.

Mr. Gartrell uses plaster of Paris for taking the impression of the mouth, and is of opinion that in suitable cases Crown Composition can also be used with advantage,—as, for example, when it is desirable to make use of a tougher material than plaster for the purpose of compressing the gum and thus securing a more equally fitting plate. This, however, must be left to the judgment of the dentist. The mode of procedure is as follows: The surface of the gum on the model is studied, and the soft parts are scraped, while the hard parts are relieved with a thin layer of wax, as in preparing a model for making a gold plate. The dies to strike the plate are made of an alloy of tin, antimony, copper, and zinc, as Mr. Gartrell considers that it is harder and more easily melted than zinc, that it does not shrink more than plaster expands, and that it does not deteriorate by repeated use like zinc (Fig. 138).

All the American authorities recommend soft platinum for the plate in continuous-gum work, but Mr. Gartrell recommends hard platinum, which is an alloy of platinum and copper. This alloy is not only hard, but tough, so that a thin plate can be used, which is as rigid and strong as a thicker plate made from soft platinum. The hard platinum plate used by Mr. Gartrell is perforated (Fig. 139). This not only lightens the weight of the plate, but gives the body great support, and makes it as rigid as a solid plate when the porcelain is fused upon it. The labour of roughening the solid plate is thus avoided, the hard platinum perforated plate is struck up or swaged just as an ordinary sheet plate, care being taken not to tear it as it is stamped on the die; its toughness can be retained by frequent annealing.

Fig. 139.



Perforated Hard Platinum Plate.

As the perforated plate is struck up between the die and counter-die, care is taken to protect it from the metals of which they are made, the pickle-pot containing nitric acid being freely used to keep the plate "clean." Mr. Gartrell recommends an alloy of four parts of lead to one of tin for the counter-die, as it is somewhat tougher than lead alone, and will not stick to the die metal mentioned in Chapter VII. and also above (Fig. 138). Should a warp or spring occur in the plate during the striking up, a counter-die impression of Stent's or Crown Composition made in a suitable iron ring will be found of great value.

In lower sets it is sometimes necessary to make the plate double as far back as the bicuspids in order to render it sufficiently rigid. The added piece of perforated hard platinum is made and attached by solder to the lower plate as in gold work, care being taken to heat the platinum thoroughly after each stamping of the die. If it is necessary to pencil the size of the metal when designing the area of a gold plate, it is still more important in the case of a platinum plate used for continuous-gum work, as the margin left for adjustment in this process is less than is the case in gold work. The greatest care should therefore be taken to ascertain beforehand that the margins of the plate are not likely to cause discomfort to the patient. The finishing die should in all cases be preserved till the completion of the denture in order to try the plate on it whenever necessary.

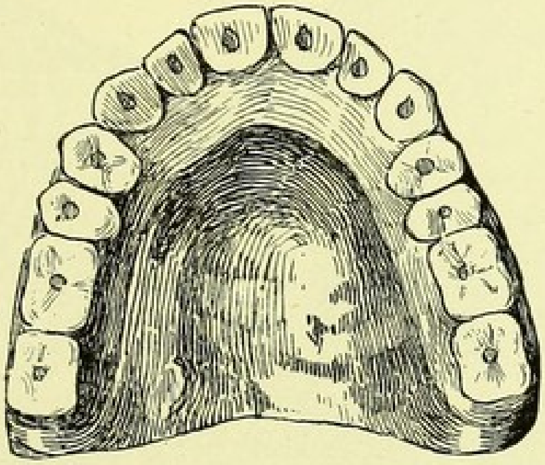
A wax bite and plaster articulator are made in the ordinary manner as for a gold plate, and the teeth suitable for the case are selected. As the heat used by Mr. Gartrell does not exceed the melting point of pure gold, any style of English or American teeth can be used, as well as those specially prepared for this work.

At the Annual General Meeting of the British Dental Association, which was held at Exeter in August, 1890, Dr. George Cunningham, of Cambridge, read a paper and gave demonstrations on the use of tube-teeth mounted in continuous-gum. In his paper he says :

" For full, but especially for partial dentures, both upper and lower, this new enamel seems to afford a great and important sphere of usefulness for the excellent English tube work. One reason why this work is so little employed is no doubt due to the fact that too frequently the dental mechanic of to-day is lacking either in the ability or in the patience requisite in nicely and accurately adjusting the tube-teeth to the plate. This fine-fitting of tube-teeth, which occupies, even in the hands of an expert, the greater part of the time of manufacture, is entirely obviated by the new method of working it. The plate is struck up in platinum, and, instead of gold, platinum pins are mounted in the usual way, only soldered with pure gold. No fine-fitting of the teeth to the plate is necessary, as the body does that more effectually than the most expert manipulator of the corundum wheel. The use of sulphur cement and the working loose of the teeth is also obviated, since they are held firmly in position by the body and the enamel. The general excellence of ordinary tube work is further improved by the filling up of all spaces where food might lodge,—while, without impairing in any way the utility and strength of the older method, the artistic colouring of the restored gum is, I think, a great advance on the often unsightly long-rooted tube-teeth.

"I can confidently recommend, from an experience of quite a number of practical cases in the mouth, this method as being peculiarly applicable to tube-teeth mounted on a platinum base, and also feel very certain that if the method were at all generally adopted, it would be followed by the introduction of a new and improved form of tube-teeth, which practi-

Fig. 140.



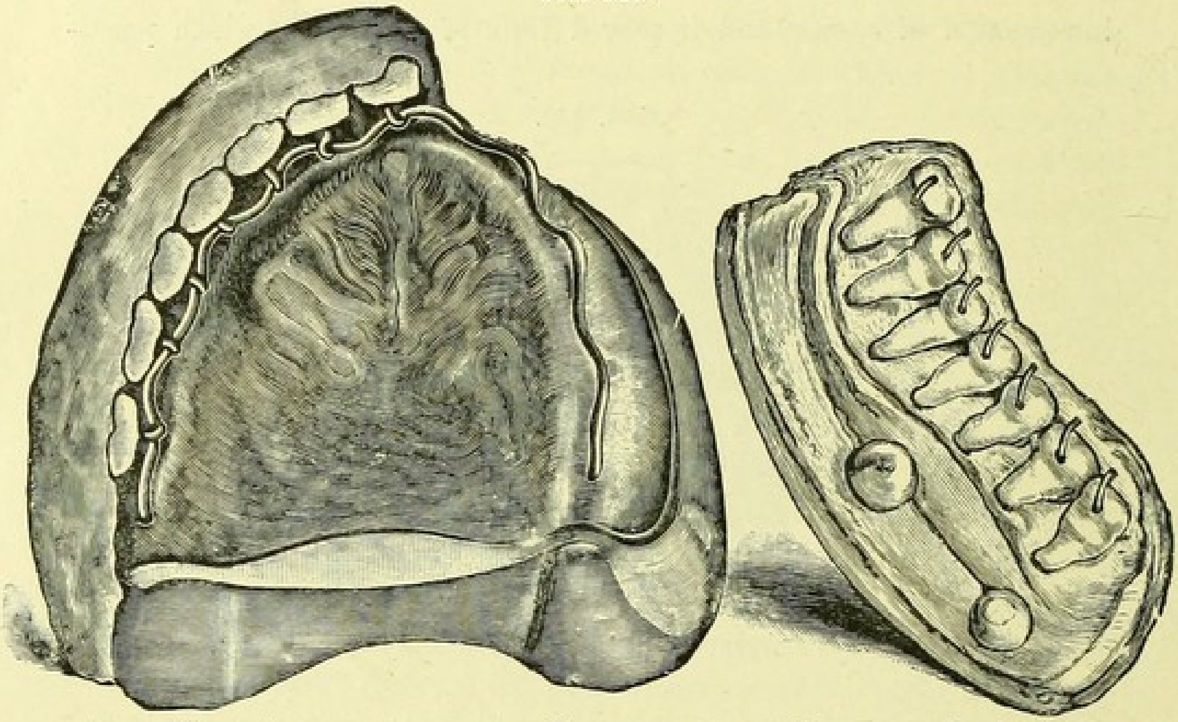
Mr. Simms's Continuous-Gum Case with Ash's Tube-Teeth.

tioners in this country would at once recognise as being fitly described by the term diatoric tube-teeth. These would have the improved form of the American counter-sunk teeth and the solidity of the English tooth-body without the unnecessary platinum tube. For our purpose such teeth would be immensely superior to the flat ordinary teeth, if only from their having that rotundity of outline which is characteristic of the natural teeth."

Mr. Wm. Simms, of Manchester, has been using tube-teeth in continuous-gum work for some time past with great advantage (Fig. 140). I had the pleasure of examining some beautiful work made in this novel way by Mr. Simms at the annual meeting of the Midland Branch of the British Dental Association lately held in Rochdale.

To resume my description: The teeth selected are next mounted in wax on the plate like a set on a gold plate with vulcanite attachments. The adjustment of the teeth to the bite is then completed and tried in the patient's mouth. The model on which the denture is set has grooves or pits prepared on the labial surface for the purpose of receiving the plate to be cast on it and to hold the teeth in position while the attachments are being prepared. As shown in the illustrations (Fig. 141), the plaster investment is commonly made in two pieces, with the line of junction

Fig. 141.

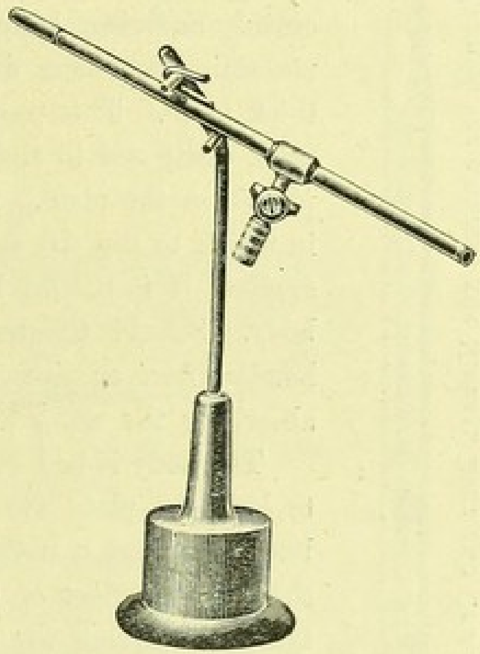


Wire Attachment, with the Teeth invested in Plaster of Paris.
Mr. Gartrell's Method.

between the central incisors. A hard platinum wire of No. 3, 4, or 5 Ash's gauge is prepared and soldered to the plate at intervals along the ridge, the loops being made so that the pins of the teeth can touch them. The plate is stiffened by wire soldered to it in serpentine curves inside the line of the teeth. The loops of wire are made to pass under the pins of the teeth, so that when all the loops are soldered to the plate, the pins of the teeth will rest on the wire in such a way that they can be united to it with solder.

When soldering hard platinum perforated plates, it is necessary to smear the palatine surface with whiting and water in order to prevent the solder running over it through the perforations and so causing the fit to prove imperfect. An alloy of eight and a half parts of pure gold to one and a half parts of platinum is used for solder. With this solder the wire attachment and tooth pins remain firmly united during the fusing together of the body and enamel. If an American gum body is used, solder with a higher fusing point is required, such as gold three parts, pure platinum one part. The text-books recommend the use of pure gold as solder, and a body and enamel that need a far higher heat than the melting point of pure gold to fuse them. This invites disaster, as the teeth are apt to shift during the firing of the body, which does not unite with surfaces coated with melted gold.

Fig. 142.



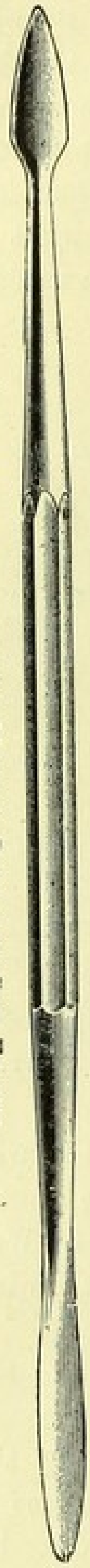
Mr. Gartrell's Oxygen Blowpipe.

The above-mentioned alloy, which has been severely tested in Mr. Gartrell's experiments, is not, when melted, as thin and fluid as pure gold, so that the surfaces to be united need not always be in actual contact, as they must be when pure gold is used. By the aid of the oxygen blowpipe (Fig. 142) this platinum solder is easily fused, and so intense and local is the heat that the plate may be held in the hand while the soldering is done.

The wire attachments having been duly soldered, the plate is tried on the model to test the fit, which is corrected if necessary. The teeth pins are next soldered to the wire attachment. This is effected by again placing the teeth in the plaster sections on the model, when the pins are bent to the wire loops. Wax cement is melted round the pins so as to secure their free ends to the wire, after which the plate and teeth are invested in sand and plaster.

The investment being set, the wax is scalded out, and a piece of the platinum-gold solder is placed in position on each pin by means of borax. The investment is first dried, and then gradually made red-hot by the petroleum burner while it rests in the soldering furnace. The furnace is carried by the handle to the work-bench, where the soldering is done by the oxygen blowpipe with oxygen and coal gas. A full case can be soldered in a minute, and if due care be used and the backs of the teeth are coated with whiting beforehand, no accident will happen to the teeth. When the investment is cooled it is removed from the plate, which with the teeth is then placed in sulphuric acid in order to be cleaned. The plate should again be tested on the die, which it should fit as accurately as before soldering.

FIG 143.



SPATULA FOR APPLYING THE MINERAL BODY AND GUM ENAMEL.

The plate and teeth are now ready for the application of the mineral material commonly known as "body." During this part of the work everything should be kept scrupulously clean. Sufficient body to cover the metal plate is mixed in a porcelain dish with distilled water to the consistency of a thick paste. This paste should be mixed sufficiently moist to work easily and to slide away from the position in which it is placed on the plate. A dish of distilled water is kept at hand in which to dip the spatula (Fig. 143) with which the body is applied, if it should be necessary to add more water to the body. Should the body be mixed too wet, a clean pocket handkerchief or piece of linen is the best material to use for absorbing the water and for pressing the body into place.

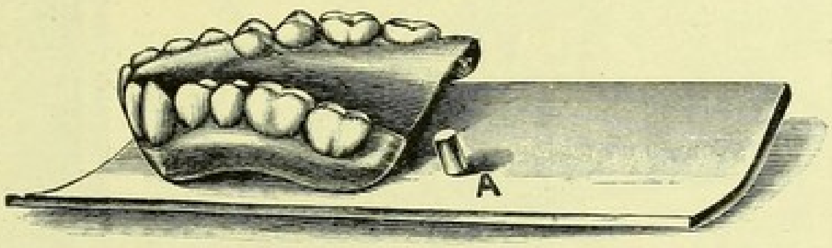
The body is laid over the platinum plate sufficiently thick to hide the plate when the case is fired. On the labial and buccal surfaces a sufficient thickness should be used to model the natural effect of the gums around the teeth, care being taken, by jarring the plate on the bench from time to time, to make the body as compact as possible. When the body has been backed on a perforated plate, care must be taken to remove any of it that may have passed through the perforations or any that may adhere to the enamel of the teeth. A stiff camel-hair brush will remove this excess, if the case is dried over a spirit lamp or gas burner.

The case is next placed on the nickel slide (Fig. 144) which is supplied with the furnace, and fits the muffle. Should the body be built over the edges, it may be supported on scraps of platinum wire or plate. The case having been duly adjusted on the nickel slide, a gold cylinder *A* (Fig. 144) is placed close to it to form a "tell-tale" in the firing. The melting of the cylinder indicates the fusing point of the body and gum enamel.

When the nickel slide is first used, it is painted with a mixture of ground flint and water. This coating on the slide prevents the gold adhering to it when the cylinder melts. The gold cylinder can be supported on a little wet body placed on the slide, and with such an accurate "tell-tale," even a novice can fire a case successfully. The little globules of melted gold can be collected after they have done their work of showing the fusing point of the body and enamel, and used for making solder.

The furnace is made of fire-clay bound with iron bands, and is supported on a four-legged stand (Fig. 145). The nickel muffle, which is its novel feature, is 5½ inches long by 3 inches wide. Porcelain is very

FIG. 144.

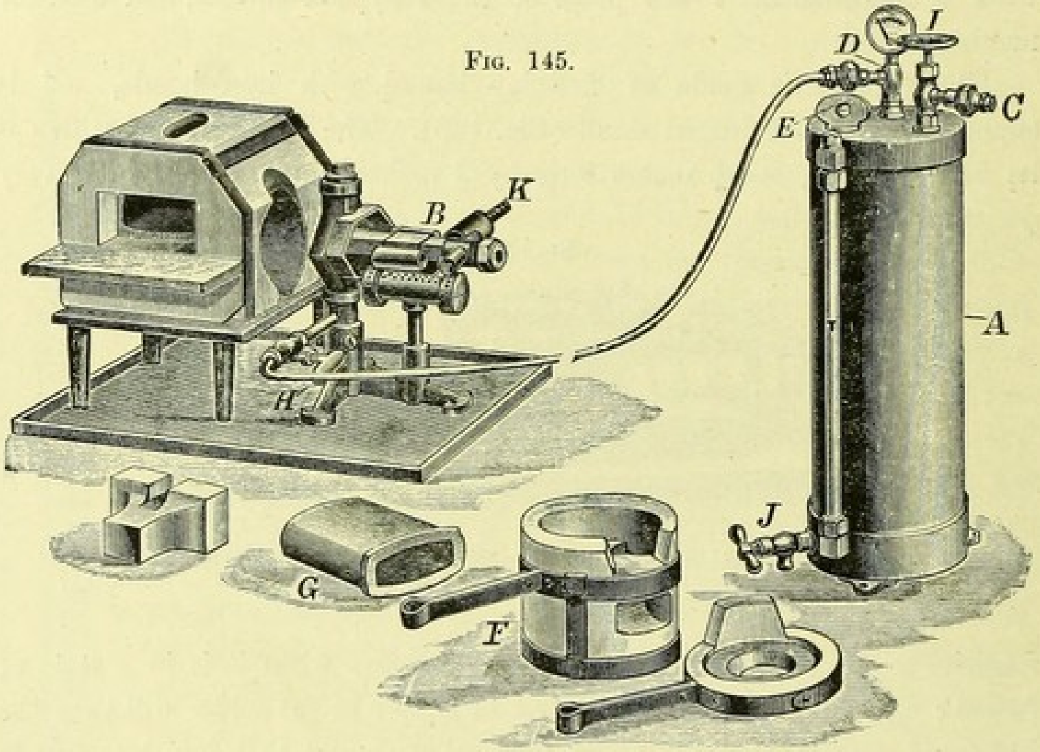


NICKEL SLIDE WITH CONTINUOUS-GUM SET AND GOLD CYLINDER *A*. MR. GARTRELL'S METHOD.

sensitive to the action of various metals or gases when it is in a state of fusion; *e.g.*, minute particles of silver or copper in the solder will turn the body and enamel yellow. Every precaution should therefore be taken in the solder to keep it free from impurities. Again, fire-clay muffles crack and admit volatilized particles of metal to the heated porcelain, which spoil it. A muffle capable of protecting the work under all circumstances is thus a *necessity*. A platinum muffle is too expensive if made of *sufficient thickness* to stand hard wear, a *thin* platinum muffle permits the heat to reach the teeth too quickly for safety, and does not last long, for, as is well known, the cutting action of a coal-gas flame, due to the power of combination between platinum and carbon at high temperatures, is destructive to platinum. Moreover, the accidental dropping of a bit of gold on the heated platinum muffle at a temperature high enough to bake porcelain causes the platinum to melt at the spot on which the gold falls, and "gassing" takes place as with a cracked fire-clay muffle.

Mr. Gartrell's nickel muffle is free from these defects. I have recently seen in his workroom a muffle which he has put to severe and constant use for months without any deterioration in its protective influence on the porcelain used in making continuous-gum work. The fuel used in this furnace is made from vaporized petroleum, which is blown out of the burner into the furnace by the force of the town water pressure which enters the oil tank. The petroleum recommended is one with a high flashing point,—the same, indeed, as that in all good household lamps.

Fig. 145.

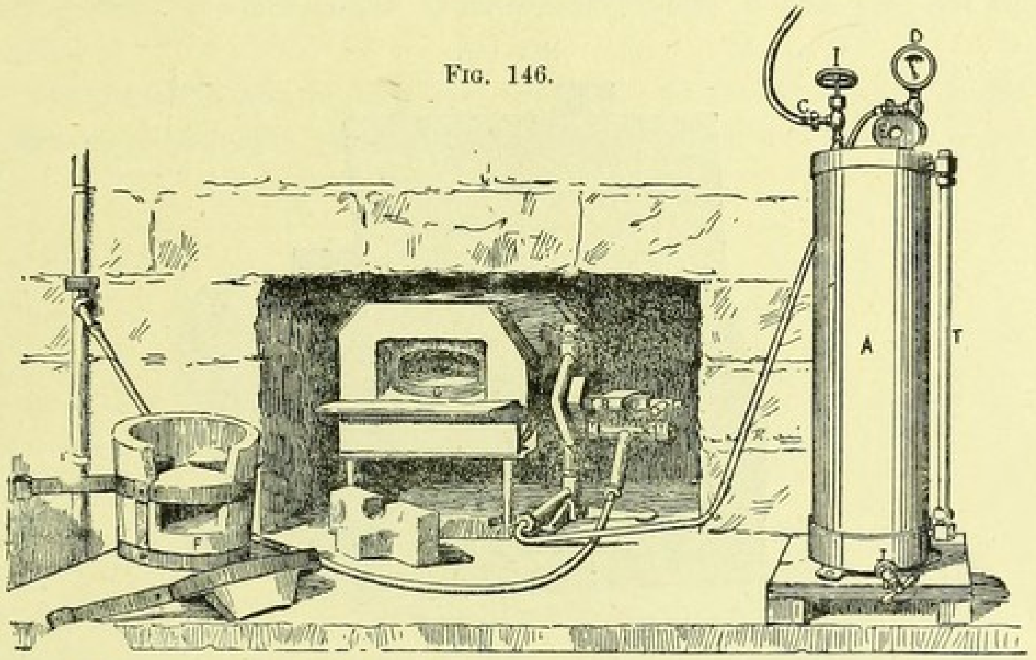


Mr. Gartrell's Continuous-Gum Furnace, etc., with Petroleum Blast.

The oil tank, which holds about a gallon, is connected with the petroleum burner by a small copper tube less than a quarter of an inch in diameter. The tube may be of any length to suit the position of the apparatus in the workroom ; it is usually from two to four feet long.

The town water supply is connected to *C* (Fig. 146), and is controlled by the valve *I*. The gauge *O* shows the pressure as the valve *I* is adjusted. At the side of the tank there is a glass tube *T*, which shows the quantity of oil and water in store. At the bottom of the tank there is a valve *J*, which is used to let off the water when the oil is nearly consumed. The plug *E* can then be unscrewed in order to refill the tank with oil. The water, being a heavier body than the oil, remains at the bottom of the tank and presses the oil to the top, so as to make it pass into the copper tube connecting the burner with the tank. When starting the furnace for fusing a case, a Bunsen burner *K*, fixed below the burner *B*, is lighted, and in a couple of minutes the burner is sufficiently heated to work the blast. The valve *I* is then opened to admit water into the tank. The water forces the oil to the petroleum burner and through the heated passages connected with two small jets which have holes in them small enough for a fine needle to pass into them. These jets are fixed to a

Fig. 146.



Mr. Gartrell's Petroleum Furnace as arranged in the Author's Workroom.
(The Soldering Furnace is seen on the left hand side.)

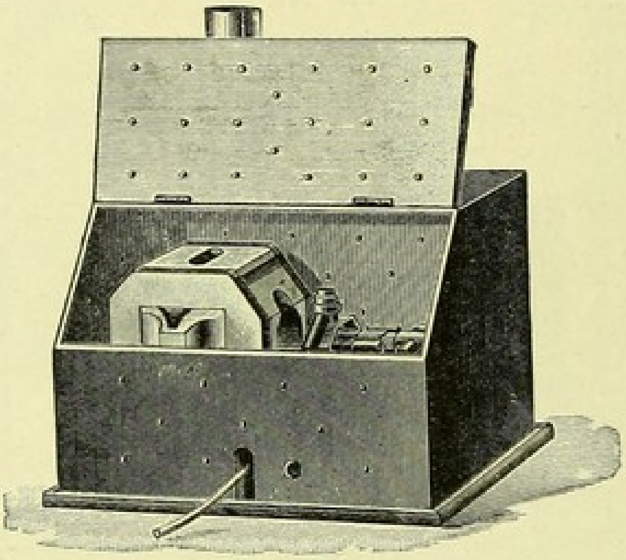
cross tube at the end nearest the tank. The oil is vaporised in passing through the tubes of the burner, and is blown through the adjustable tubes sliding on the square tube. The vapour yields a blue flame, which is thrown into the side opening in the furnace, where it surrounds the muffle.

The continuous-gum case having been placed in the muffle on the slide, a pressure of from two to five pounds, as shown by the gauge, for a few moments, will be found sufficient to slowly heat the case. The power of the burner is reduced or increased by the pressure of the water on the oil, and is under the absolute control of the valve *I*.

As soon as the petroleum flame will work, the Bunsen burner is turned off, and the sliding tubes are drawn close to the jets till the furnace is hot. When the muffle becomes red-hot, the sliding tubes are pushed along the square tube *away* from the jets as far as they will go, so that the flame is thrown into the furnace, and the mixing of the air with the vapour produces a most powerful heat.

The valve *I* is then opened further to give greater pressure; a pressure of from 25 to 40 lbs. will be found sufficient to fuse a continuous-gum case in from fifteen to twenty minutes, from the time of lighting the burner.

Fig. 147.



Hood made of Sheet-Iron, lined with Asbestos, for placing over the Furnace to Muffle the Noise.

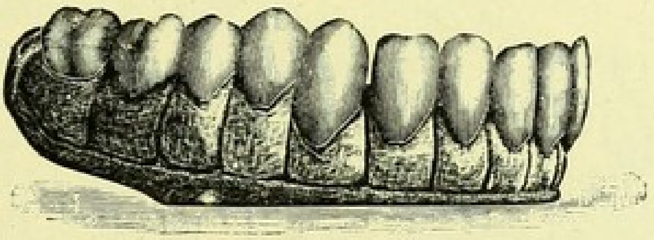
The burner, when first lighted, is placed nearly touching the furnace, and as the latter becomes red-hot it is drawn three-quarters of an inch away from the burner. If the furnace is not drawn away, the burner becomes red-hot, and a deposit of carbon is formed in the tubes. With good oil no deposit is seen, but with badly refined oil a deposit is formed after some use. This deposit blocks up the tubes and renders it necessary to unscrew the plugs to clean out the passages. The position of the sliding tubes has a great effect on the blast, and until their use is understood, close attention should be given to their adjustment.

The closing of the valve *I* puts out the flame, and the opening of the valve *J* cuts off the water pressure, when the burner instantly ceases to work. If required, the burner can be immediately started again by closing the valve *J*, provided the furnace is red-hot, or a light is applied to the burner. Fig. 147 shows a hood for placing over the furnace to reduce the noise of the blast, should it be found objectionable.

The fire-clay plug is not used till near the end of the firing, as Mr. Gartrell considers that the muffle is better ventilated without the early use of the stopper to close its mouth. When fusing the first coat of body, the heat is maintained till the gold cylinder melts. The case is then left to cool, and in about twenty minutes it can be taken out and plunged in boiling water, to which colder water is slowly added till the case can be handled.

Mr. Gartrell's mineral body does not crack and shrink as much as the American preparations, consequently a second coat is not always needed

Fig. 148.



Shows the Mineral Body divided into Definite Blocks, each containing One Tooth.

before applying the gum enamel, but a more artistic result is gained by applying a second coat. After firing, the case should be tried on the metal die. If some pressure is required to bring the plate to its place, the teeth should rest against the palm of the hand, the fingers should grasp the die, and the latter should be struck upon the bench ; the jar thus given will often cause the case to fit ; this failing, the shot swager mentioned on page 263 should be employed.

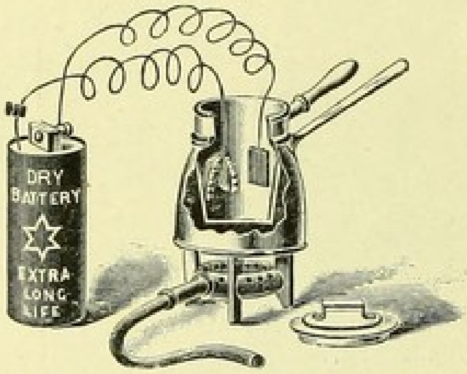
A method of preventing the fit of the plate being disturbed by the contraction of the body, described by the American authorities, consists of dividing it completely into separate blocks, as illustrated in Fig. 148. The divisions are made from both sides of the arch, with the packing spatula, before the first firing of the body. The introduction of Mr. Gartrell's shot swager, I am pleased to state, has rendered this procedure quite needless.

It does not matter if the body cracks on the labial or buccal surfaces during the first firing, as the second coat will repair it. When hard platinum perforated plate is used, the shrinkage of the body in the holes will allow of a little more body being rubbed into them from the palatal side, but the new body covering the platinum between the holes should be brushed off before the case is placed a second time in the muffle. The rugæ can also be better modelled by a second coat.

The second firing is conducted in the same way as the first, by heating the furnace as already described, but the action of the heat should be stopped as soon as the gold cylinder is seen to melt. The case is then allowed to cool.

The rims or margins of the case should be smoothed with a grinding wheel in the dental engine, and the gum enamel should be applied with the spatula, a little at a time, and put where it is wanted. The case is placed in the muffle on the slide and fired as described for baking the body, the heat, as before, being discontinued at the melting of the gold "tell-tale." The case can be left in the muffle to cool after the firing is completed.

Fig. 149.



Mr. Gartrell's Gilding Apparatus.

The platinum plate has to be polished before it is placed in the mouth; many practitioners gild it, which certainly adds to its appearance. A simple and efficient form of gilding apparatus is shown in Fig. 149. Should the case be intended to be used with gold spiral springs, suitable platinum tubes, to hold the swivel bolts, can be soldered to the plate and baked into the body when the denture is being constructed. In the finished case, the bolts can be secured in the tubes with cement, or the tubes can be tapped and the bolts screwed into them. Air chambers are not necessary if the plate is made on a good model and care is taken in the design.

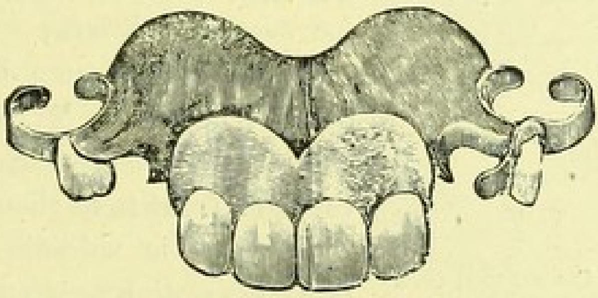
Patients should be told to clean continuous-gum work over a wooden bowl, or in a bowl with a fold or two of towel or flannel placed in it. Accidents are more frequent from dropping continuous-gum cases into the ordinary earthenware hand-basin than from all other causes put together.

Patients will not admit this, but invariably say it happened when eating soft bread and butter, or from the vibration of the mandible when walking down stairs.

Repairs can be made to continuous-gum sets which it is impossible to detect, so beautifully does the new material join with the old. In making a repair, more care has to be used than when the work was new. The deposits left on the surface by the fluids of the mouth, and which, to some extent, enter the pores of the teeth and body, have to be driven out by slow heating. If the work is *hastily* heated, the steam is formed faster than it can escape, and blows off a piece of the gum or of a tooth, or causes a flaw in a tooth.

In repairing continuous-gum work, the secret of success is to heat it to redness very, very slowly. Mr. Gartrell recommends investing the case in

Fig. 150.



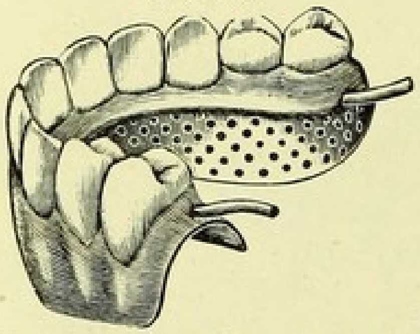
Partial Continuous-Gum Set,
with Vulcanite Attachments and Platinum-Iridium Clasps, made by Mr. Gartrell, which has been in use in the mouth for years.

plaster and sand and heating it for two hours, slowly raising the temperature to redness in order to burn out the mucus. The case is then allowed to cool, the investment is removed, and it is well washed with soap and pumice powder.

A small sharp chisel is the best tool to use for chipping away a broken tooth or the old mineral body. The plate should be supported on a plaster cast, and light taps given to the chisel with a hammer. It is usually practicable to add a new tooth without soldering the pins, as the teeth at each side and the new body and gum enamel will hold it securely. The wire attachments can be exposed by the aid of the chisel, and the pins of the new tooth can then be bent to rest on the wire.

One baking will sometimes answer for both body and enamel by putting the gum enamel on the unbaked body. In cases where much body has to be added to the plate, it is better to make two bakings. Partial cases are not recommended by the writers on continuous-gum work, for the reason that soft platinum has hitherto been used for both plates and clasps, and the soft platinum is not suitable for clasps. Platinum alloyed with 15 to 20 per cent. of iridium, Mr. Gartrell informs me, is as elastic and strong as the best spring band gold. Fig. 150 shows one of Mr. Gartrell's cases with platinum iridium clasps. Fastenings made from this alloy will retain their elasticity after three bakings of body and gum enamel. As a rule, in partial cases, two bakings are sufficient, one for the body and one for the gum enamel. Should it be necessary to add more body after the first firing, it can be added, the gum enamel can be put over it, and both fired together.

Fig. 151.



Partial Set of Continuous-Gum Work ready for the Addition of Vulcanite.

Continuous-gum blocks can be modelled and baked by the dentist to suit certain peculiarities of the patient and mounted for wear in vulcanite.

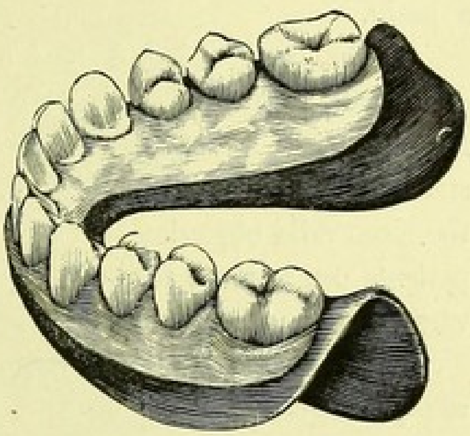
Of continuous-gum blocks with vulcanite attachments Mr. Gartrell says :—

"A continuous-gum block such as the four front teeth shown [in Fig. 150] may be set in vulcanite. A perforated piece of platinum is swaged to fit the model where it is to be covered by the block, and extending over the ridge on to the palate about a quarter of an inch or more; the teeth are then set up and invested with plaster as illustrated [in Fig. 141, page 244]. The wire attachment is then soldered to the plate, the case invested, and the pins of the teeth soldered to the wire. It will sometimes be unnecessary to fit the wire attachment, provided the pins are long enough when bent to touch the plate. The case is then invested in plaster and sand, and the teeth soldered. The body is packed over the labial surface and around the teeth, leaving the pins uncovered for attaching the vulcanite.

"Fig. [151] illustrates a modification of the method, in which the perforated plate is carried further over the palate and left uncovered by the body about a quarter of an inch, in order to unite it to the vulcanite; the wire attachment also projects on each side so as to be imbedded in the vulcanite plate. The block when finished is placed on the plaster model, the molar teeth mounted in wax, and the case treated in the usual manner for vulcanite work. Care should be taken to close the flask with as little force as possible. A weak point in the usual methods of making continuous-gum facings is the risk of cracking the gum enamel in vulcanising, which may happen from undue pressure in packing the case, but chiefly from the shrinkage of the vulcanite in cooling. This risk is greatly reduced by carrying the platinum over the palate, and making a border of gum body and enamel inside the teeth, [as shown in Fig. 151] ; this forms a girder which prevents the two ends of the block being pulled towards each other by the contraction of the vulcanite.

"The great objection to these combination pieces is the necessity of destroying the vulcanite plate in case of a repair to the block ; pink rubber may be used, but the block is then a piece of patchwork.

Fig. 152.



Continuous-Gum Set of Twelve Teeth with Vulcanite Attachment, as made by Mr. Gartrell.

"The combination of vulcanite and continuous-gum is more satisfactory in a case like [Fig. 152] than any other, as lower plates have more frequently to be scraped or cut away to relieve undue pressure, generally caused by absorption of the alveolar ridge, on which, unlike the upper, the plate depends entirely for support; for this reason continuous-gum work is better adapted for upper cases as a rule than lower. A set like [Fig. 152] is made by moulding a plate of wax or gutta-percha over the plaster model. Dies are made upon which a plate of perforated platinum is constructed ; this is placed upon the gutta-percha and the teeth set up. A wire attachment is made and soldered to the plate and pins of the teeth similar to the illustration [on page 244], the continuous-gum is added, and a vulcanite plate made to take the place of the gutta-percha."

With Mr. Gartrell's furnace and a little practical experience, a dentist with artistic ideas and some ingenuity will find opportunities of doing work such as has not yet been placed within the reach of those who want to hold "the mirror up to nature."

Objections are brought against continuous-gum work to the effect that it cannot be easily repaired. Anyone who can make continuous-gum in Mr. Gartrell's furnaces can repair it so that the repair cannot be seen. This can hardly be claimed for any other kind of work.

The *weight* of a continuous-gum denture is so invariably urged as an objection that this point seems to overpower what little judgment the objectors have at their disposal. I have seen very heavy cases made by the text-book methods which were worn with comfort for several years. Mr. Gartrell's perforated hard platinum plate reduces the weight to limits which we are accustomed to use in gold plate and tube work. If a plate fits well, patients never complain of the weight; the greatest objection to extra weight is the risk of breaking a tooth or the gum enamel when cleaning the denture, should it slip out of the hand into a basin.

It has been objected that continuous-gum work requires skill and experience beyond that of every-day practice. By one who has become familiar with Mr. Gartrell's methods, the work can be as readily constructed as good gold-plate work. The clattering noise made in eating is the most valid objection that can be made to continuous-gum dentures, but patients can learn to eat quietly. The following appear to be the reasons why such dentures are not generally used :—

First.—The use of soft platinum and its unsuitability for bands. To use pure gold, instead of 18-carat gold, for plates would be just as reasonable as it is to use soft or pure platinum in continuous-gum work.

Second.—The complicated and difficult manner of fitting platinum backings to the teeth.

Third.—The use of pure gold as a solder. The fusing point of the continuous-gum body being higher than that of the joint made with pure gold on platinum, the teeth and metal fastenings are liable to shift from the places which they were intended to occupy.

Fourth.—The use of a body having great powers of contraction with a higher fusing point than pure gold.

Fifth.—The risk of "gassing" the work in fire-clay muffles, and the inconvenience of the coke and gas furnaces hitherto in use.

Sixth.—The want of a convenient "tell-tale," such as a gold cylinder, to serve as a guide in the baking.

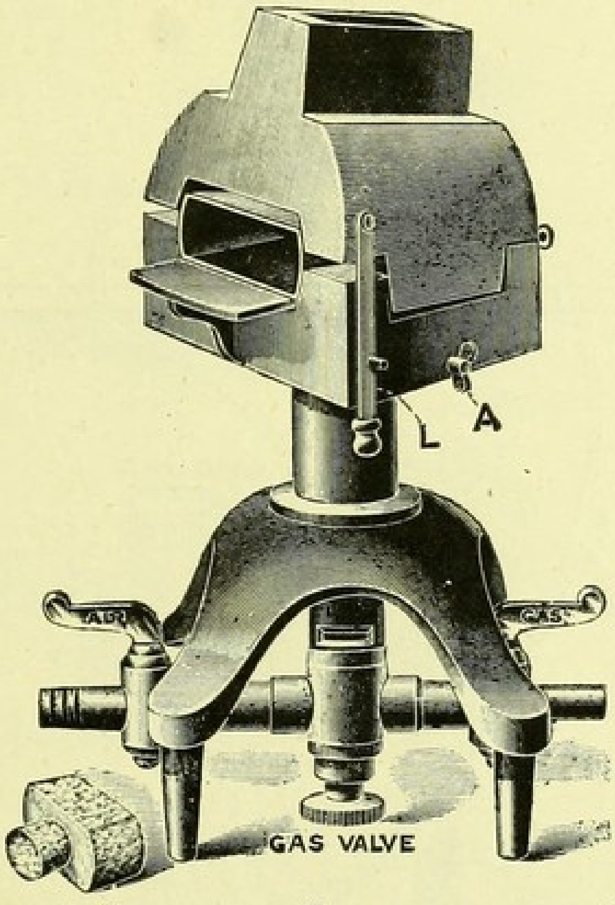
Seventh.—The want of a good body with little shrinkage and a natural-coloured gum enamel, both fusing at about the melting point of pure gold.

FUSING WITH MR. GARTRELL'S GAS FURNACE.

The furnace here shown (Fig. 153) will be found the best of any in the market, not excepting the electric.

It is made in two sizes—(1) for full dentures, and (2) for crowns and bridges, the former of which is fitted with a nickel muffle three inches wide inside measurement, by five and a half inches long, or large enough

FIG. 153.



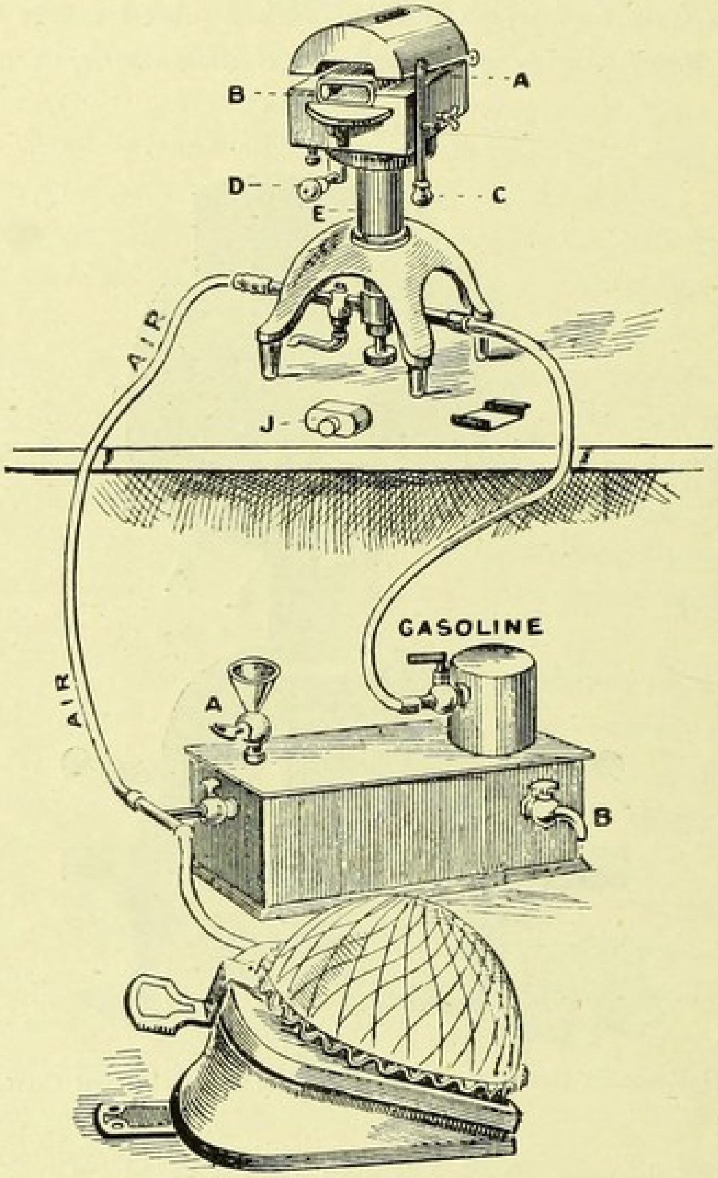
MR. GARTRELL'S CONTINUOUS-GUM FURNACE FOR USE WITH COAL-GAS.

for any size of denture. Nickel is used for the muffles, because it stands high temperatures as well as platinum, and only costs about the twentieth part of what platinum costs.

The nickel muffles can be made thicker in substance than platinum, at a comparatively cheap rate, and are therefore better fitted to resist the stress of heat than the thin and fragile platinum muffles which are used in many of the small modern crown and bridge furnaces.

Air-gas made from benzoline is used as a fuel in some of the modern furnaces owing to its pure flame. Fig. 154 shows Mr. Gartrell's crown and bridge furnace arranged for use with benzoline. Where coal-gas is not to

Fig. 154.



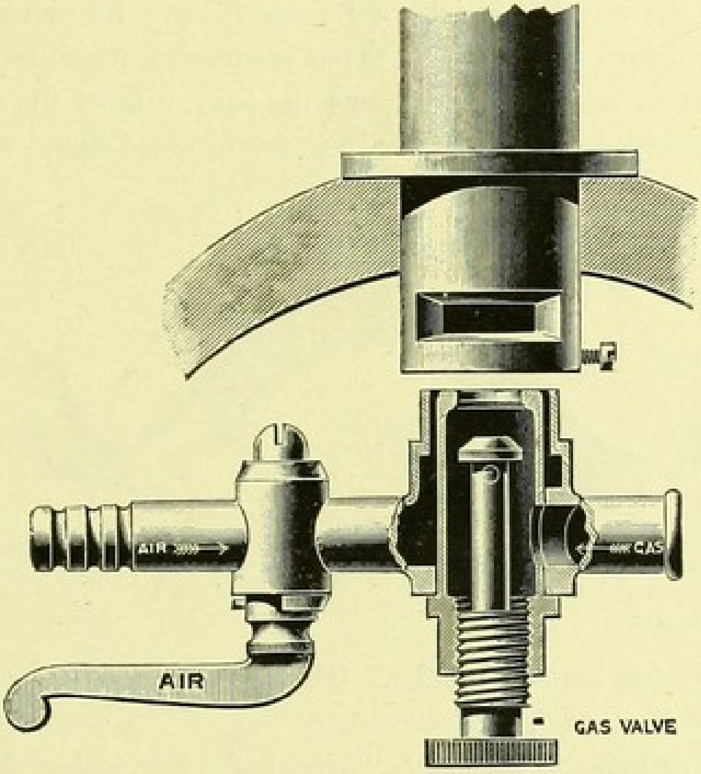
Mr. Gartrell's Crown and Bridge Furnace, with Fletcher's Generator and Bellows.

be obtained, air-gas may be valuable, but benzoline is a dangerous fluid to handle in the neighbourhood of a naked light, and further, under certain conditions, the air-gas obtained from it has a highly disagreeable odour which penetrates to a considerable distance from the place where it is used.

For my own part I prefer coal-gas to air-gas, on the ground that, wherever coal-gas can be obtained, it is a more convenient and better fuel than air-gas. Moreover, every dental mechanic is familiar with its use, and there is no complicated apparatus connected with it to keep in order.

Mr. Gartrell's furnace has a burner (Fig. 155) which is a modification of a type of Bunsen and blast burner introduced many years ago by Mr. Fletcher, of Warrington.

Fig. 155.

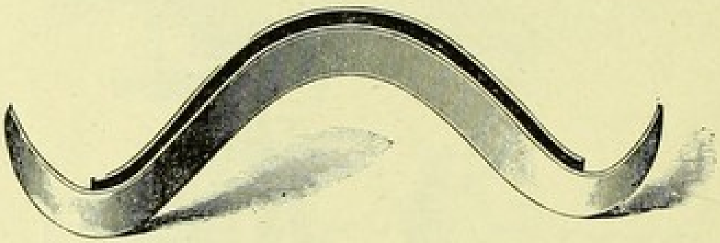


Burner of Mr. Gartrell's Gas Furnace.

The object in using such a burner is, first, to dry slowly the work in the muffle with a Bunsen flame, the heat thus obtained being more gentle and equally distributed than with the aid of a bellows. The necessary heat for fusing the continuous-gum body can then be readily developed with the foot-blower, the hard work of blowing thus being reduced to about one-half the time. It only takes some ten minutes altogether to heat with the Bunsen, and then fuse the body with the blast. There is no need to watch the Bunsen, so that the process of drying the work can be lengthened if desired, and no injury can befall the case.

The furnaces (Figs. 153, 154) are shown partially open on a hinge at the back, held so by a lever at the side, ready for using the Bunsen flame. The nickel muffle is ventilated by a hole through the inner end, in order that an oxydising heat may be produced, which is the most effective for fusing porcelain. With this model of furnace, the muffle can be removed when it is red-hot and another substituted for it. At the bottom of the burner and support to the furnace there is a convertible gas tap. The gas enters the inside tube and escapes through this tap. A turn of the screw closes the valve, and the gas escapes through a slit or small hole in the centre of the valve, and yields a Bunsen flame. By giving the milled headed screw a turn to the left more gas is supplied, which becomes mixed with a circular jet of air blown through the outer tube of the tap; the air of the bellows added to this produces a powerful broad flame, which will be

Fig. 156.



Shows Mr. Gartrell's Method of Forming a Border to Stiffen the Posterior Margin of the Plate.

found suitable for heating muffles. The furnace does not make a loud noise when it is worked.

The gold cylinder is used as a "tell-tale" when fusing the body and enamel in the same way as described on page 246. All the steps taken in the construction of the hard platinum plate and the application of the body and gum enamel are the same as already described in the early part of this chapter.

The American continuous-gum workers have various ways of forming a "rim" round the margin of the platinum plate to support the porcelain gum. Although with perforated hard platinum there is not the same necessity for a metal support for the edges of the porcelain as there is when unperforated soft platinum is used, much strength is given to the plate if a small wire is soldered round its edges; moreover, the wire also offers resistance against warping. A metal border soldered across the plate

(Fig. 156) is likewise useful when made by means of thin plate and wire combined in one strip. This strip is soldered to the middle of the plate with gold platinum solder, and carried to each side of the plate across the palate and over and round the alveolar ridge on each side.

Fig. 157.

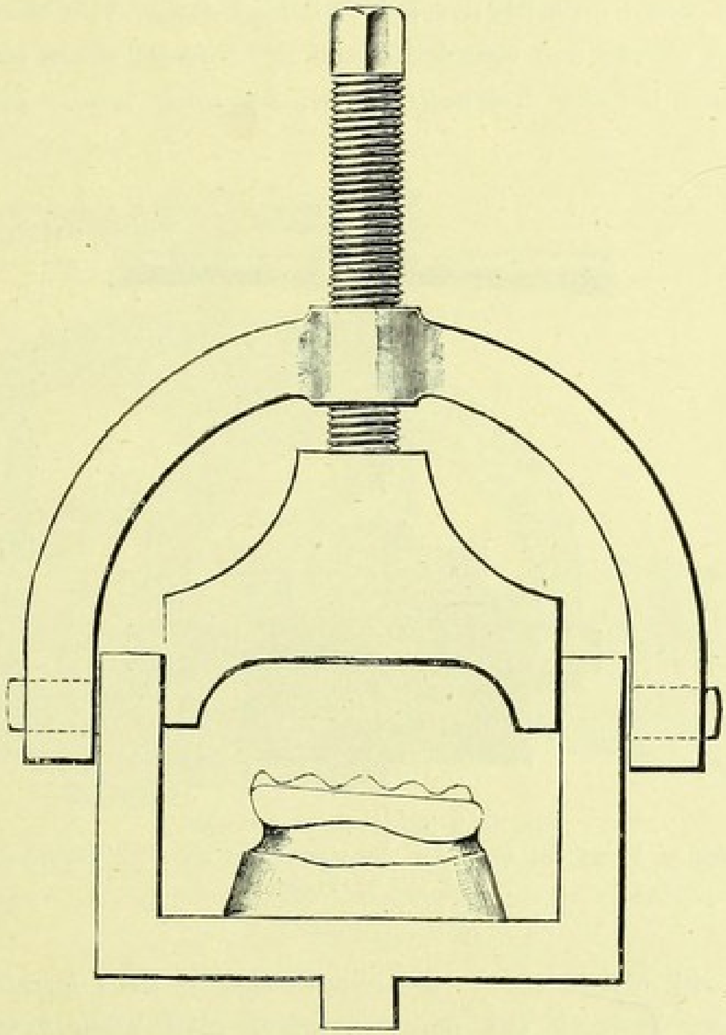
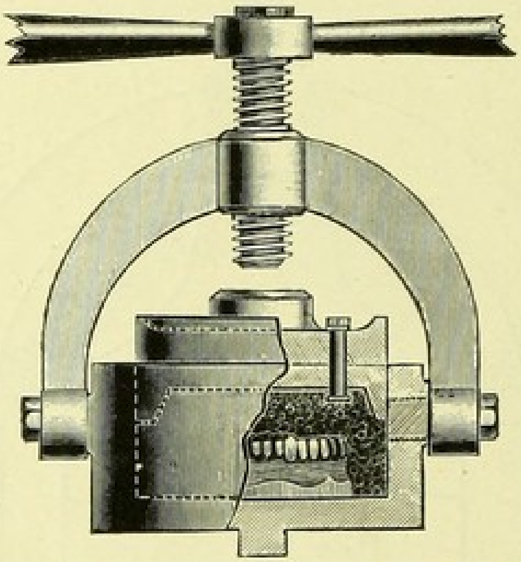


Diagram of Mr. Gartrell's Shot Swager,—with Plate on Model ready to be Swaged.

A piece of thin sheet platinum, No. 2 gauge, wide enough to cover the wire and the posterior edge of the plate, is cut to pattern, and fitted by bending to the position which it is intended to occupy. A counter-die is made, and the thin strip of platinum is struck in it till it half covers the wire and extends to the edge of the plate. This strip is soldered to the wire and the plate lengthwise. Great resistance to warping is offered by a plate strengthened in this ingenious way, when solder is used of a higher fusing point than the mineral body with the aid of the oxygen blow-pipe, and when the mineral body is divided into sections.

Continuous-gum plates which have warped from unequal contraction of the body can be swaged into accurate fit by screw pressure exerted on the case if it be placed on a die covered with bird shot. The use of shot for swaging gold crowns and completing the fit of metal plates by striking a plunger with a hammer has been known for some time. The diagram

FIG. 158.

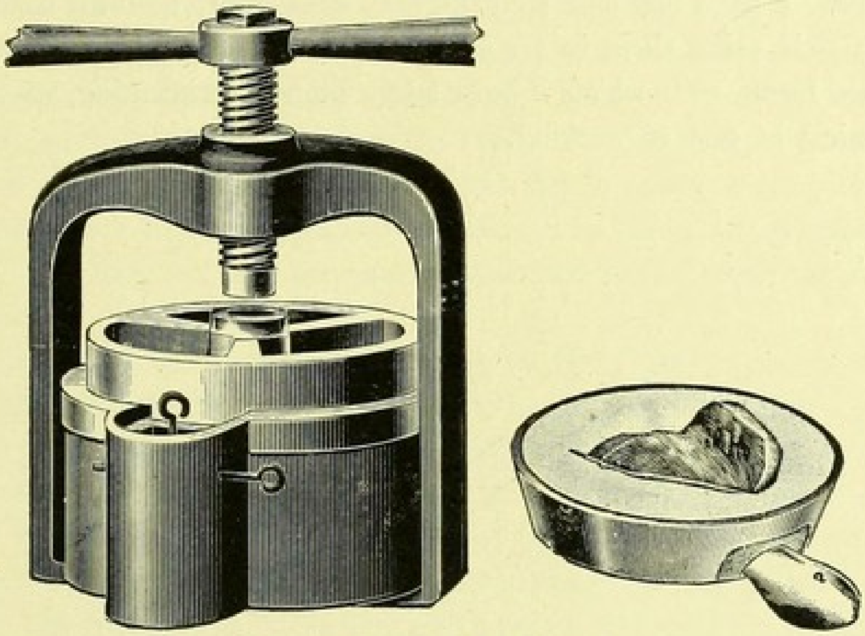


MR. GARTRELL'S SHOT SWAGER,
with Portion of Front cut away for the purpose of showing the Shot, Denture, and Die in Position.

(Fig. 157) will explain clearly the construction of the apparatus used for this purpose. I never was more surprised than when I saw, in Mr. Gartrell's workroom, a large case of continuous-gum pressed into place on a die by the aid of the powerful screw. I expected to see the teeth and gums come out in fragments, if not in powder, but nothing was damaged.

This use of shot for pressing a warped continuous-gum case into exact fit on a metal die has been introduced by Mr. Gartrell, and the shot press or swager which he has designed (Figs. 158, 159) will be found a useful addition to the workroom for many purposes. Vulcanite plates can be brought to a good fit with a little trouble by warming the press, even if only a plaster model is used. When using this shot "adjuster," it is well to leave the pressure to bear for a few moments before slackening the screw. No. 8 or 10 size shot can be used, or No. 1 or 2, according to the nature of the warp in the plate, and small steel balls, such as are used in the bearings of bicycles, are also most useful in certain cases. The swager has a rib on the bottom of the cylinder, by which it can be gripped in a vice, and the screw pressure is applied by means of a two-handled lever.

FIG. 159.



MR. GARTRELL'S SHOT SWAGER,
with Brass Cup containing Impression Tray and Impression.
(The recess on the front of the Swager is for receiving the Handle of the Impression Tray.)

Full details of this excellent shot swager, and the numerous uses to which it can be put, will be found on pages 46 to 54 of Mr. Gartrell's book on Continuous-Gum Work and Porcelain Crowns.

The electric furnace, when used for continuous-gum work, has not proved as great a success as was anticipated, and so far as I can learn, it is far slower in action than either of Mr. Gartrell's furnaces. The time taken to heat a full-size case before fusion can take place is forty-five minutes. This slowness of action is due to the caution necessary in slowly turning on the current, else the wires embedded in the fire-clay will melt under the great strength of the electric current employed. There are many models of the electric furnace in the market, British, American and German; but by the mere cost in current this class of furnace is placed at a great disadvantage, when compared with the trifling expenditure in petroleum, gas, or benzoline, as used in Mr. Gartrell's apparatus which I have illustrated and described.

Those who use the electric furnace think that there is nothing to equal it, while those who use the latest forms of Mr. Gartrell's furnaces, with nickel muffles, are equally persuaded that work, in no way to be distinguished from that made in the electric furnace, is made in his furnaces. I have not only seen these at work under his own hands, but I am myself using them in my own workroom, and I find them superior to other forms with which I have lately been experimenting, as well as economical in cost of working.

CHAPTER XXIV.

CLEFT PALATE.

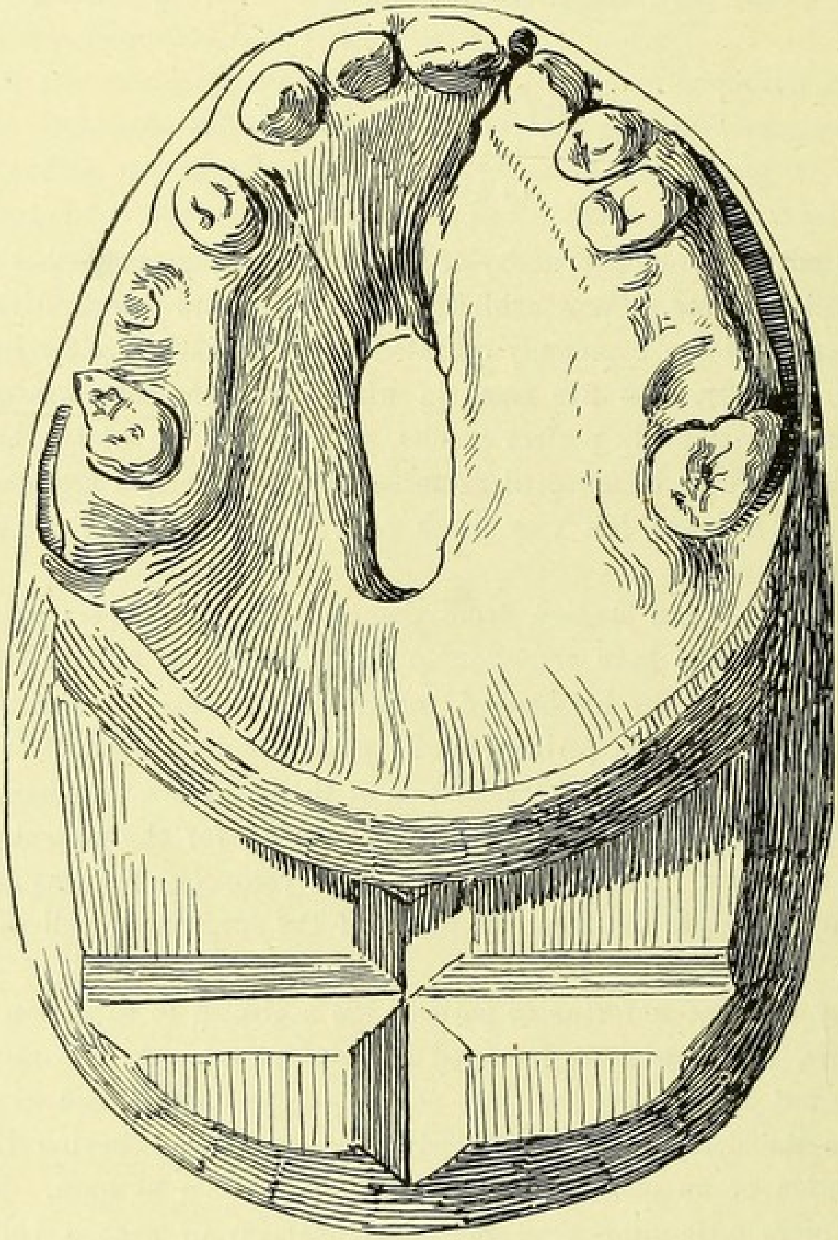
I HAVE not had the opportunity of seeing or treating many cases of congenital cleft palate. Cases exhibiting this defect are comparatively rare in Ireland, and are commonly operated on at an early age by surgeons. I have, however, seen five cases in which the deformity was operated on with approximately perfect results, so far as union of the hard and soft palates are to be accepted as success. The defective articulation in speech was, however, left very much as it had been before the surgical treatment.

I have read and studied, from time to time, the papers written by those dentists who have endeavoured to encourage us to deal with this terrible deformity by mechanical rather than by operative means. If these authors have not, perhaps, shown us an absolutely perfect or certain way of improving the vocal articulation of their patients, they have shown us conclusively that surgical methods do nothing for the patient beyond uniting the parts. The indistinct and nasal voice-tone remains as it was before operation, to the disappointment of the surgeon as well as of the patient.

Many of these unfortunate patients are neglected in education and in social life, by those more favoured in development. As a consequence, they are not taught how the voice sounds are produced,—and when they apply to the dentist for mechanical aid, they come believing that the construction of an obturator will give them a voice at once. Nothing can be more misleading than the encouragement of such a belief. It should be explained to them that it is only by their own efforts, with the aid of a well-designed obturator, that success in distinct articulation is possible.

I have seen three cases in which soft vulcanite vela were used by other practitioners. This pliable material is supposed to offer many advantages in the treatment of cleft soft palate,—but I must confess to being disappointed with the results, judging from the speaking powers of these

FIG. 160.

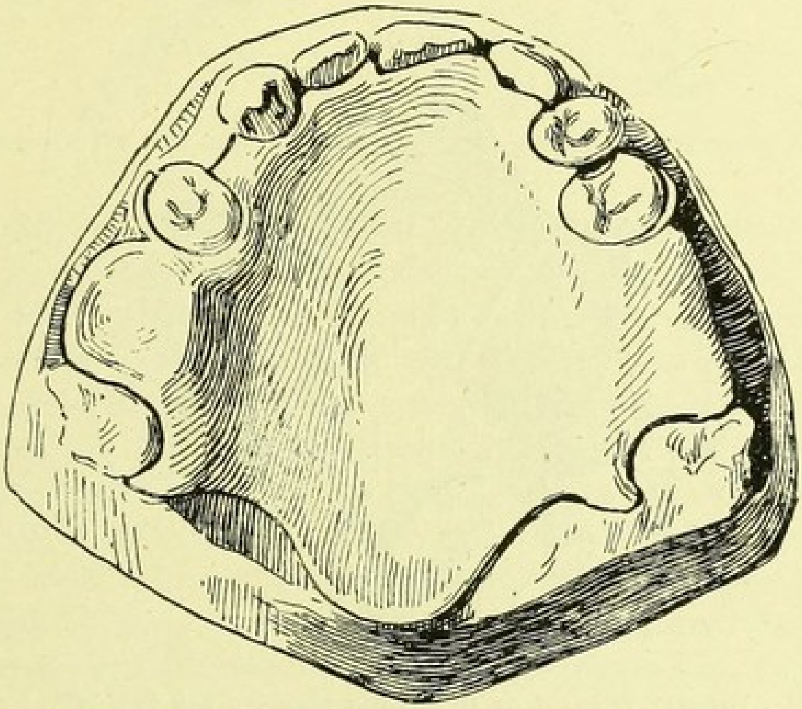


CAST OF CLEFT PALATE.

patients. The cases which I have been asked to treat seemed to me to offer better opportunities of success with *hard* vulcanite, rather than with soft, as the divided curtain of soft palate could be trained by the patient to close together, if a smooth support were given on which it could close. Such an obturator can be designed without any movable or working parts.

To design a simple apparatus is not an easy matter. Since the development of elaborate obturators by Dr. Norman Kingsley and others, it would seem as if a dentist were not doing his duty to his patient if he fail to follow in their footsteps.

Fig. 161.



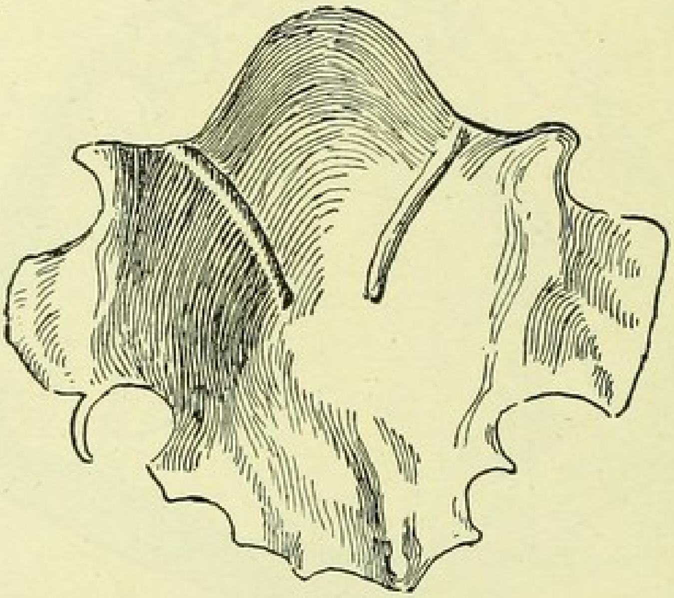
Lingual Surface of Obturator designed for Fig. 160.

I have endeavoured, however, to treat this deformity by simple mechanical means,—and, although I cannot offer a large number of cases, the results have been gratifying to my patients. I give drawings of cases in which a simple form of plate has enabled two patients to communicate with others, in business and in the social circle, without comment or ridicule.

The first case which I illustrate (Fig. 160) is that of a male patient, who has for some eight years been wearing the obturator figured in the illustrations (Figs. 161, 162). The mechanical treatment has been of great assistance to him, and has enabled him to improve his position in the business house in which he is employed. His is a congenital fissure, through hard and soft palates of a wide type, running from the left side of the maxilla into the soft palate. His hare lip was operated on and closed in infancy, but nothing was done for the closure of the hard or soft palate till he had reached his twenty-third year. The wide cleft of the hard palate was operated on by a skilful surgeon without success, but the soft palate was perfectly united.

The patient was deeply mortified at the failure of the operation on the cleft in the hard palate, as he found his lack of power of articulate

Fig. 162.

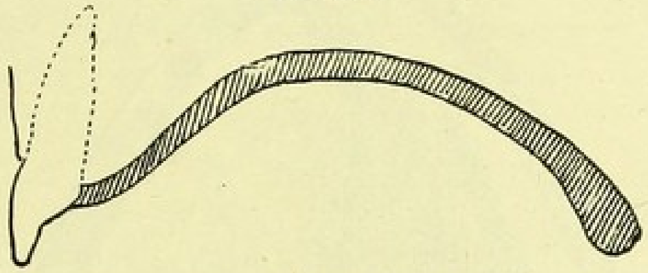


Palatal Surface of Obturator designed for Fig. 160.

speech very much as it had always been. His opinion was that the tense, drum-like velum was not a benefit to him from any point of view.

He was afterwards sent to me by the surgeon to do what I could for him. The nares and back of the pharynx were very irritable, and covered with bright-coloured granulations. I noticed that he spoke with an indistinct, muffled tone, and that the left nostril closed like a valve and shut off the escape of air through the nose. Speech was accompanied with much facial grimace, and the intonation was more easily understood when the nostrils were closed by the action of the thumb and forefinger. I had to make a special tray to obtain an impression of the parts, which was only secured after many failures, owing to the extreme irritability of the divided palate and the fauces. It was not till I had got the patient to train the parts, by touching them many times a day, that I could obtain a satisfactory impression. This was cast in plaster, and a bite was taken, the teeth of the mandible being nearly perfect in number.

FIG. 163.



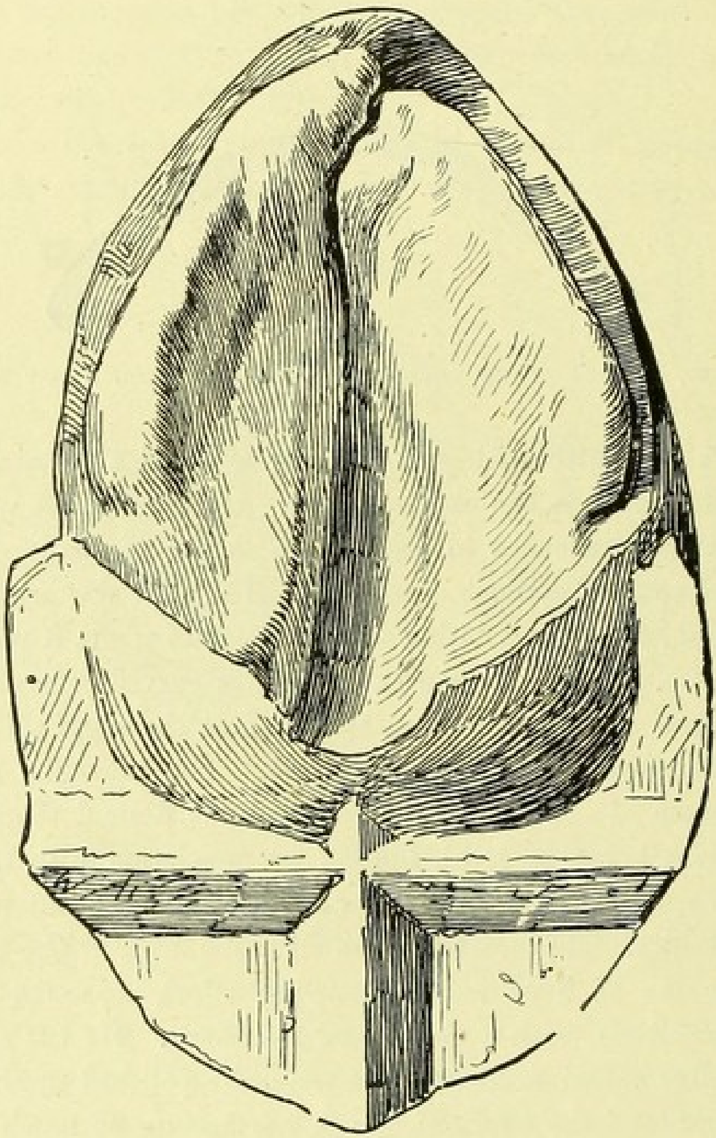
SECTION OF FIG. 161 DRAWN THROUGH MIDDLE LINE FROM FRONT TO BACK.

The cleft was filled with wax, making as good a restoration of the contour of the palate as the case admitted. On this surface was modelled a plate, which was extended in a curved, beak-like way as far back as the patient could swallow without discomfort. The plate was articulated with the lower teeth, the patient biting on the vulcanite where it was thickened for the purpose. This beak-like extension was curved somewhat like the bowl of a spoon, and was bent and thickened at the edges till the patient could swallow solids and fluids with ease. The beak-like surface was altered a couple of times before it assumed the desired shape.

The patient began to teach himself pronunciation with the aid of a child's primer, and followed on by practising syllables and words of increasing difficulty. He took lessons in elocution, and, at the end of some eighteen months of hard and persevering effort, mastered the art of speaking articulately, with a good nasal resonance. He has educated the tense, drum-like velum to grasp, as it were, the polished upper surface of the obturator; and the effort of speech has become so much easier, that the nostril does not now close as it did, nor does the patient use the facial grimaces which I noticed when he first came to me. He has lost the tendency to cold in the head peculiar to such cases. I see him enjoying the company of other young men, and able to hold his own in a war of words.

I had to cut the channels or grooves seen on the upper surface, after the case had been worn about a month, to guide the discharge of mucus to the part of the obturator where it could be easily and automatically swallowed, drop by drop. Until these gutters were provided the mucus used to collect above the obturator, and prove an inconvenience when he spoke or coughed.

Fig. 164.

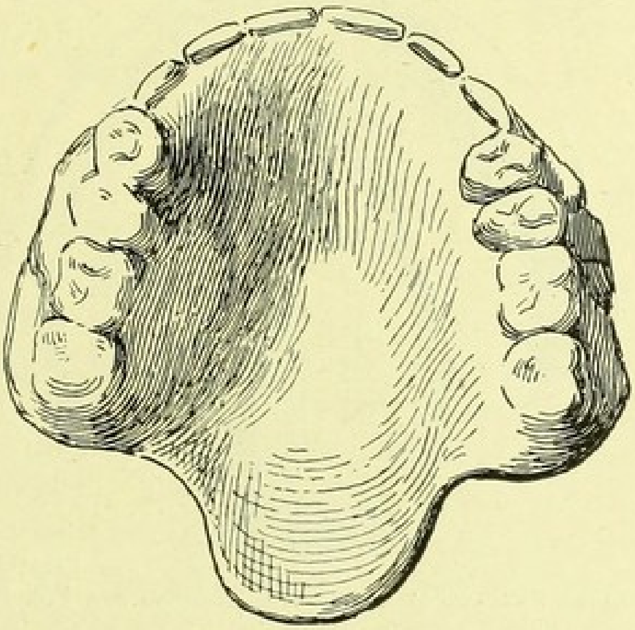


Cast of Edentulous Cleft Palate.

During the past winter, I have treated a lady patient for a similar congenital cleft in the hard and soft palates (Fig. 164). She was operated on for hare lip in infancy, and was considered, at the time and for many years after, as beyond the reach of surgical skill.

The case has one peculiarity which I had never before seen in the various cleft palates which I have examined in life, in plaster casts, and in museum preparations. The patient is edentulous, her jaws are of moderate size, and she has a very small mouth. She had suffered much at the hands of many dentists, and came to me much emaciated, with the pained expression of face which we so commonly associate with badly fitting work. A study of the mechanical appliances which she had tried to wear was not encouraging from the patient's point of view, as they all showed a lack of understanding of the nature of the case, particularly in the position of the springs.

Fig. 165.



Lingual Surface of Obturator designed for Fig. 164.

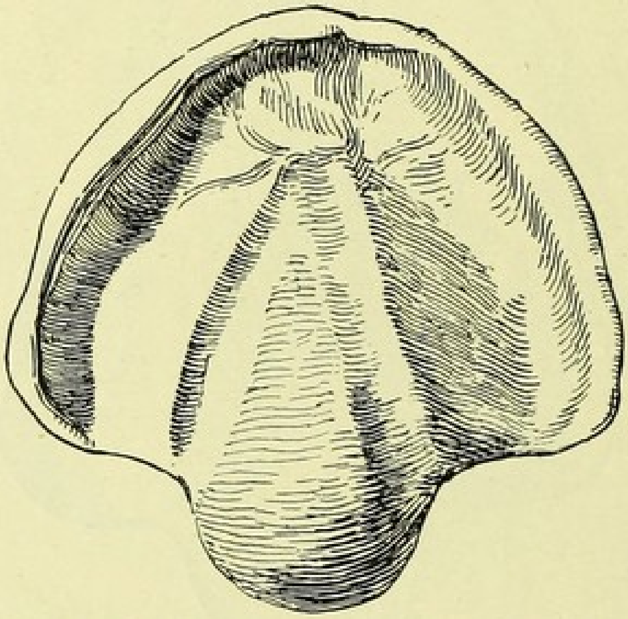
This poor patient was so much discouraged with her experiences of mechanical assistance, as supplied by several "eminent dentists," that she was far from willing to go again through the trying ordeal represented by the various stages of construction and adjustment of an obturator and a denture.

I examined the case with deep interest, for I had never before seen a congenital edentulous cleft palate. Taking an impression with Crown composition was not easy, owing to the smallness of the mouth and the nervousness of the patient, who did not, happily for herself, suffer from nausea, as did the other patient in the case which I have just described.

Having secured good impressions of the jaws, I had them cast in plaster, and the bite was taken on a following day on fusible metal plates.

Having gathered all the useful data which I could, I undertook to construct for the patient an experimental case, to be worn for some weeks or months, as circumstances might permit. A permanent case was then to be designed with the riper experience gained, during the construction and adjustment of the experimental case.

FIG. 166.



PALATAL SURFACE OF OBTURATOR DESIGNED FOR FIG. 164.

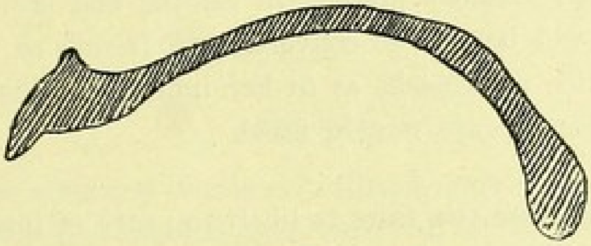
The denture with obturator (Fig. 165) had to be held in position by the aid of spiral springs, and, as the natural bite was "eccentric," great care had to be taken in mounting the teeth as well as the swivels for the springs.

The dentures were modelled in wax, built on the fusible metal plates, and tried in with the springs and swivels in position. This was an anxious time, as the risk of undermining the teeth set in the wax with the viscid saliva was very great. The face had been very much disfigured with the work previously worn, the hollow under the lower lip having been changed into a swelling.

The articulation of the mounted teeth was found to be correct when a swallowing action was repeated several times with the aid of cold water.

The patient has the peculiarity of being able to sip only a teaspoonful of fluid at a time, and this added to the difficulty of determining the correctness of the bite, as did also the smallness of the orifice between the lips. The only change that was necessary in the obturator was the

FIG. 167.



SECTION OF FIG. 165 DRAWN THROUGH MIDDLE LINE FROM FRONT TO BACK.

shortening of the curved beak-like ending, which covered the divided curtain of the soft palate. The end touched the tongue, and the patient complained of not being able to swallow. As it had been cast in fusible metal, it was quickly shortened with a hot tool.

The edges were rounded and smoothed, and tried again. The case was invested, packed, vulcanised, polished, and finished, with the gratifying result that the patient could eat almost at once; swallowing food presented no difficulty. In the course of a couple of days the patient felt the want of the curved beak as originally modelled; this was then added. The only defect was the bite, owing to the lower jaw having been slightly protruded when I was clamping the wax bites together with the wire staples. A little adjustment with the aid of the grinding lathe corrected this and allowed the patient to use the denture in mastication from the beginning.

The patient's health had suffered so much from loss of masticating power, that I encouraged her to give her whole attention to learning how to eat, and not to be too anxious about learning to speak. The adjustment of pressure spots on the lower denture occupied three sittings, with the result that she returned to her home, having lost the anxious and pained expression with which she had come to me.

The patient has now acquired a voice, her progress in nasal resonance being very satisfactory. She has been able to pay some visits away from her home without distress to herself or her hosts, and she appears bright and happy, with the clear healthy look of one whose food nourishes her.

I have recently completed the permanent case, guided by the information which I gained from the experimental one, with the gratifying result that the lady is able to eat with comfort, and that her powers of articulate speech are becoming more confirmed every day. I hope to find that, with due and sedulous practice in reading and pronunciation for a few months, she will be able to converse with friends or visitors, without exciting any notice or remarks as to her infirmity. The *quality* of the voice must, I fear, always remain nasal.

I have figured these two cases as likely to prove of interest to some of my professional brethren. I have also drawn a section of each case as it would show if cut through the middle line from before backwards. I have not seen any obturators made in this simple form in the mouths of patients, or figured in the books or papers which I have read on this subject.

The upper side of the spoon-like projection, and indeed the whole palatal surface of the upper denture, should be well polished,—else thick adhesive mucus will adhere to the plate, and cause the patient much discomfort.

The shaping of this surface needs great care on the part of the dentist to prepare it for the divided soft palate to act on. Delicate adjustment and repolishing of the thick round edges are necessary at first, but a few visits will suffice for all to be done that is needed. Once the patient has learned to use the apparatus with tolerable comfort, he or she will be found to have become very nice and discriminating as to the accuracy of adjustment, and where it should be effected on the well-rounded edges.

CHAPTER XXV.

REPAIRS.

THE subject of repairing damaged artificial dentures is one upon which very little stress has hitherto been laid, but it is, nevertheless, an exceedingly important one to the practitioner.

It will be obvious to sensible mechanical minds that it is well for the dentist to confine himself, as far as possible, to one process, in the construction cf a denture. In metal work, for instance, he should confine the methods of construction to tube teeth, to plate teeth, to plate and tube teeth combined, or to vulcanite attachments.

A combination of plate teeth, with vulcanite attachments for the bicuspids and molars, involves a great deal of trouble and delay in carrying out a repair, should a front tooth be broken off the plate. The plate teeth have to be soldered to the plate by means of heat,—while the vulcanite, of course, will not endure the high temperature necessary for the soldering, and has to be destroyed.

Repairing a broken plate tooth by means of vulcanite is a clumsy and insecure way of treating such a breakdown when there is a close bite. It takes time and skill to remodel teeth held to a plate by means of vulcanite, should it be necessary to displace the latter; and the practitioner may be sure that, no matter what care is taken, he will have an uncomfortable time with the patient in adjusting the bite.

In repairing metal work, in the case of a broken pin carrying a tube tooth, the following procedure will be found advantageous. First, the teeth should all be carefully examined. Any tooth which is broken or flawed should be pointed out to the patient before the work is taken in hand for repair, so that the practitioner may escape unmerited blame for breaking or damaging the tooth or work during the process of repair. The examination concluded, the plate with the teeth should be held with a pair of pointed-nosed pliers; and care should be taken that the plate is not bruised or bent by too vigorous a grasp with the pliers, and that it is gradually heated till the cement is melted.

The tooth or teeth should then be gently removed with the aid of an old forceps, or with the fingers protected by a cloth. The teeth, having been removed, are placed in a curved row on the bench in the order in which they are taken off the plate. The plate is then annealed, dipped in hot pickle, and rinsed in boiling water.

The broken pin can now be attended to. If it is broken close to the plate, or torn out of the plate, it can sometimes be replaced and soldered on; but in case this cannot be done, a piece of wire of suitable length is measured in the tube of the tooth to replace the damaged or missing pin. The end of the broken pin should be filed almost level with the plate, and the centre of the pin should be carefully marked, so as to afford a starting point for the use of the drill; the plate is then drilled, and the end of the pin is scraped, trimmed, and inserted, with the aid of a little borax, into the position in which it is intended to be soldered. Some use cramps to hold the new pin in position, others use sand and plaster as an investment, and others again use binding wire. Two or three small panels of solder are placed on the pin close to the plate—touching it, in fact—and the process of soldering is gone through, care being taken not to melt or sweat the neighbouring pins.

When the plate has cooled, after being soldered, it is carefully examined to see that the solder has flowed to both sides of the metal. The short part of the pin found projecting on the concave side of the plate is carefully cut away with a sculptor,—or it may be dressed down level with the surrounding gold with the aid of a grinding point in the dental engine. The teeth that are taken from the plate are all carefully cleansed from the discolouration caused by the heat carbonizing the food, or by secretions left on the surface, as well as by the sulphur cement.

A broken tube-tooth denture can be readily repaired by replacing the broken tooth with one similar in colour and size. The tooth is fitted on the pin and the plate in the same way as described in mounting tube teeth, by the alternate painting of the surface, grinding at the lathe with carborundum or corundum wheels, and letting it down to the bite. It can then be cemented in position with sulphur, or with mastic and silk. The teeth can now be re-sulphured in their proper positions on the pins, and the work can be polished.

In repairing broken pin teeth, the damaged tooth with its back is removed from the plate, and a suitable tooth with a back is selected to replace it. The tooth is ground to fit the mouth, and the denture, with the new tooth, is carefully waxed to the plate, placed in the mouth, and adjusted to suit the position which it is intended to occupy. If the position is found to be satisfactory, the plate is then removed from the mouth, slightly invested in plaster and sand, or plaster and pumice, and the tooth is soldered to the plate in the way already described.

It takes more time to vulcanize attachments, if a metal plate, with which they are used, is broken or damaged. Although broken teeth can be as easily vulcanized to a plate as in the case of an ordinary vulcanite denture, if any of the metal work is damaged, it is often necessary to dismount the entire work, repair the damaged metal plate, and then renew the vulcanite.

To undertake a repair of this kind needs the expenditure of from three to five hours ; and it is not an uncommon thing to meet with patients who want it done in twenty minutes. The point to be dwelt upon, therefore, is that a dentist will be wise to construct his work always with a view to its being repaired. If he will bear in mind Henry Maudsley's ideas of building a steamer, and regard "the come-at-ability of parts," he will be more esteemed by the patient than the man who constructs his denture without any regard to the possibility of a disaster.

VULCANITE REPAIRS.

Vulcanite, like other dentures, is exceedingly subject to accidents, and a fall or blow may in an instant break a case, which a patient has worn for several years with comfort. Injured cases are not uncommonly sent by post, accompanied by an urgent letter to the effect that the patient cannot do without them, and that they are to be repaired and returned immediately, if not sooner.

In repairing vulcanite cases a distinction has to be drawn between the injuries that happen from a fall, a sudden blow, or other casualty of this kind, and the alterations that are rendered necessary by a change in the form of the jaw on which the work is worn.

It is not an uncommon thing to find in vulcanite uppers, which have been worn for five or six years, particularly where two or three teeth remain, and also in some forms of edentulous maxillæ, that a fracture extends from the centrals or laterals to the posterior margin of the palate. Fractures of this kind are sometimes unsatisfactory to repair, because, during the absence of the work from the mouth, the patient has time to learn that a great change has taken place, and, no matter how exactly and carefully the repair may be executed, patients will invariably complain that the denture has been spoiled or altered. This cause of fracture is a simple one, namely, the want of support on the alveolar border on which the vulcanite rests. The pressure from the lower jaw brings the pressure to bear on the centre of the palate, and a very slight accession of pressure will first tear or crack the case between the central or lateral teeth. This tear or crack, as the pressure is continued, gradually extends across the plate until it is broken into two pieces.

The best method of *repairing* an accident of this kind is first to examine carefully the broken surfaces, and see that the edges have not been bruised in any way. The broken parts of the denture should be held exactly in position close to the Bunsen burner, while a fellow-workman or assistant drops some sticking wax on the lingual surface of the fracture. The denture is held until the wax toughens, when more wax can be cautiously added to the surface. The wax is now carefully cooled, so that, if it should contract, it does not open the other or gum side of the fissure. The surface of the plate which covers the jaw is now filled with some plaster of Paris, with a view to making a temporary model. When the plaster is thoroughly set, the broken denture can be removed from the model thus made. The denture is now removed from the plaster model, and the workman can either cut a series of dovetails or drill a number of holes in it, as his experience may dictate, in order to make a fresh joint, the great point to remember being that the surface of the vulcanite must be cut away, for at least a quarter of an inch on each side of the fracture, in order to ensure the adhesion of the new vulcanite to the old. If the surfaces are not carefully prepared in this way, it is a certainty that complete attachment will not take place, and that the new vulcanite can be chipped or peeled off the denture.

Many dentists repair these fractures by means of a plate of gold and some rivets. A light piece of gold or platinum is carefully fitted by hand across or along the entire surface of the crack. Suitable holes are drilled in the metal plate to take rivets of soft gold or platinum, which are generally riveted in pairs so as not to disturb the fit of the plate.

Riveting work of this kind requires a great deal of skill, and in repairing a case by this method, in a workmanlike and skilful manner, almost as much time is occupied as if the case were being re-vulcanized. By the aid of fusible metal a die and counter can be quickly made with which to stamp the gold plate to fit the vulcanite, as recommended by Mr. R. P. Lennox in his practical book. It is better to vulcanize in all cases, if time will permit, as with neatness and skilful treatment a repair can be made quite presentable, as in some rubbers the change of colour is not very marked.

Dovetails, holes, or undercuts, such as the workman may desire to use as retaining points for the rubber, are carefully cut. The parts of the broken denture are placed on a plaster model, and sticking wax or any other adhesive material can then be dropped on the repaired surfaces and neatly trimmed. When this is done, the broken denture can be invested in a flask, as if the work were quite new, the wax scalded out, replaced with warm and softened rubber, and the flask with its contents placed in the steam chamber for vulcanization. The usual routine is then adopted of trimming and polishing the freshly vulcanized surfaces.

When the trimming and polishing are complete, care should be taken to try whether the repaired denture will fit the model—as, if it should have warped from careless handling or too rapid work, it is certain that the patient will complain very loudly, and possibly the work cannot be retained in place. If warping should take place from careless handling, the denture should be boiled in either oil or water, and rapidly pressed on the plaster model till it cools.

The shot swager, designed by Mr. J. H. Gartrell, will also bring a warped denture into place on a plaster model. Another method is to place the repaired denture on the model and warm it over a spirit lamp while it rests on the model; then to press it carefully into position when the vulcanite yields from heat. Once the parts are brought into their true position, the denture, with the plaster model, should be put under a tap of cold water, in order to chill it or shrink it into place.

Another way of repairing a broken vulcanite case is to cut away the vulcanite in which the platinum pins of the tooth were embedded, and to make a dovetail into which the new rubber is to be packed. Care should first be taken to scrape the surface of the vulcanite around the margins of the intended dovetail, so as to remove any greasy matter which would prevent the adhesion of the new rubber to the old.

The new tooth having been selected, it may be fitted into the socket of the old one. If the new tooth should not be of the same pattern or mould as the one which it replaces, it may be necessary to cut away a portion of the vulcanite on the labial aspect; but, if it should fit with tolerable accuracy into this cavity, it is not necessary to cut anything away.

Having been ground down to the proper length, it may be held in position in the cavity by means of modelling wax, which is trimmed to the level of the surface of the vulcanite on the palatine aspect, while around the cervical margin of the tooth a solution of pink rubber and chloroform may be painted with a brush or spatula. The case may then be flasked, as if a new case were being packed; but it is not necessary to leave the entire palatine surface of the plate exposed, only sufficient being exposed to allow of the packing of the new rubber. By this plan it is considered that the denture is less liable to warp during a second vulcanizing.

In order to do away with the necessity of waxing the teeth to the plate, and scalding out the wax again and packing fresh rubber in, some dentists prefer the quicker method of packing before investing the plate in the plaster. To do this, it is necessary, as in the preceding plan, to cut a dovetail in order to fit the teeth to the socket,—and, having done so, to smear the cavity and the edges of the dovetail with this solution of rubber and chloroform. The tooth is now held in position by the fingers of the left hand, while portions of freshly warmed rubber are packed into the cavity around the necks of the teeth with a heated spatula or probe-pointed packer.

When sufficient or a slight excess of rubber is packed into the cavity, the surface may be smoothed with a flat spatula warmed in the Bunsen flame, and more of the liquid rubber should then be painted over the surface.

The case may now be flasked, and will need only one mixing of plaster of Paris for this purpose. The cup of the flask being filled with plaster, the concave surface of the case is also very carefully filled with the same material, as if a cast of an impression were being taken, and the entire surface of the denture is then likewise carefully covered with the liquid plaster. Then, when the plaster is setting, the denture is placed in the cup in such a position that it will not touch the side of the flask, or else it may become burned by resting against the metal.

The second portion of the flask being filled with the remainder of the plaster of Paris, the two parts are closed together, and the excess of plaster is squeezed out. When the plaster of Paris is set, the flask may be clamped and put into the vulcanizer. This method of repairing a broken tooth will save, on an average, about half an hour's time; but where repairs are extensive, and several contiguous teeth have to be replaced, it is better to wax them in position as in the first description.

When vulcanite is used on an upper denture in which the front teeth are soldered, the following plan may be adopted in order to avoid the necessity of stripping off the vulcanite when one soldered tooth is broken. The backing of the broken tooth is filed away with a square-edged file, and the surface of the plate may be removed, leaving an elevated ridge on either side,—in other words, a shallow furrow may be cut in the surface of the gold about half an inch long and the width of the missing tooth.

A piece of gold plate, of the same substance as that from which the plate is made, should next be fitted into this furrow, and held in position on the plate while the points where the rivets are to be placed are marked on the superimposed piece of gold. Holes may be punched or drilled to fit the soft gold wire. This piece of gold is again placed in position in the furrow, and the places for the holes are marked to correspond on the plate with a piece of wire or a pencil. These points are drilled through the plate, gold wire is now soldered into the pieces of gold, and passed again through the holes in the plate. If care is taken in marking these points for the rivets, the added piece of gold will fit accurately into this furrow, and the pins will protrude through the holes in the gold denture.

The selected tooth is backed and fitted to the plate, and is attached by means of sticking wax or hard wax to the new piece of gold. When the wax is chilled, the tooth and gold tongue may be removed by pressing the free ends of the rivet out of the holes in which they lie in the denture. The tooth, with gold tongue, is now invested in plaster of Paris and sand,—and, the wax having been scalded out, the tooth is soldered to the metal tongue. When the tooth attached to the small plate is cold, the investment is broken away from it and placed in the hot pickle. The tongue of gold with the tooth is now tried on the plate to see that it fits accurately,—and the plate, having been placed on the model, may be riveted to the tongue carrying the new tooth. All edges should be carefully rounded off, so that the patient's tongue may not be injured, and the case polished and finished. If the pins are judiciously placed, this will form a strong repair,—in fact, almost as strong as if the teeth were soldered to the plate itself.

Another, though not such an efficient, method of effecting these repairs is as follows:—The backing of the original tooth is left intact in cases where it is not broken off with the tooth; a tooth of the same size and pattern is obtained; the exposed backing is then drilled through where the pins of the new tooth will fit it, and they can then be riveted to the lingual surface of the backing, and the surface burnished down with an onyx burnisher.

Sometimes, in cases where vulcanite and gold are used in combination, a tooth may be added to the denture, or a fractured tooth can be replaced by the aid of vulcanite alone,—but this should not be attempted unless the bite is open enough to allow of vulcanite being left of sufficient strength to hold the tooth securely, or unless the added vulcanite can be brought into contact with that already on the plate.

A broken spring is a mishap that patients expect to have attended to very promptly, and such a break-down is best relieved by placing a new pair of springs upon the dentures. In the opinion of many dentists, this is an extravagant way of meeting such a difficulty, but there are few patients of intelligence who will not prefer a new pair of springs to having a new spring set to work with a worn or distorted one. No matter how carefully the resilience of the new spring may be calculated, there is a very great difference in the elasticity of an old or worn spring and a new one.

I have had many cases under my observation where the broken spring was replaced, with the unpleasant result that the worn spring did not sustain the dentures in their position with the same firm support given by the new spring.

The denture on the mandible, particularly in cases of very great absorption, usually "slews round," as a sailor would say—*i.e.*, rotates towards the side on which the weaker spring is to be found, and causes a good deal of tenderness and irritation on the mucous membrane. This tenderness disappears when springs of equal strength or resiliency are used instead of springs of unequal power. The springs placed in the market vary a good deal in quality, and gold springs should be used in preference to any of the cheaper but less elastic kinds.

A broken swivel is a much more serious disaster than a broken spring, and there are two ways of replacing the worn-out swivel,—one is by bending the end of a piece of wire that will fit the calibre of the spring into a loop, which is left open enough to pass a hook on to the bolt. The loop of the new, or "London" swivel, as it used to be called in my youth, was suitably flattened and bent with a hammer and punch, so that when it was filed into shape the workman had only to close the loop and make it grasp the bolt inside the head. Care was taken that the unclosed part of the loop was placed in the situation most removed from stress of wear, so that in the lower denture the slit was *below* the bolt, and in the upper denture *above* the bolt.

The depôt swivel can be used for effecting a repair by cutting a slit in the loop with a thin piercing saw, gently opening it till it will slip on the bolt, and then closing it with the pliers. Care should be taken, as recommended above, to place the slit upwards on the upper bolt and downwards on the lower bolt.

APPENDIX:

CONTAINING

CLASSIFIED LISTS OF TOOLS

SUITABLE

FOR USE AT THE VARIOUS BENCHES

IN THE

DENTAL WORKROOM.

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Gold Bench, Tool Racks, and Tools.

TOOLS FOR HOLDING OR BENDING METAL.

Pliers with Jaws shaped as follows: Square, Pointed, Half-round, Oval and Hollow Chop;
Sliding Tongs, Hand Vice, Pin Vice, Tweezers or Corn Tongs, Spring Pliers, Swivel Pliers, and Parallel Vice.

TOOLS FOR CUTTING METAL.

Straight Shears, Bent Shears, Cutting Pliers, Plate Cutters (often called "Nippers"), Piercing Saw, Metal Saw, Small Brass-backed Saw, Scissors, Engraver's Scraper, Screw Plate, and Taps.

TOOLS FOR PERFORATING OR DRILLING METAL.

Young's Adjustable Perforators for Punching Two Holes at Once for backing Pin Teeth, Pin Nippers, Tube Pin Perforators, Drill Bow, Drills set in Drill Stocks and Spindles, Loop Punch, and Broaches.

TOOLS FOR SHAPING METAL.

Steel Punches, Bossing Hammer, Riveting Hammers, Copper-headed Hammer, Flat, Picking, and Reeded "Scorpers," Graver, Gold Files, Dividing Files, Reamers or Countersinks, Dividers, Scriber, Round Point, Beak-Iron,
"Steady" Block of Lead with Wax Surface for Riveting or Fitting Backs,
Steel Steady, Broach Handles with Screw Three-jawed Chucks,
Copper Punches,
Wire Brush for Cleaning Files, Dental Engine, and Used Burs from Surgery.

TOOLS FOR MEASURING METAL.

Gauges for Plate, Wire, etc., etc.—Boley's, Ash's, and Stubs'.

Zinc Trays for Catching Lemel or Filings of Precious Metal.

TOOLS FOR SMOOTHING OR POLISHING METAL.

Steel or Agate Burnishers, Hand Polishing Buffs, Water-of-Ayr Stone, Hindostan Stone, Arkansas Stone, and Slate Pencil.

TOOLS FOR SHARPENING.

Oil Stones, Oil Can, and Grindstone and Trough.

ASH'S SET OF TWENTY-FIVE TEETH SHADES.
THE S. S. WHITE MANUFACTURING COMPANY'S TEETH SHADES.
THE DENTAL MANUFACTURING COMPANY'S SET OF SHADES.
WORKROOM SEAT, ADJUSTABLE AND REVOLVING.
FORMULÆ AND RECIPES.

GOLD BENCH—*continued.*

TOOL RACKS AND TOOLS.

Fig. 168.

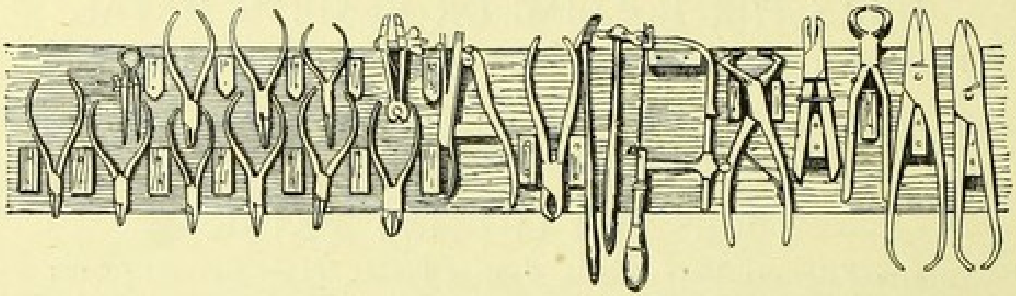


Fig. 169.

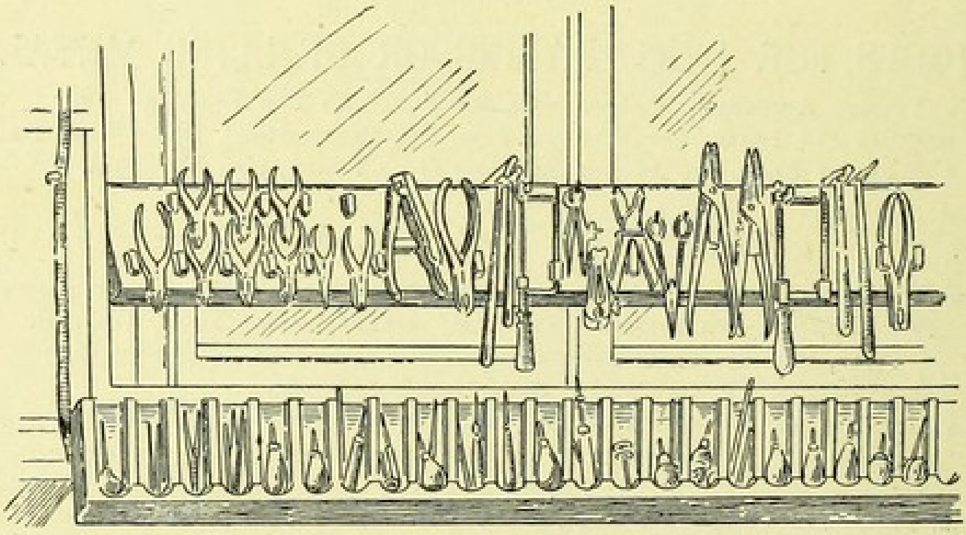
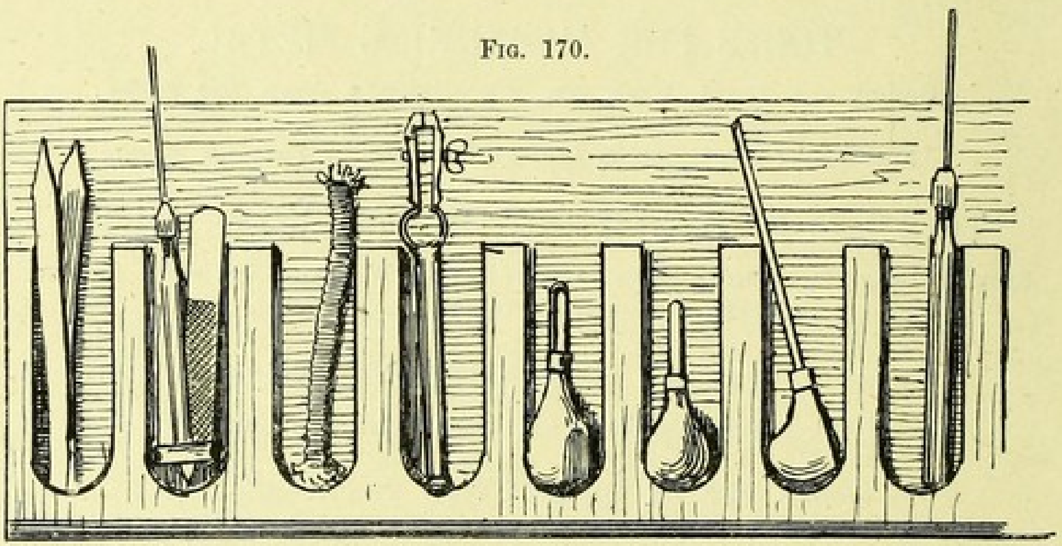


Fig. 170.

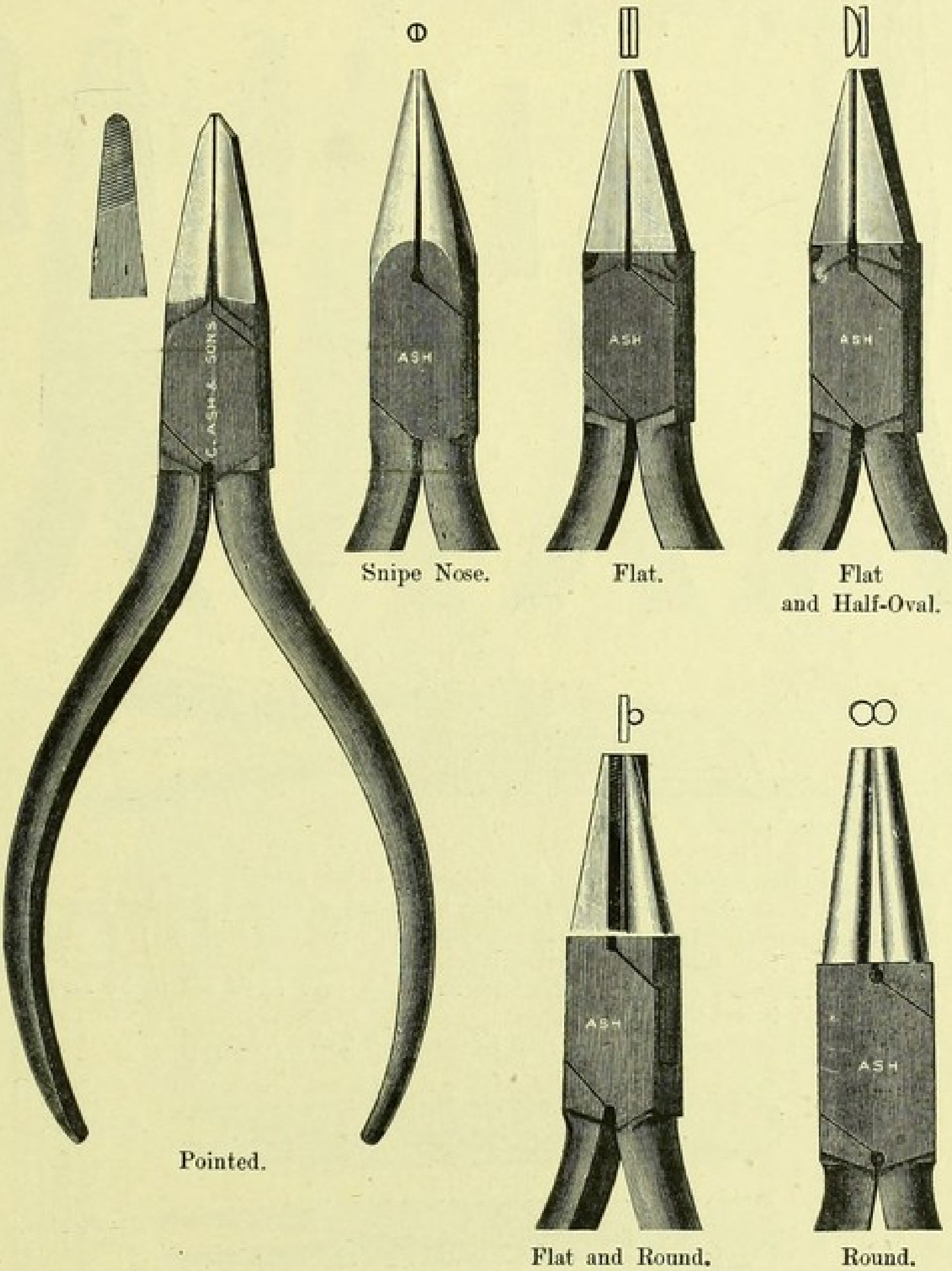


Figs. 168–170.—Tool Racks designed and used by the Author (see also pages 22, 330 and 372).

GOLD BENCH—*continued.*

TOOLS FOR HOLDING AND BENDING METAL.

Fig. 171.—Pliers, various (Stubs').



Of these Pliers, the two sizes most generally used are the $4\frac{1}{2}$ and 5 inch lengths.

GOLD BENCH—*continued.*

TOOLS FOR HOLDING OR BENDING METAL, ETC.

Fig. 172.

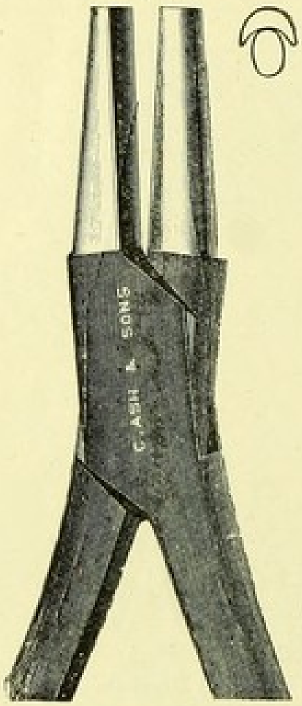


Fig. 173.

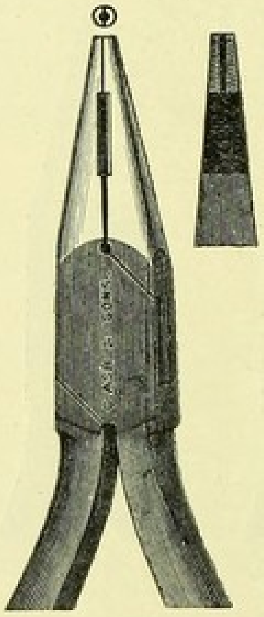


Fig. 174.

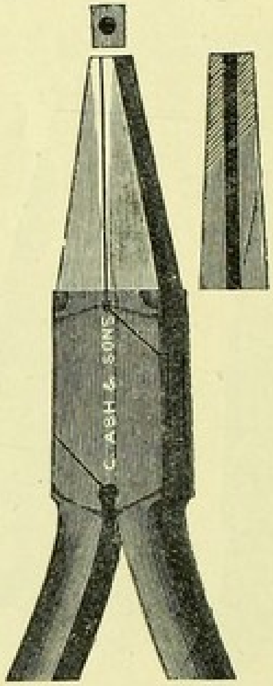


Fig. 175.

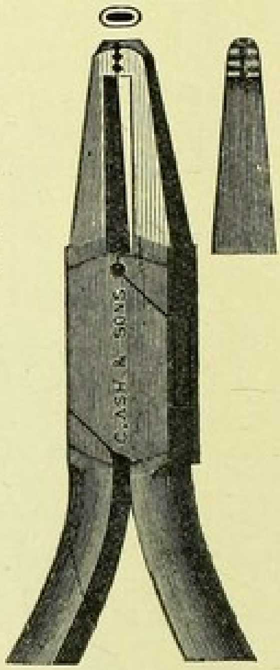


Fig. 176.

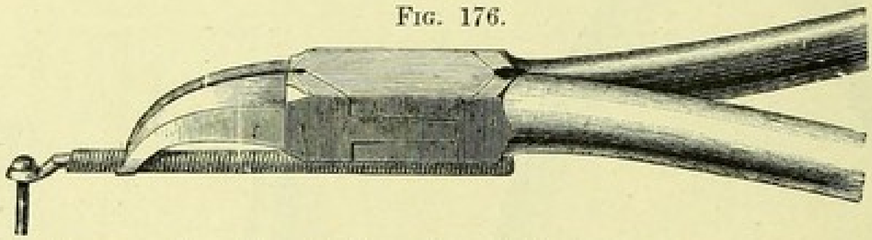
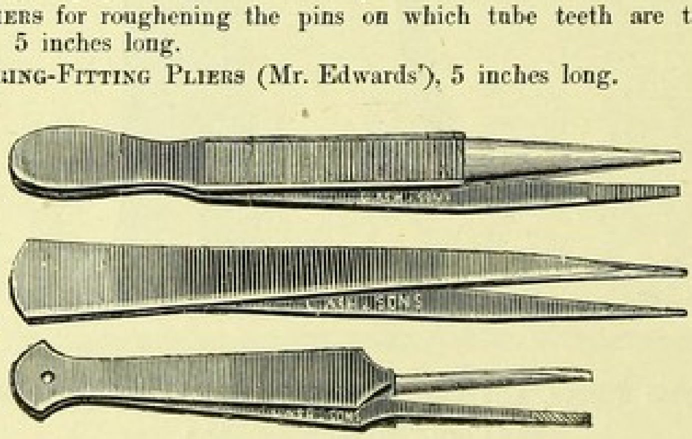


Fig. 172.—Pliers with oval and hollow chops, 5½ inches long.
„ 173.—Pliers (Mr. Miles's) for reducing the tangs of swivels, 5 inches long.
„ 174.—Grooved Pliers for bending the pins on which tube teeth are to be mounted (see page 140), 5 inches long.
„ 175.—Pliers for roughening the pins on which tube teeth are to be mounted, 5 inches long.
„ 176.—Spring-Fitting Pliers (Mr. Edwards'), 5 inches long.

Fig. 177.

Tweezers, also called Corn Tongs.



A—Blunt.

B—Pointed.

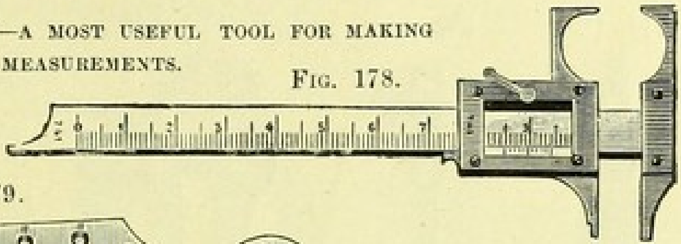
C—Blunt.

GOLD BENCH—*continued.*

GAUGES AND PLATE AND WIRE PATTERNS.

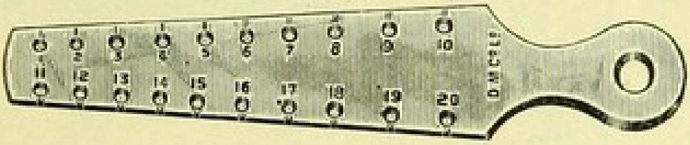
Boley's Millimetre Gauge—a most useful tool for making accurate measurements.

Fig. 178.



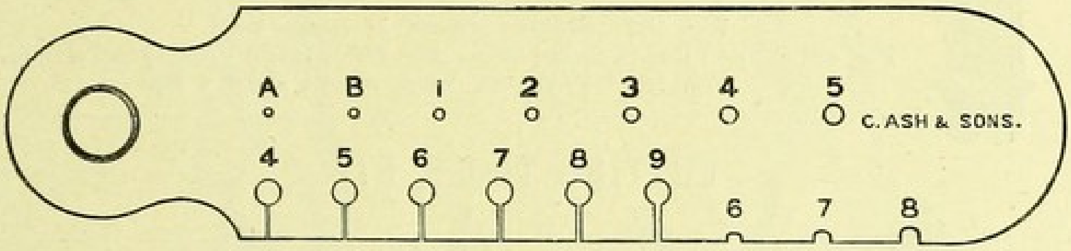
Length: 131 mm; measures up to 100 mm.

Fig. 179.



Stubs' Plate Gauge.
Small Sizes: 1–20; 5¼ inches long.

Fig. 180.



Ash's Plate and Wire Gauge—full-size.
A, B and Nos. 1, 2, 3, 4, 5 show round wire sizes; Nos. 6, 7, 8 half-round wire sizes; and Nos. 4, 5, 6, 7, 8, 9 on the lower part of the Gauge show plate sizes.

Fig. 181.

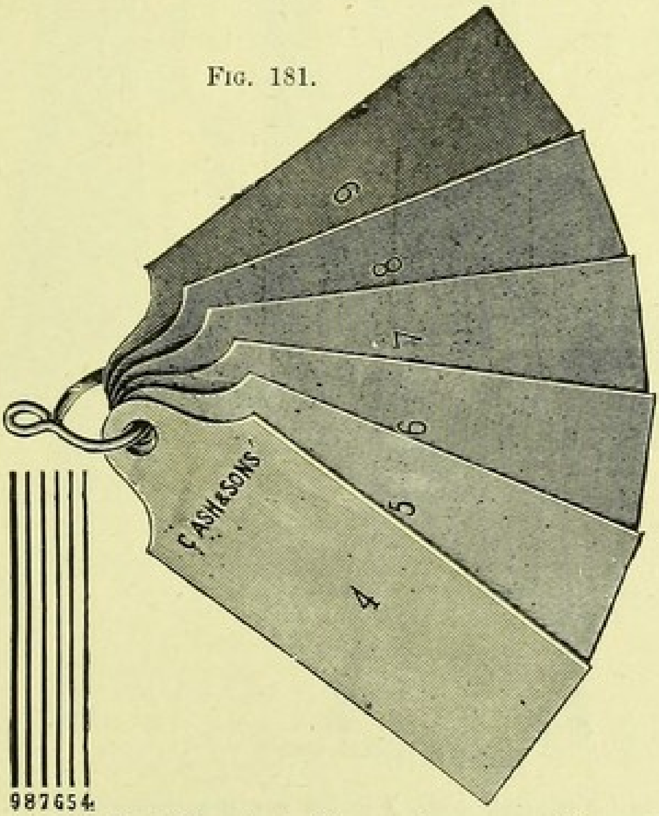


Fig. 182.

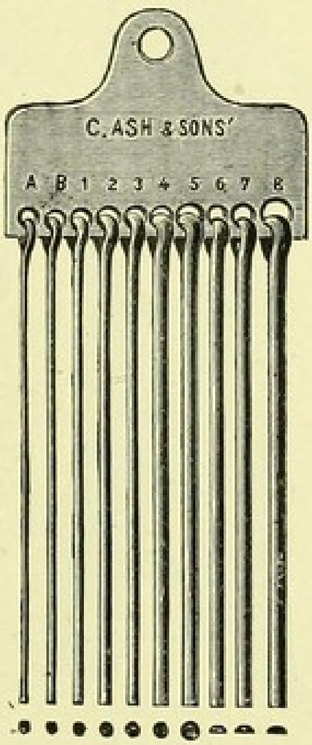


Fig. 181.—Ash's Plate Patterns. Sizes 4, 5, 6, 7, 8, 9.
,, 182.— ,, Wire ,, ,, A, B, 1, 2, 3, 4, 5, 6, 7, 8.

GOLD BENCH—*continued.*

TOOLS FOR HOLDING OR BENDING METAL.

Fig. 183.

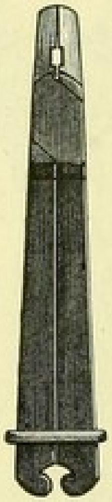


Fig. 184.

Fig. 185.

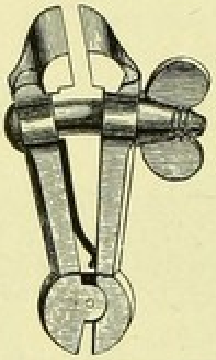


Fig. 186.

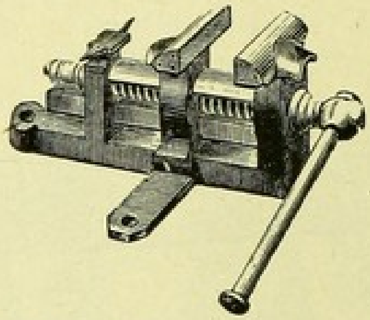
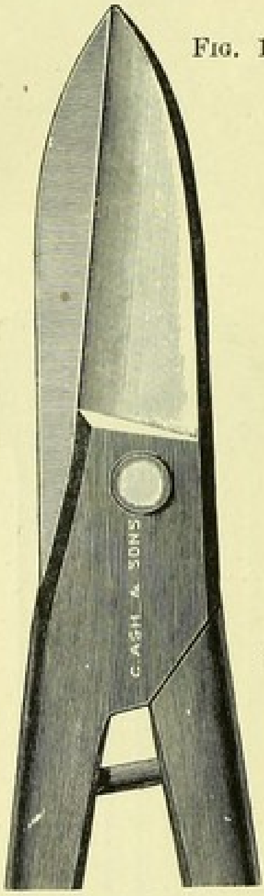


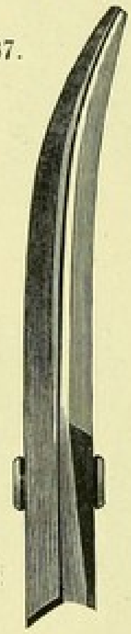
Fig. 183.—Sliding Tongs, 5¼ inches long.
Fig. 184.—Pin Vice, 4½ inches long. Fig. 185.—Hand Vice, 4½ inches long.
Fig. 186.—Parallel Vice, weight about 4 lbs.

CUTTING TOOLS, ETC.

Fig. 187.

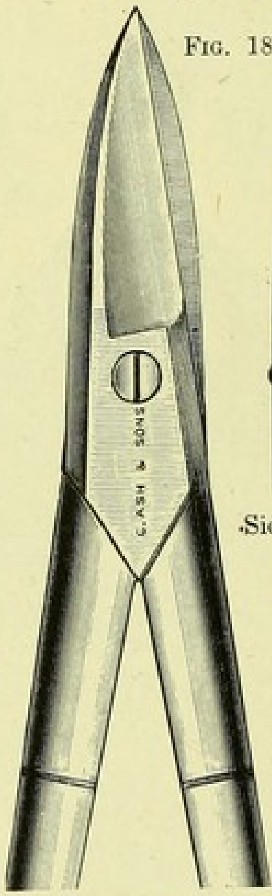


Left Side.

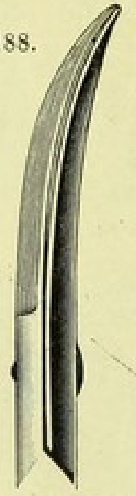


Side View of Curved Blades.

Fig. 188.



Right Side.



Side View of Curved Blades.

Fig. 189.

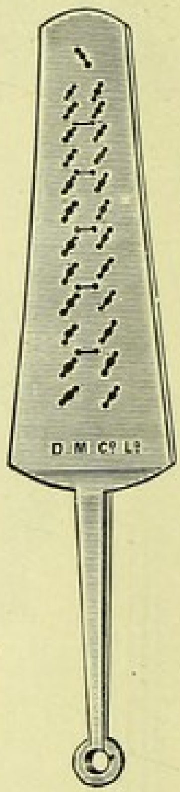
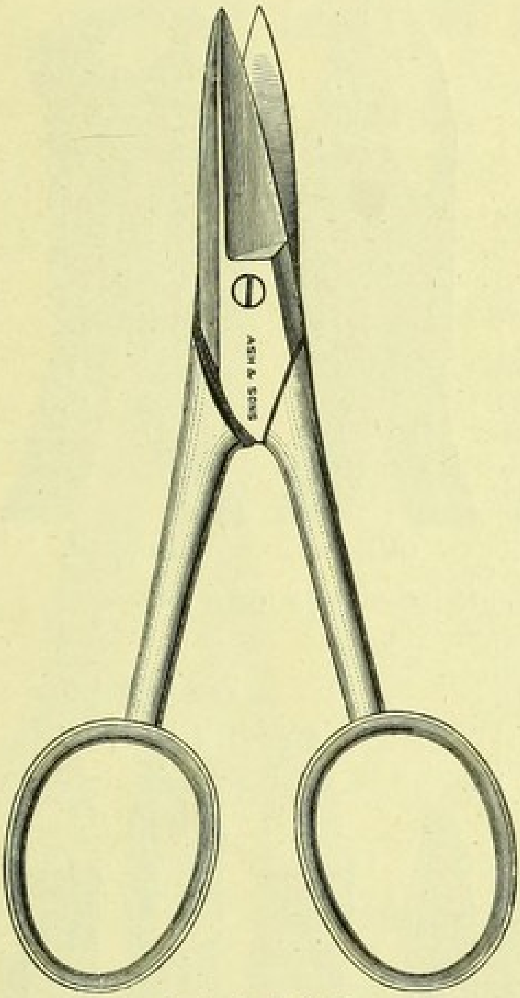


Fig. 187.—Plate Shears for general work, 7 inches and 8 inches long.
„ 188.—Light Plate Shears for crown work, etc., 7 inches long.
„ 189.—Stubs' Screw Plate, 6 inches long.

GOLD BENCH—*continued.*

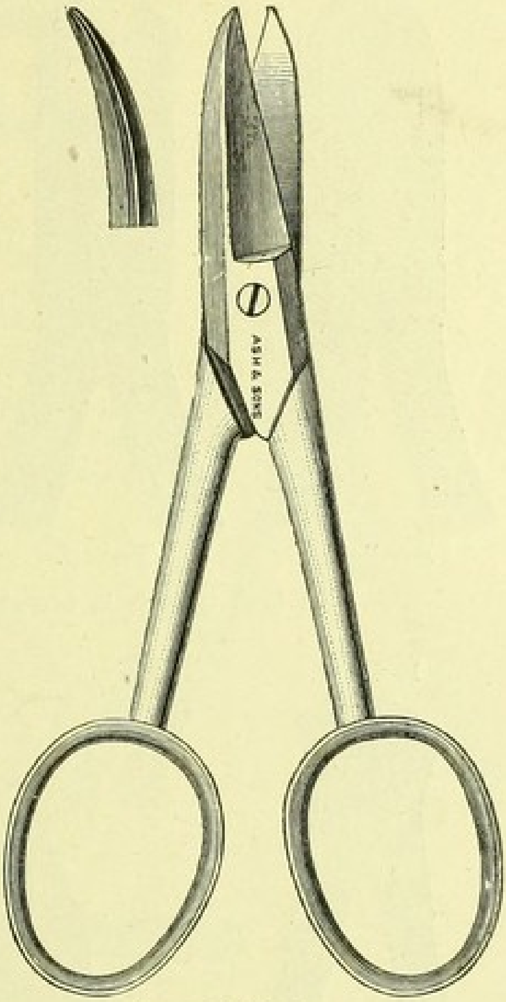
CUTTING TOOLS.

Fig. 190.



Straight, full-size.

Fig. 191.



Curved, full-size.

PLATE SCISSORS FOR CROWN WORK, introduced by Mr. Girdwood, of Edinburgh.

The two forms here illustrated are strong enough for the purposes for which they are intended.

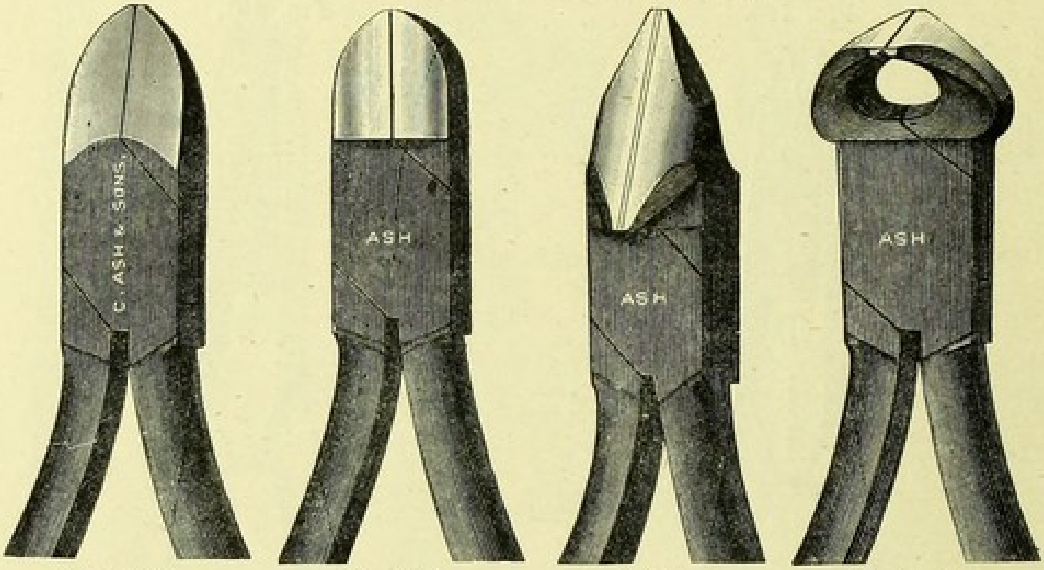
The Engraver's Bayonet Scraper,

Fig. 352, shown on page 376, should also be included among the cutting tools on the Gold Bench.

GOLD BENCH—*continued.*

CUTTING TOOLS.

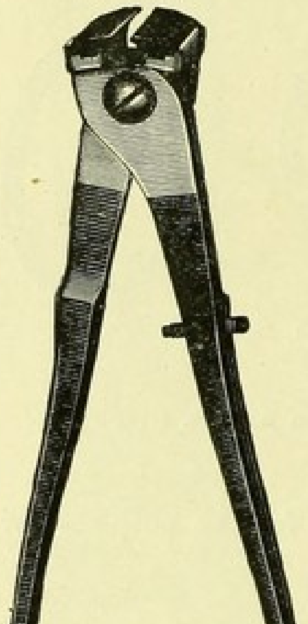
Fig. 192.—Cutting Nippers (Stubs').



Bevelled. Vertical. Oblique. Horizontal.

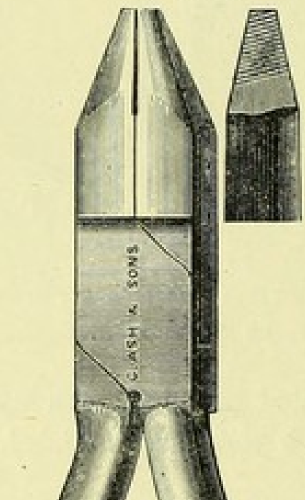
Each form is made in two sizes—4½ inches and 5 inches long.

Fig. 193.



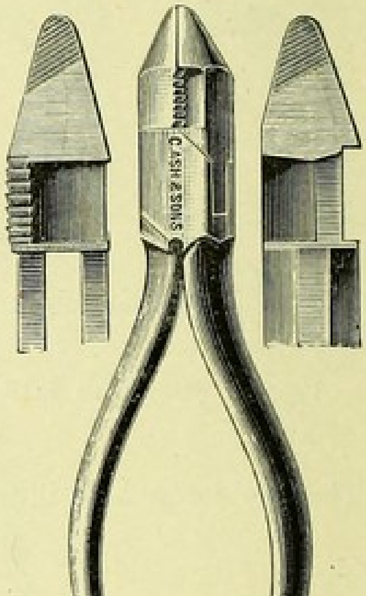
Cutting Nippers,
with removable jaws,
5 inches long.

Fig. 194.



Combined Pliers
and Cutting Nippers,
4½ inches long.

Fig. 195.

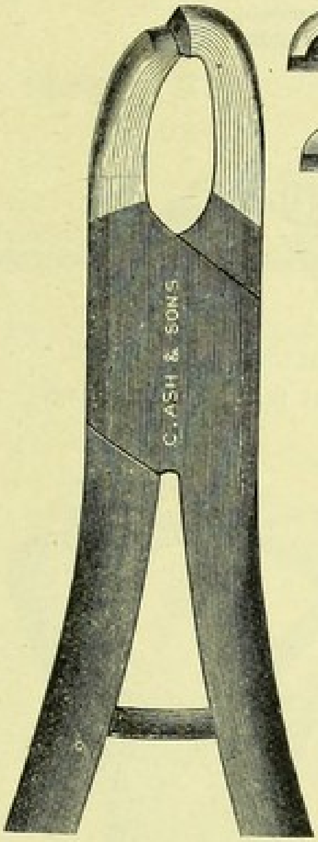


Pliers,
for cutting and bending
piano wire, 5 inches long.

GOLD BENCH—*continued.*

CUTTING TOOLS.

Fig. 196.



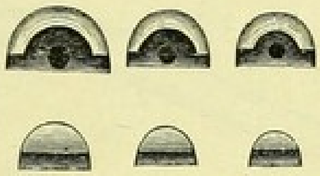


Fig. 196.—Plate Cutters, also called Nippers, $6\frac{3}{4}$ inches long, made in the three widths shown above.

Fig. 197.—Round Nose Nippers for cutting off the ends of pins, etc., in confined spaces, $5\frac{1}{2}$ inches long (see page 140).

Fig. 197.

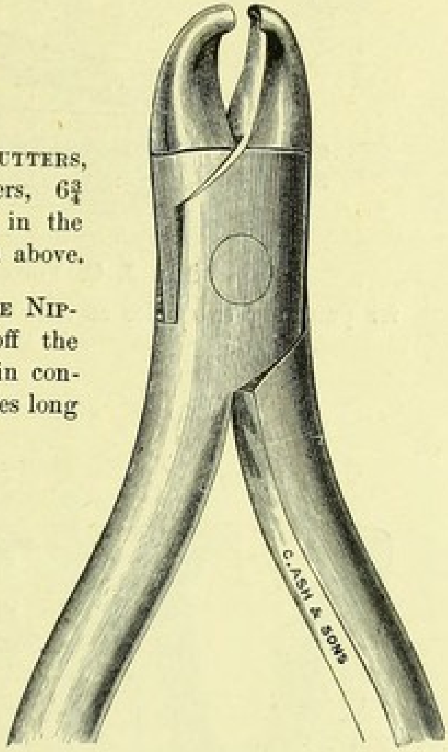
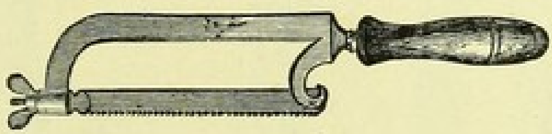
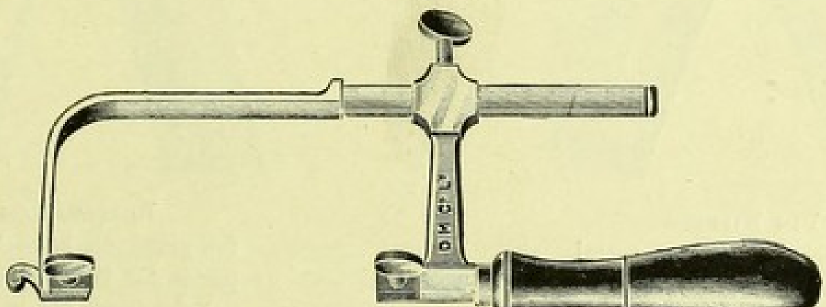


Fig. 198.



Metal Saw.

Fig. 199.

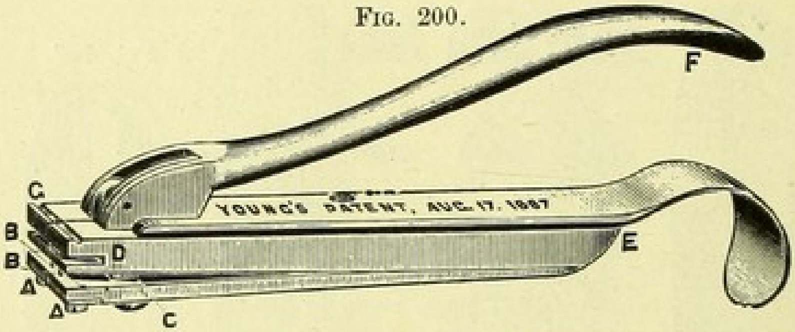


Piercing Saw Frame.

GOLD BENCH—*continued.*

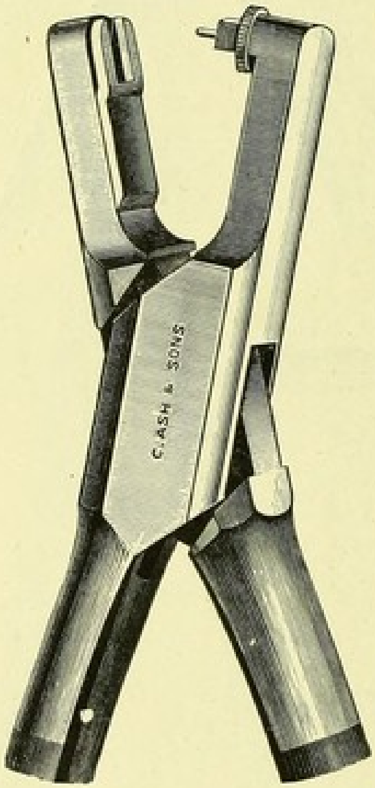
PERFORATING TOOLS.

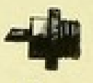
Fig. 200.



Mr. J. C. Young's Adjustable Perforators
for punching two holes at once in metal backings for flat teeth, 7 inches long.

Fig. 201.

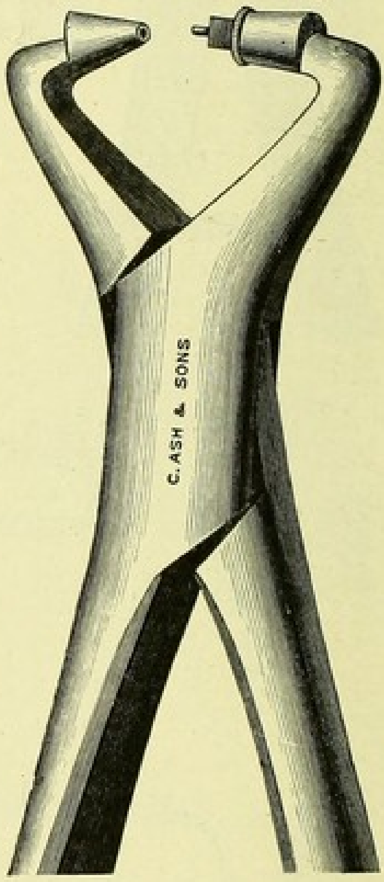




Pin
Socket.

Pin Nippers
for punching holes in metal
backings for flat teeth
pins,
6½ inches long.

Fig. 202.

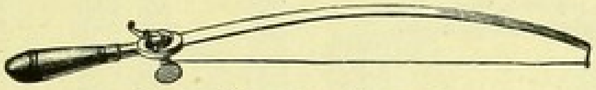


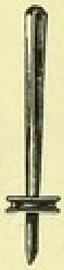
Perforators
for punching holes in metal
plates for the pins on which
tube teeth are mounted,
7½ inches long.

GOLD BENCH—*continued.*

PERFORATING AND DRILLING TOOLS.

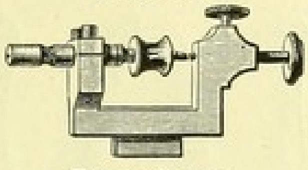
Fig. 203.





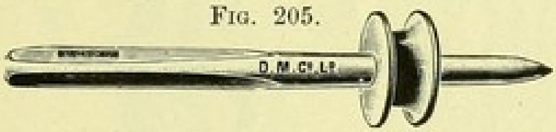
Drill-Bow and Spindle.

Fig. 204.



Drill Stock.

Fig. 205.



Drill-Bow Spindle, Simple Form.

Fig. 206.

Drill-Bow Spindle, with Screw Chuck.

Fig. 207.

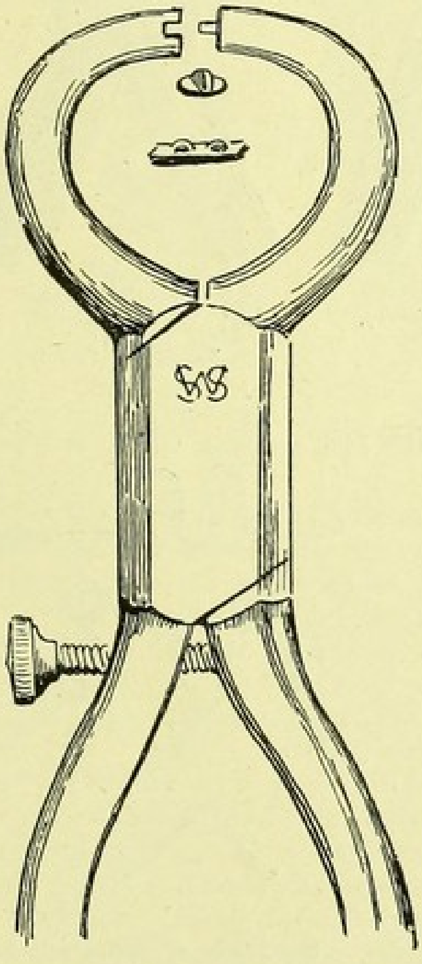


Fig. 208.

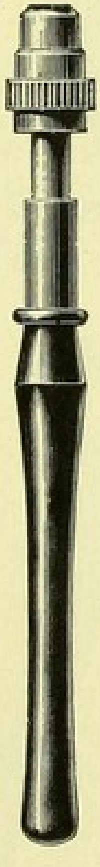


Fig. 209.

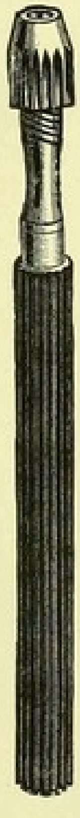
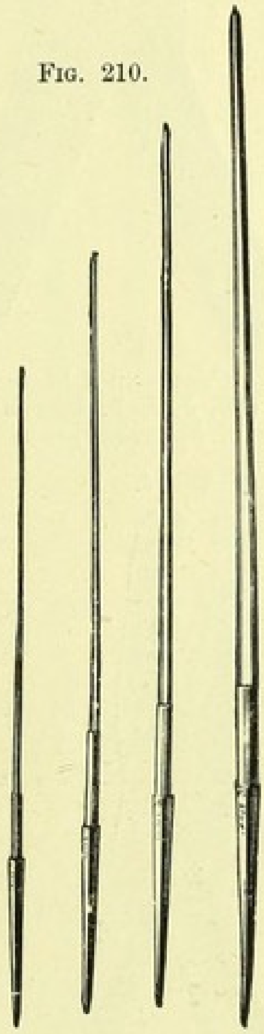


Fig. 210.



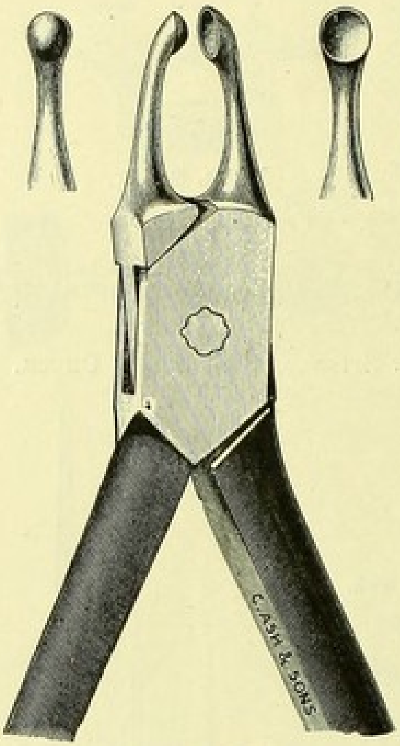
60. 55. 52. 44.

Fig. 207.—Dr. Peck's Loop-Punch. See page 162 *et seq.*
„ 208.—Broach Holder with Ebony Handle.
„ 209.— „ „ all Steel.
„ 210.—Four useful Sizes of Broaches, with Stubs' numbers underneath them.

GOLD BENCH—*CONTINUED.*

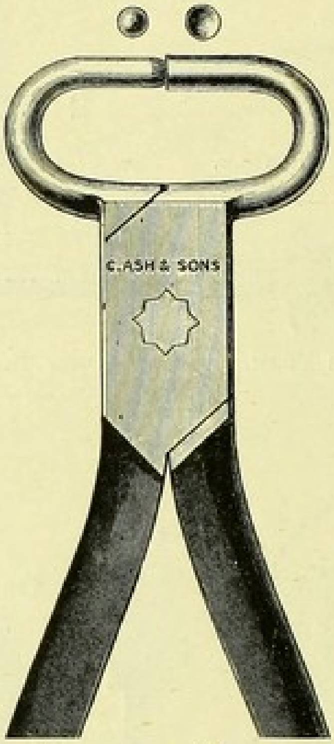
SHAPING TOOLS.

Fig. 211.



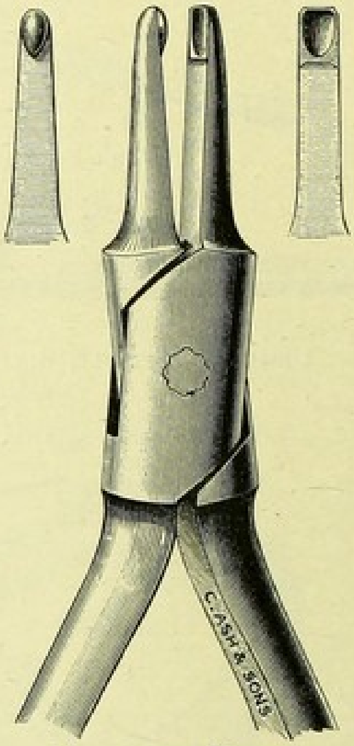
Contouring Pliers
(Dr. J. J. R. Patrick's),
$5\frac{3}{4}$ inches long.

Fig. 212.



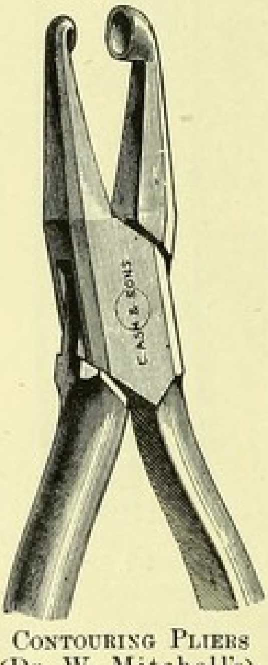
Contouring Pliers
(Dr. J. J. R. Patrick's),
$5\frac{1}{2}$ inches long.

Fig. 213.



Contouring Pliers
(Dr. W. Mitchell's),
$5\frac{3}{4}$ inches long.

Fig. 214.



Contouring Pliers
(Dr. W. Mitchell's),
5 inches long.

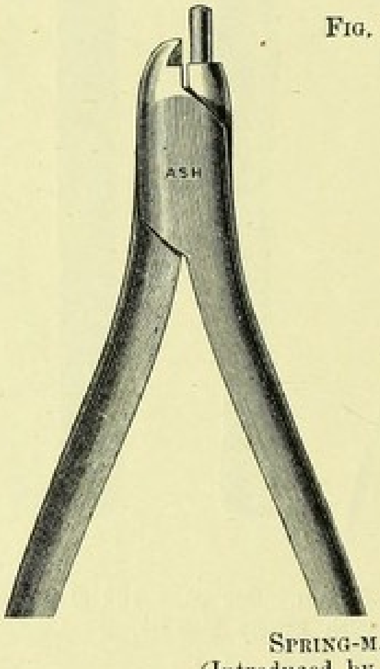
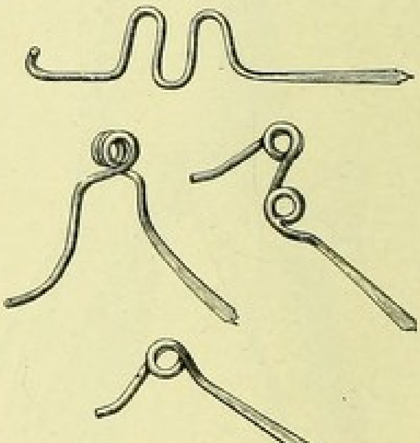


Fig. 215.



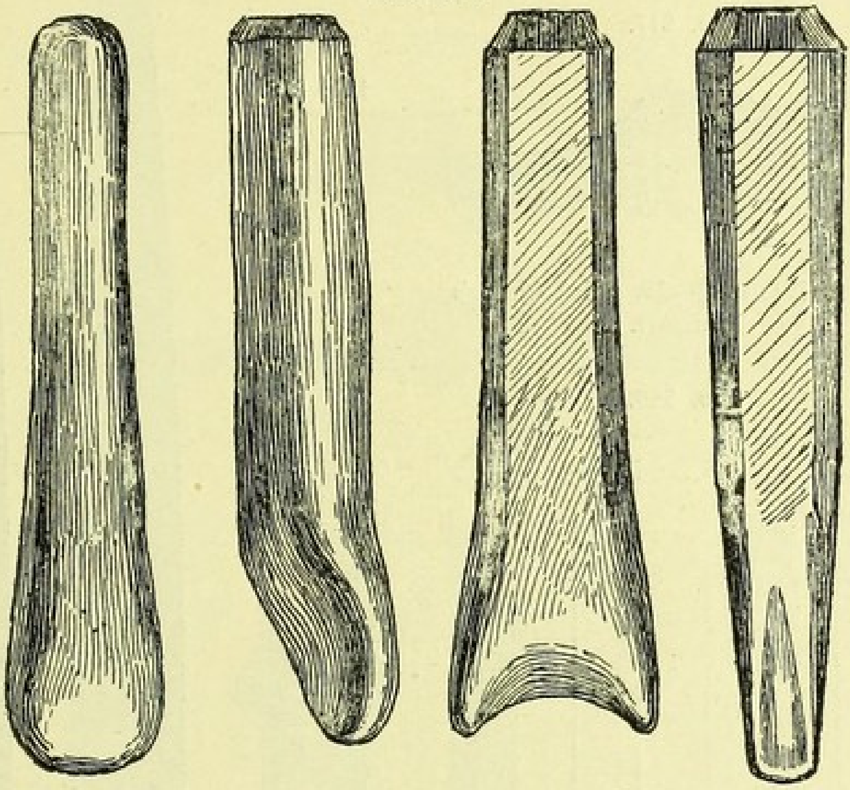
Specimens of Springs made
with the Pliers.

Spring-making Pliers
(Introduced by Mr. G. Northcroft),
$4\frac{1}{2}$ inches long.

GOLD BENCH—*continued.*

SHAPING TOOLS.

Fig. 216.



1. 2. 3. 4.

Copper-Plate Punches designed by the Author—full-size.

Close adaptation of difficult plates to the surface of a die can often be obtained by the use of the chasing punch among the rugæ of the palate *while the plate lies in the counter-die.*

Narrow punches should not be used, but such as are here illustrated in Nos. 2 and 4, with rounded ends, which bear some resemblance to the surface to be "bossed" out. The end of each can readily be *filed* to a suitable contour for use on a special plate.

Nos. 1 and 3 are very serviceable for adapting a plate *to the surface of a zinc die or a die made of Gartrell's metal.*

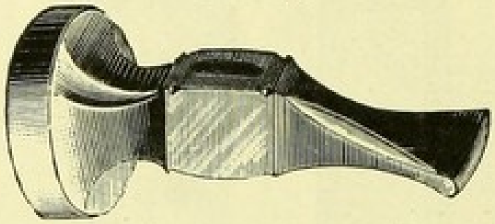
Of the two, No. 1 is especially useful for gently forcing a plate into a deep palate, with light taps from a hammer, while No. 3 is invaluable for working it over the alveolar ridge, where it sometimes has a tendency to buckle; it is also of great use on plates for V-shaped edentulous cases, when it is intelligently employed.

A few experiments made with brass plates on zinc dies, or dies made of Gartrell's metal, and in lead counter-dies, will demonstrate the superiority of the copper punches over the existing forms of steel and brass punches, and also over the pieces of bone, soft wood, and boxwood, which are sometimes used.

GOLD BENCH—*continued.*

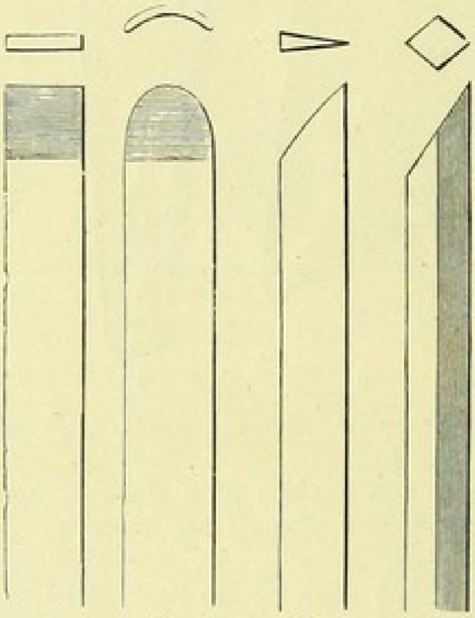
SHAPING TOOLS, ETC.

Fig. 217.



Bossing Hammer—also called Chaser's Hammer.

Fig. 220.

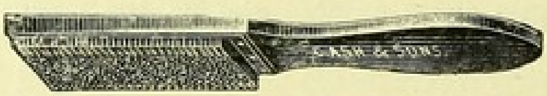


1. 2. 3. 4.

No. 1.—Flat Sculptor.
No. 2.—Gouge or Reeded Sculptor.
No. 3.—Picking Sculptor.
No. 4.—Graver.

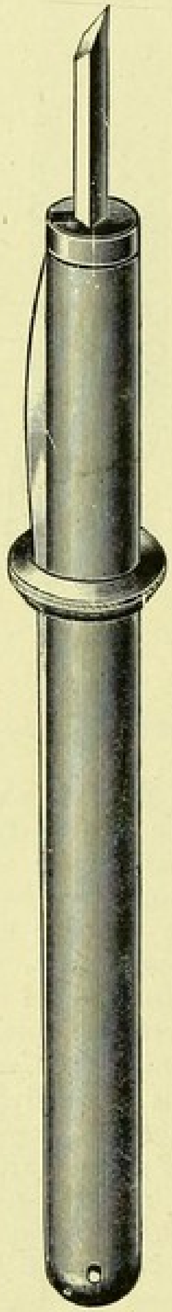
Nos. 1, 2, and 4 are made in broad, medium and narrow widths—the broad is here shown—and No. 3 in one width as illustrated.

Fig. 221.



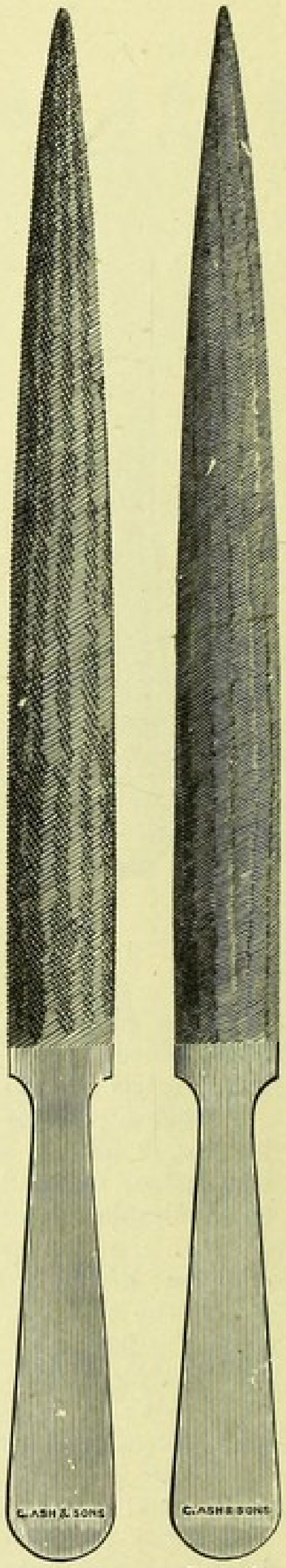
Wire Brush for Cleaning Files.

Fig. 218.



Penfold's Graver Handle. Full Size.

Fig. 219.

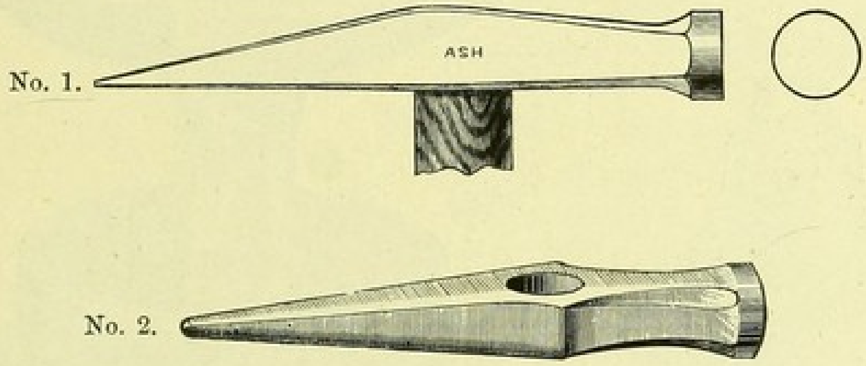


Bastard. Smooth.
Files for Gold Work.

GOLD BENCH—*continued.*

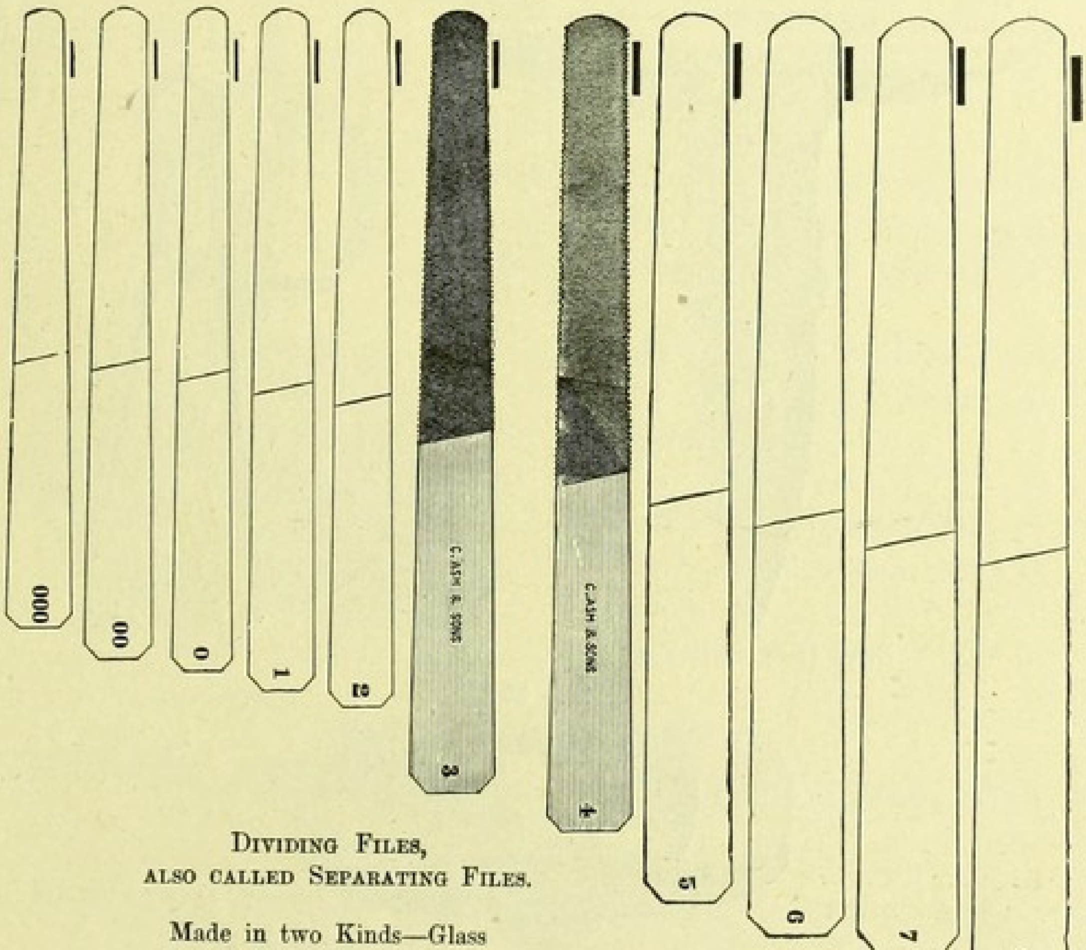
SHAPING TOOLS, ETC.

Fig. 222.



Riveting Hammers.

Fig. 223.



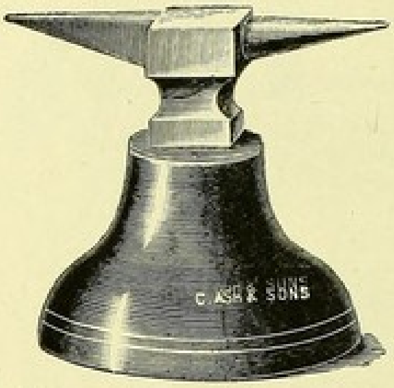
Dividing Files,
also called Separating Files.

Made in two Kinds—Glass
hard and Flexible.

GOLD BENCH—*continued.*

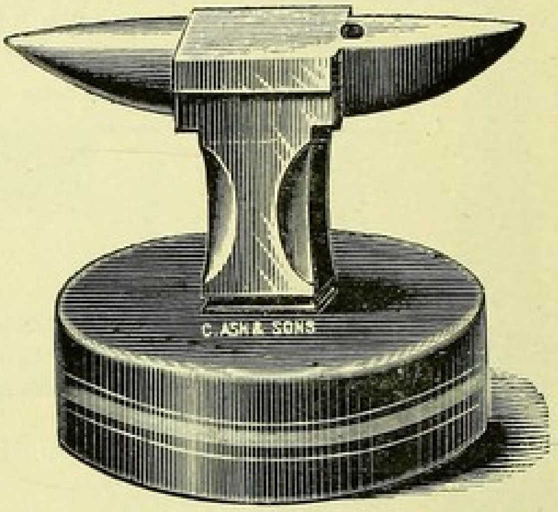
SHAPING TOOLS, ETC.

Fig. 224.



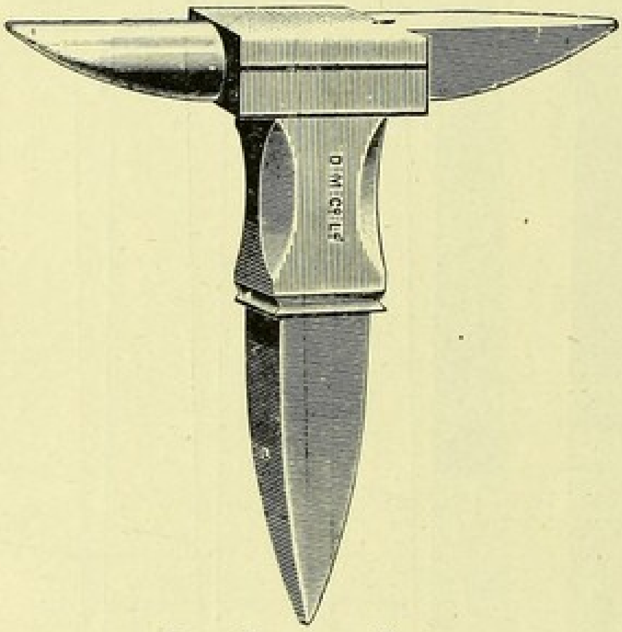
Light Anvil on Stand for Crown Work, etc.

Fig. 225.



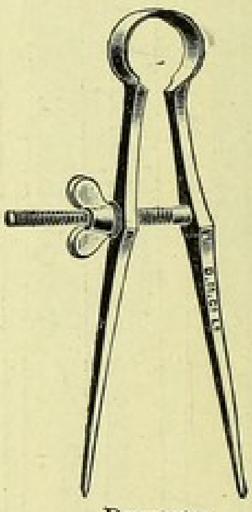
Beak Iron on Stand.

Fig. 226.



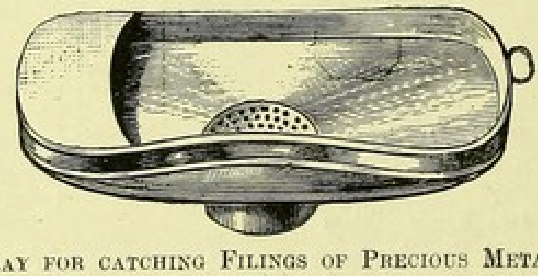
Beak Iron with Tang.

Fig. 227.



Dividers,
4½ inches long.

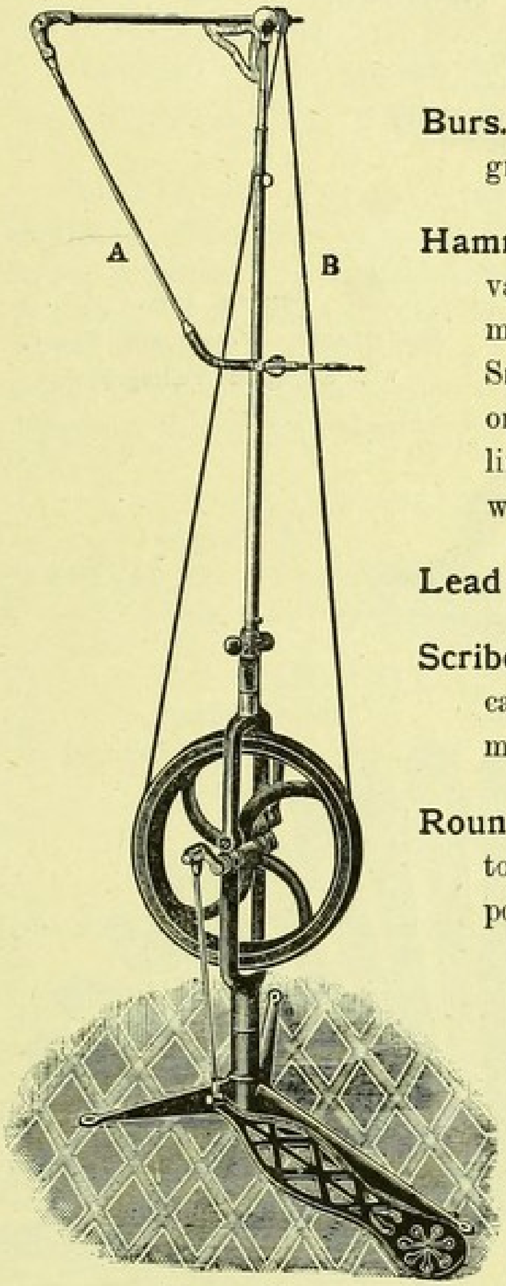
Fig. 228.



Tray for catching Filings of Precious Metals.

GOLD BENCH—*CONTINUED.*

Fig. 229.



Dental Engine.

SHAPING TOOLS, ETC.

Burs. — Used Burs from surgery are of great value in the workroom.

Hammers.—Copper-headed Hammers of various sizes and shapes, as designed, made and used by my friend Mr. James Smith Turner, for malleting gold plates on zinc models, when folding or buckling occurs, and for fitting pin teeth with backs.

Lead Pencil for marking models, etc.

Scriber. — A broken octagon-handled excavator, ground to a suitable point, makes a good scriber.

Round Point.—A small bradawl, ground to a suitable taper, makes a good round point for tube work—see page 139.

"Steady" Block of Lead with wax surface for riveting and fitting backs on.

Steel Block or "Steady," known also by watchmakers as "Flat Stakes."

SMOOTHING, POLISHING AND SHARPENING TOOLS, ETC.

Buff Sticks for Polishing.

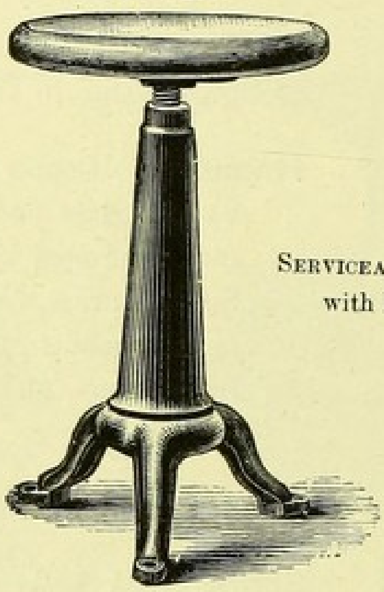
Burnishers—Steel or Agate. **Oil Can.** **Oil Stones.**

Water of Avr (Scotch) Stones.

GOLD BENCH—*CONTINUED.*

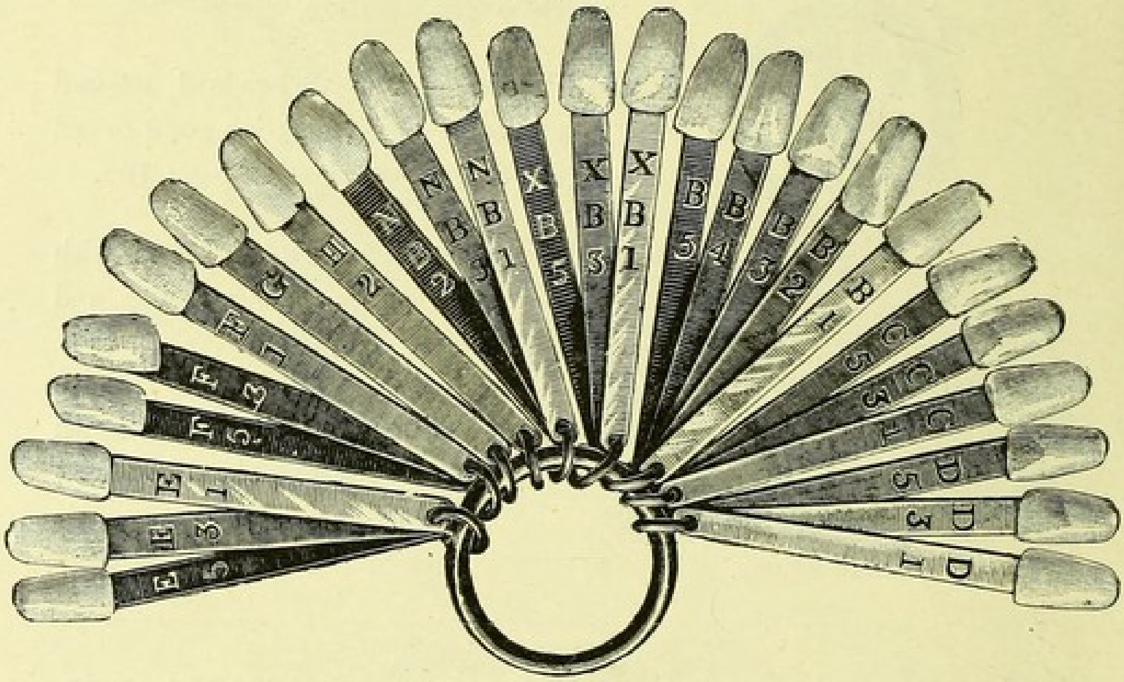
ARTICLES, VARIOUS.

Fig. 230.



Strong and Serviceable Work-room Stool, with Rising and Falling Seat.

Fig. 231.



Ash's Set of Twenty-five Teeth Shades.

The Dental Manufacturing Company of London also supply a set of Shades of the teeth of their manufacture.

For shades of American Teeth the reader is referred to the sets of Shades of The S. S. White Dental Manufacturing Company of Philadelphia, and Messrs. Justi & Son of the same city.

THE FOLLOWING FORMULÆ AND RECIPES ARE TAKEN FROM THE SEVENTH EDITION OF RICHARDSON'S MECHANICAL DENTISTRY :—

Pages 81, 82.—**Formulæ for Gold Plate used as a Base for Artificial Dentures.**—Any of the following formulæ 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 formulæ is 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.
$7\frac{6}{7}$ grs. platinum.

GOLD PLATE.—TWENTY-TWO CARATS FINE.

FORMULA No. 10.
22 dwts. pure gold. 18 grs. silver.
1 dwt. fine copper. 6 grs. platinum.

Page 82.—**Formulæ for Gold Plate used for Clasps, Wire Stays or Backings, Dowels, etc.**—Gold used in the formation of clasps, backings, 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.	1 dwt. fine silver.	20 dwts. coin gold.	10 grs. silver.
2 dwts. fine copper.	1 dwt. platinum.	8 grs. fine copper.	20 grs. platinum.

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

Page 83.—**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 to make selections from.

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 666, 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 a 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.	20 grs. copper.	Gold coin, 30 parts.	Copper, 1 part.
30 grs. silver.	10 grs. brass.	Silver, 4 parts.	Brass, 1 part.

In the reduction of gold for solders Dr. Dorrance recommends the use of what he calls "solder alloy." This is derived from the following formula :—

1 part pure silver. 2 parts pure zinc.
3 parts pure copper.

The copper and silver are melted without flux, in a clean crucible which is well lined with borax ; the zinc is then added in small quantities as rapidly as may be without chilling the molten mass so that it loses its fluidity, meanwhile stirring it with a clay pipe-stem or rod, or a white-wood stick, until the profuse fumes of the burning zinc just pass off, when pour immediately into an ingot mould, or into clean water in a clean wooden pail. The metals entering into the composition of this solder alloy should be absolutely pure, especially should they be free of arsenic, antimony, cadmium, etc., in which case not only the alloy, but gold and silver solders made from it, will be tough and easy-flowing.

Inasmuch as the zinc, in compounding the alloy, has not been protected from oxidation, if it has been cast at the proper moment, it will be found present at about its combining weight. Both gold and silver solders made with this alloy will, as has been stated, be found very tough and easy-flowing, the range of proportion most desirable being for gold solder from twenty to twelve carats, or from 15 to 50 per cent. of alloy.

Dr. Dorrance very properly says, however, that the twelve carat or 50 per cent. solder is too coarse for dental work. From 10 to 15 per cent. of the alloy added to gold coin is recommended as a suitable solder in the construction of coin-gold crowns. Zinc, as a constituent of solders, is used principally with a view of rendering them more fusible without materially debasing them, if the proper proportion is observed. Its employment under any circumstances has been objected to by some, on the ground that the alloy is more readily tarnished in the mouth, is more brittle, and that it furnishes more favourable 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 alloy, equal, or nearly so, in purity to solder not so contaminated. If such is the case they are acceptable alloys for soldering purposes, inasmuch as it is not only desirable to have an easy-flowing solder, but one which shall have as little affinity as possible for acids often found associated with the fluids of the mouth. Care should be taken to add no more zinc than is necessary to make the solder flow freely under a heat that may be safely applied without danger of melting the pieces to be united.

Page 175.—**Fusible Alloys.**—The following tabular view of the more fusible alloys, the respective properties of which are deduced from actual experiments, was given by Prof. Austen in a paper on "Metallic Dies." * Zinc is introduced into the table for the purpose of comparison :—

		MELTING POINT.	CON-TRACTILITY.	HARDNESS.	BRITTLE-NESS.
1.	Zinc	770° F.	·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

In commenting on the preceding table, Professor Austen 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 five are malleable metals ; those above five are brittle ; zinc, marked five, 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, which has already been alluded 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 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."

* American Journal of Dental Science, vol. VI., page 367.

Page 315.—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.
60	295° F.	72	308° F.	84	319° F.
61	296°	73	309°	85	320°
62	298°	74	310°	90	324°
63	299°	75	311°	95	328°
64	300°	76	312°	100	332°
65	301°	77	313°	105	335°
66	302°	78	314°	110	339°
67	303°	79	314°	115	342°
68	304°	80	315°	120	345°
69	305°	81	316°	125	349°
70	306°	82	317°	130	352°
71	307°	83	318°	—	—

It will readily be seen by the above that a pressure of sixty pounds requires a temperature of 295° by Fahrenheit's scale to produce it, and eighty-five pounds, 320°, at which latter pressure I (Dr. Lawrence) vulcanize, running one hour, and with the most satisfactory results.

FROM THE AMERICAN TEXT-BOOK OF PROSTHETIC DENTISTRY IN CONTRIBUTIONS BY EMINENT AUTHORITIES. Edited by CHARLES J. ESSIG.

Pages 103, 104.—Gold plate suitable for dental purposes may be prepared according to the following formulæ :—

GOLD PLATE.—EIGHTEEN CARATS FINE.

No. 1.		No. 2.	
Pure Gold	18 dwts.	Gold Coin	20 dwts.
Pure Copper	4 dwts.	Pure Copper	2 dwts.
Pure Silver	2 dwts.	Pure Silver	2 dwts.

GOLD PLATE.—NINETEEN CARATS FINE.

No. 3.		No. 4.	
Pure Gold	19 dwts.	Gold Coin	20 dwts.
Pure Copper	3 dwts.	Pure Copper	25 grs.
Pure Silver	2 dwts.	Pure Silver	40 grs.

GOLD PLATE.—TWENTY CARATS FINE.

No. 5.		No. 6.	
Pure Gold	20 dwts.	Gold Coin.	20 dwts.
Pure Copper	2 dwts.	Pure Copper	18 grs.
Pure Silver	2 dwts.	Pure Silver	20 grs.

GOLD PLATE.—TWENTY-ONE CARATS FINE.

No. 7.

Pure Gold	21 dwts.
Pure Copper	2 dwts.
Pure Silver	1 dwt.

No. 8.

Gold Coin	20 dwts.
Pure Silver	13 grs.

No. 9.

Gold Coin	20 dwts.
Pure Copper	6 grs.
Pure Platinum	$7\frac{5}{7}$ grs.

GOLD PLATE.—TWENTY-TWO CARATS FINE.

No. 10.

Pure Gold	20 dwts.
Fine Copper	1 dwt.
Pure Silver	18 grs.
Pure Platinum	6 grs.

GOLD PLATE.—EIGHTEEN CARATS FINE.

No. 11.

United States Gold Coin ($60)	$64\frac{1}{2}$ dwts.
Pure Silver	13 dwts.

On account of its greater strength and power of resisting the chemical action of the fluids of the mouth, many dentists prefer to use gold plate 20 or 21 carats fine, in which the reducing constituents are copper and platinum, the following formula being an example :—

Gold Coin	20 dwts.
Pure Platinum	10 grs.

The union of platinum with gold yields an alloy possessing great strength and considerable elasticity. Such an admixture, however, has its disadvantages. Owing to its increased strength and stiffness, a much thinner and lighter plate may be employed without the additional labour and cost of doubling the plate at what, in partial cases composed of ordinary 18, 19, or 20-carat gold, would be weak points. It may also be justly claimed for gold alloyed with platinum that it will perfectly resist the action of the fluids of the mouth. On the other hand, the richness of colour of the gold is always more or less impaired by the admixture of platinum. But perhaps the greatest objection to be urged against the employment of platinous gold is the increased difficulty of swaging a plate composed of it so that it shall perfectly conform to all the depressions and irregularities of the model. Having invariably found, when the alloy contained any considerable percentage of platinum, that the ordinary method of swaging between zinc and lead was not effective, the author has for more than twenty years employed zinc for counter-dies as well as for dies; this entirely overcomes any difficulty in swaging.

* * * * * *

The following formulæ will afford alloys of 20-carat fineness suitable for clasps, backings, hard wire for crown-posts, spring wire, and wherever elasticity and additional strength are required :—

Formula No. 1.		Formula No. 2.	
Pure Gold	20 dwts.	Coin Gold	20 dwts.
Pure Copper	2 dwts.	Pure Copper	8 grs.
Pure Silver	1 dwt.	Pure Silver	10 grs.
Pure Platinum	1 dwt.	Pure Platinum	20 grs.

Page 105.—**Alloys of Gold employed in Dentistry as Solders.** —These are a class of alloys formed of the metal to be united, the fusing-point of which is reduced by the addition of silver, copper and brass :—

No. 1, 14 Carats Fine.		No. 2, 15 Carats Fine.	
Pure Silver	2½ dwts.	Gold Coin	6 dwts.
Pure Copper	20 grs.	Pure Silver	30 grs.
Pure Zinc	35 grs.	Pure Copper	20 grs.
18-Carat Gold Plate (Formula No. 11)	20 dwts.	Brass	10 grs.

No. 3, 16 Carats Fine.		No. 4, 18 Carats Fine.	
Pure Gold	11 dwts. 12 grs.	Gold Coin	30 parts.
Pure Silver	3 dwts.	Pure Silver	4 parts.
Pure Copper	1 dwt. 12 grs.	Pure Copper	1 part.
Pure Zinc	12 grs.	Brass	1 part

No. 5, 20 Carats Fine, for Crown and Bridge-work.		No. 6, 20 Carats Fine, same use as No. 5.	
American Gold Coin (21·6 carats fine), $10 piece	258 grs.	Pure Gold	5 dwts.
Spelter Solder	20·64 grs.	Pure Copper	6 grs.
		Pure Silver	12 grs.
		Spelter Solder	6 grs.

No. 7, 20 Carats Fine, for Crown and Bridge-work.

Zinc	1½ grs.	Pure Gold	20 grs.
Silver Solder	3 grs.		

No. 8, Dr. C. M. Richmond's Solder, for Bridge-work.

Gold Coin	5 dwts.
Fine Brass Wire	1 dwt.

Dr. Low's Formula for Solder in Crown and Bridge-work, 19 Carats Fine.

Coin Gold	1 dwt.	Copper	2 grs.
Silver	4 grs.		

Dr. W. H. Dorrance prepares an Alloy of—

Pure Silver	1 dwt.	Pure Zinc	2 dwts.
Pure Copper	3 dwts.		

With this alloy he forms the different grades of gold solders. To form a solder suitable for bridge-work, of 20 carats fine, he melts 4 grains of the alloy with 20 grains of pure gold.

Pages 120, 121.—**Silver Solders.**—When the plate to be united consists of pure silver alloyed with platinum, the solder may be formed of the standard metal (coin), with the addition of one-tenth to one-sixth its weight of zinc according to the proportion of platinum contained in the alloy. Silver solders are, however, generally composed of silver, copper, and zinc, or silver and brass, in variable proportions, of which the following are examples :—

No. 1.		No. 2.	
Silver	66 parts.	Silver	6 dwts.
Copper	30 parts.	Copper	2 dwts.
Zinc	10 parts.	Brass	1 dwt.

No. 3.

Silver	$5\frac{1}{2}$ dwts.
Brass Wire	40 grs.

In putting together the constituents of silver solders, the affinity for oxygen manifested by zinc, brass, and copper when exposed to high temperatures should be remembered, and in order to guard against loss the mode of procedure should be as follows: The silver, placed in a clean crucible, with a sufficient quantity of borax to cover it, should be thoroughly fused, and without permitting it to cool in the least, the zinc, brass, or copper, as the case may be, should be quickly added. Before pouring, it should be shaken or agitated to ensure admixture. When cool, it may be removed from the ingot-mould and rolled into plate of, say, No. 27 of the standard gauge.

The surface of standard silver may be whitened by being heated and immersed in dilute sulphuric acid. It is in this way that frosted silver is produced. The acid, dissolving the oxide of silver from the surface, leaves a quite pure superficial film.

FROM CHARLES HUNTER'S MECHANICAL DENTISTRY.

Page 219.—**SOLDER,** SIXTEEN CARATS FINE. USED WITH TWENTY-CARAT PLATE.

	ozs.	dwts.	grs.
Fine gold	0	6	0
Roset copper	0	2	0
Fine silver	0	1	0
	0	9	0

Page 221.—TABLE SHOWING THE PROPORTION OF ALLOY TO BE ADDED TO ONE OUNCE OF STANDARD GOLD IN MAKING FOLLOWING QUALITIES.

QUALITIES.	STANDARD GOLD.			ALLOY ADDED.			TOTAL.		
Carats.	ozs.	dwts.	grs.	ozs.	dwts.	grs.	ozs.	dwts.	grs.
21	1	0	0	0	0	23	1	0	23
20	1	0	0	0	2	0	1	2	0
19	1	0	0	0	3	4	1	3	4
18	1	0	0	0	4	10	1	4	10
17	1	0	0	0	5	21	1	5	21
16	1	0	0	0	7	12	1	7	12
15	1	0	0	0	9	8	1	9	8

Page 222.—TABLE SHOWING THE PROPORTION OF ALLOY TO BE ADDED TO ONE OUNCE OF FINE GOLD IN MAKING THE FOLLOWING QUALITIES.

QUALITIES.	FINE GOLD.			ALLOY ADDED.			TOTAL.		
carats.	ozs.	dwts.	grs.	ozs.	dwts.	grs.	ozs.	dwts.	grs.
23	1	0	0	0	0	20	1	0	20
22	1	0	0	0	1	18	1	1	18
21	1	0	0	0	2	20	1	2	20
20	1	0	0	0	4	0	1	4	0
19	1	0	0	0	5	6	1	5	6
18	1	0	0	0	6	16	1	6	16
17	1	0	0	0	8	5	1	8	5
16	1	0	0	0	10	0	1	10	0
15	1	0	0	0	12	0	1	12	0

Page 222.—TABLE GIVING THE WEIGHTS OF PIECES OF GOLD OF THE SAME DIMENSIONS, BUT OF DIFFERENT CARAT VALUE.

Qualities.	ozs.	dwts.	grs.
24 carat of given dimensions will weigh	1	0	0
23 " " " " "	0	19	12
22 " " " " "	0	19	0
20 " " " " "	0	18	0
18 " " " " "	0	17	12
15 " " " " "	0	16	0
13 " " " " "	0	15	0
12 " " " " "	0	14	12
10 " " " " "	0	14	0
9 " " " " "	0	13	12
8 " " " " "	0	13	0
7 " " " " "	0	12	12

From the above table an approximate estimate, therefore, may be made of the value of any pieces of gold.

Page 223.—TABLE OF VALUE.

Qualities.		£	s.	d.	Qualities.		£	s.	d.
24 carat gold costs .	per oz.	4	6	0	15 carat gold costs .	per oz.	2	14	6
23 " " " .	"	4	2	6	14 " " " .	"	2	11	0
22 " " " .	"	3	19	0	13 " " " .	"	2	7	6
21 " " " .	"	3	15	6	12 " " " .	"	2	4	0
20 " " " .	"	3	12	0	11 " " " .	"	2	0	6
19 " " " .	"	3	8	6	10 " " " .	"	1	17	0
18 " " " .	"	3	5	0	9 " " " .	"	1	13	6
17 " " " .	"	3	1	6	8 " " " .	"	1	10	0
16 " " " .	"	2	18	0	7 " " " .	"	1	6	6

Page 232.—SILVER SOLDERS.

DESCRIPTION.	FINE SILVER.	COPPER.	SPELTER.
Hard solder	16 parts.	3½ parts.	½ part.
Medium solder	15 parts.	4 parts.	1 part.
Easy common solder	14 parts.	4½ parts.	1½ parts.
Common hard	12½ parts.	6 parts.	1½ parts.
Common easy	11½ parts.	6½ parts.	2 parts.

FUSING POINTS OF ABOVE.

No. 1. Hard solder	1,866 deg. Fahr.
No. 2. Medium solder	1,843 deg. Fahr.
No. 3. Easy solder	1,818 deg. Fahr.
No. 4. Common solder	1,826 deg. Fahr.
No. 5. Common easy solder	1,802 deg. Fahr.

SOFT SOLDER.

Pure grain tin	2 parts.
Pure lead	1 part.

Melt in an iron ladle, lead first; then after heating the tin over the ladle, add it to the melted lead.

Pages 232, 233.—SOFT SOLDERING FLUID.

Spirits of salt	2 parts.
Metallic zinc	1 part.

Procure an earthen pipkin, and put into it two and a half ounces of spirits of salts, and one ounce of metallic zinc in small pieces. When the zinc has dissolved, or the effervescence has partially ceased, the temperature may conveniently be increased by placing the pipkin with its contents upon a sheet of iron over a gas-jet; the extra half ounce of spirits of salt will allow for loss by evaporation. Sometimes it will be found necessary, especially when the acid is not good, to increase its temperature in order to effect its thorough saturation, for the more neutral the mixture the better it acts. The solution may be allowed to settle when sufficiently acted upon, and the supernatant liquor poured from the sediment into a bottle ready for use. This mixture will keep any length of time in a corked bottle. When this is employed in soft-soldering iron or steel, the addition to it of a small portion of powdered sal-ammoniac is a great improvement; a quarter of an ounce to the proportion of solution given above will form a very good mixture.

Pages 234, 235.—**Properties of Metals.**—*Tenacity.* The tenacity of the metals has been measured by fixing firmly in a vice one end of a bar or wire of the metal, the strength of which is to be ascertained, and attaching to the other end a convenient support for weights, which are cautiously increased until the wire breaks. Taking the tenacity of lead as one, that of the different metals after annealing is as follows * :—

Lead	1	Silver	8·9
Cadmium	1·2	Platinum	13
Tin	1·3	Paladium	15
Gold	5·6	Copper	17
Zinc	8	Iron	26

Copper, it will be observed, resists being torn asunder with three times the power of gold.

* Miller's Chemistry.

Malleability.—Gold is the most malleable of metals ; that is, it can be hammered out into the thinnest leaves—it can be beaten out so thin that one square foot weighs less than three grains.

The following gives the order of the malleability of the metals, beginning with the most malleable :—

1. Gold.
2. Silver.
3. Copper.
4. Platinum.
5. Palladium.
6. Iron.
7. Aluminium.
8. Tin.
9. Zinc.
10. Lead.
11. Cadmium.
12. Nickel.
13. Cobalt.

Ductility.—This property of being drawn into wire is given in the following order, beginning with the most ductile :—

1. Gold.
2. Silver.
3. Platinum.
4. Iron.
5. Copper.
6. Palladium.
7. Cadmium.
8. Cobalt.
9. Nickel.
10. Aluminium.
11. Zinc.
12. Tin.
13. Lead.
14. Thallium.
15. Magnesium.
16. Lithium.

EXPANSION OF METALS.

Zinc (cast)	1 in 323.	Copper	1 in 581.
Zinc (sheet)	1 in 340.	Brass	1 in 584.
Lead	1 in 351.	Pure gold	1 in 682.
Tin	1 in 516.	Iron wire	1 in 901.
Silver	1 in 524.	Palladium	1 in 1000.
Platinum	1 in 1167.		

Page 252.—The following table represents the corresponding temperature of Fahrenheit and Centigrade below boiling point :—

TABLE OF CORRESPONDING TEMPERATURE ON THE SCALES OF FAHRENHEIT AND CENTIGRADE THERMOMETERS.

DEG. CENT.	DEG. FAHR.	DEG. CENT.	DEG. FAHR.	DEG. CENT.	DEG. FAHR.
100	212	85	185	70	158
99	210·2	84	183·2	69	156·2
98	208·4	83	181·4	68	154·4
97	206·6	82	179·6	67	152·6
96	204·8	81	177·8	66	150·8
95	203	80	176	65	149
94	201·2	79	174·2	64	147·2
93	199·4	78	172·4	63	145·4
92	197·6	77	170·6	62	143·6
91	195·8	76	168·8	61	141·8
90	194	75	167	60	140
89	192·2	74	165·2	59	138·2
88	190·4	73	163·4	58	136·4
87	188·6	72	161·6	57	134·6
86	186·8	71	159·8	56	132·8

TABLE OF CORRESPONDING TEMPERATURES, ETC.—*continued.*

DEG. CENT.	DEG. FAHR.	DEG. CENT.	DEG. FAHR.	DEG. CENT.	DEG. FAHR.
55	131	36	96·8	17	62·6
54	129·2	35	95	16	60·8
53	127·4	34	93·2	15	59
52	125·6	33	91·4	14	57·2
51	123·8	32	89·6	13	55·4
50	122	31	87·8	12	53·6
49	120·2	30	86	11	51·8
48	118·4	29	84·2	10	50
47	116·6	28	82·4	9	48·2
46	114·8	27	80·6	8	46·4
45	113	26	78·8	7	44·6
44	111·2	25	77	6	42·8
43	109·4	24	75·2	5	41
42	107·6	23	73·4	4	39·2
41	105·8	22	71·6	3	37·4
40	104	21	69·8	2	35·6
39	102·2	20	68	1	33·8
38	100·4	19	66·2	0	32
37	98·6	18	64·4		

Pages 253, 254.—**The Tempering of Instruments and Tools.**—As many are in the habit of re-shaping and tempering their own excavators, &c., and all may occasionally find it necessary to adapt an instrument for special circumstances, the following remarks upon tempering may be of value. Before the instrument can be filed or bent into shape, its temper must be taken out; this is done by heating it to a red heat. But it must be remembered that "over-heating" destroys the steel and permanently deprives it of its essential qualities. An instrument heated to a white heat, for example, cannot subsequently be satisfactorily tempered, and may indeed be considered altogether useless. Therefore it is most important to remember that in heating to extract the "temper" of the instrument or tool that is to be re-shaped, only a dull red should be given to the metal; it is then allowed to cool in air, when it may be worked upon. After being shaped, fine filed, and smoothed, the instrument is next heated in the flame to a cherry red, and instantly plunged into cold water. This operation leaves the steel too hard for our purpose, so that it is necessary to "draw" the temper to the required amount. This is done by very carefully heating the instrument more or less according to the work it is designed for. The "point" is first brightened by rubbing it on sand paper, so that the colours which the heat imparts to the steel may be clearly observed. A pale straw colour is the one allowed for excavators; when that is reached, the instrument is at once withdrawn from the flame. Or the following method may be adopted: "For excavating instruments, cover with oil and hold over the alcohol lamp, apply the heat to the instrument a little back from the point, and move it backwards and forwards in the flame so as to heat it up slowly and uniformly, and at the instant the oil takes fire at the point of the instrument it should be plunged into cold water."

Tempering Liquid.—2 quarts soft rain water, ½ oz. corrosive sublimate, 1 oz. common salt.

Tempering Drills and Gravers.—When the graver or drill is too hard —which may be known by the frequent breaking of the point—temper as follows: heat a poker red-hot and hold the graver to it within an inch of the point, waving it to and fro till the steel changes to a light straw colour; then put the point into oil to cool.

Steel alloyed with 1-500th part of platinum is rendered harder, more malleable, and better adapted for cutting instruments.

Pouillet has employed an air thermometer provided with a bulb of platinum to determine with precision high degrees of temperature.*

RESULTS.

	FAHR. DEG.	CENT. DEG.
Incipient red heat corresponds to	977	525
Dull red heat corresponds to	1292	700
Incipient cherry red corresponds to	1472	800
Cherry red corresponds to	1652	900
Clear cherry red corresponds to	1832	1000
Deep orange corresponds to	2012	1100
Clear orange corresponds to	2192	1200
White corresponds to	2372	1300
Bright white corresponds to	2552	1400
Dazzling corresponds to	2732 TO 2912	1500 TO 1600

TABLE FOR TEMPERING.

	FAHR. DEG.	
1. Very pale straw yellow	430	Tools for metal excavators, &c.
2. Shade of darker yellow	450	
3. Darker straw	470	Tools for wood, screw taps, &c.
4. Still darker straw	490	
5. Brown	500	Hatchets, chipping, and other percussion tools, saws, &c.
6. Yellow, tinged slightly with purple	520	
7. Light purple	530	
8. Dark purple	550	Springs.
9. Dark blue	570	
10. Paler blue	590	
11. Still paler blue	610	Too soft for above purposes.
12. Still paler blue tinge of green	630	

* Percy's "Metallurgy."

Pages 255, 256.—TABLE OF USEFUL NUMERICAL DATA.*

1 centimetre	=	·3937 inches.
1 decimetre	=	3·937 inches.
1 metre	=	39·37 inches.
1 gramme	=	15·432 grains.
1 kilogramme	=	15432 grains.
1 kilogramme	=	35·274 ounces avoirdupois.
1 kilogramme	=	2·2046 pounds.
1 ounce avoirdupois	=	437·5 grains.
1 pound avoirdupois	=	7000 grains.
1 pennyweight troy	=	24 grains.
1 ounce troy	=	480 grains.
1 pound troy	=	5760 grains.
1 litre of water	=	15432 grains.
1 litre of water	=	1000 grammes.
1 litre of water	=	35 ounces by measure.
1 gallon of water	=	4·536 litres.
1 gallon of water	=	70000 grains.
1 cubic inch of water	=	252·5 grains.
1 ounce measure	=	1·733 cubic inches.
1 pint (or 20 ounces)	=	34·659 cubic inches.
1 gallon (or 160 ounces)	=	277·276 cubic inches.
1 litre	=	61·024 cubic inches.

Page 256.—At the ordinary temperature and pressure of the atmosphere 100 cubic inches of:—

Hydrogen	weigh	2·11	grs.
Ammonia	,,	18·00	,,
Vapour	,,	28·57	,,
Nitrogen	,,	29·70	,,
Atmospheric air	,,	31·00	,,
Oxygen	,,	33·80	,,
Carbonic anhydride	,,	46·50	,,
Sulphurous anhydride	,,	67·78	,,
Chlorine	,,	76·40	,,
Sulphuretted hydrogen	,,	80·50	,,

* "Electro-Metallurgy" (Gore).

SOLDERING BENCH.

Soldering Lamp, Mouth Blowpipe, Soldering Lamp with Foot Bellows,
Investment Heater and Oxygen Blowpipe.

SOLDERING SUPPORTS.

Wire Bosses or Wigs, Asbestos Felt, Fibre, or Blocks,
Melotte's Soldering Outfit, Sand Crock with Damp Sand, Soft-Iron Cramps,
Charcoal Blocks,
Pumice Blocks set in Plaster, Soft-Iron Binding Wire, and Soldering Grip.

SOLDERING MATERIALS.

Cadmium Gold Solder, Gold and Silver Solder, Borax, Borax Slab,
Drop Bottle containing Solution of Borax, Corn Tongs,
Water Crock for quenching Hot Plate after Soldering, Metal Box containing
Compartments to hold Solder.

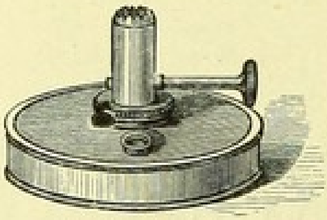
PICKLE OR ACID FOR REMOVING FLUX.

Evaporating or Fume Chamber,
Fletcher's Sand Bath and Slow-Combustion Heater, Pickle Dish of Copper or
Porcelain, Hydrochloric and Sulphuric Acid diluted, Clean Water
in Crock for washing off Pickle.

SOLDERING BENCH—*continued.*

APPLIANCES FOR SOLDERING.

Fig. 232.

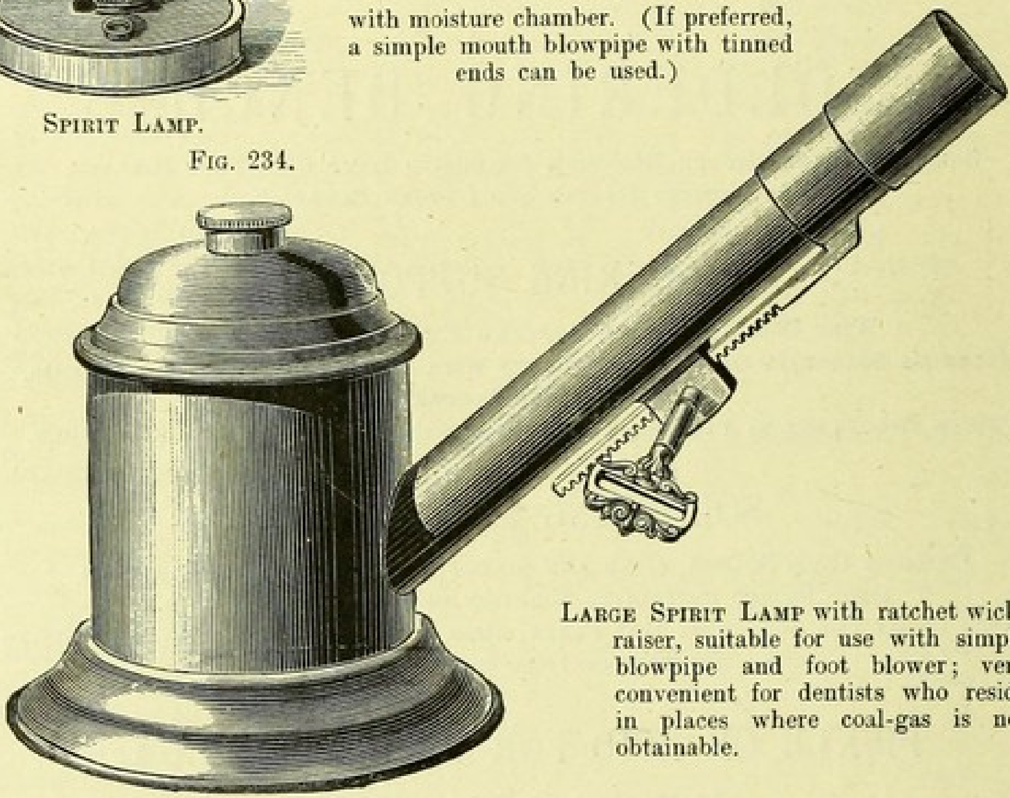


Spirit Lamp.

Fig. 233.

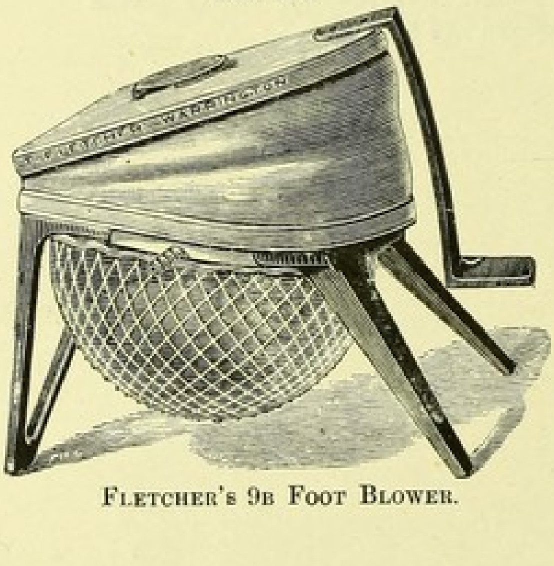
Mouth Blowpipe
with moisture chamber. (If preferred, a simple mouth blowpipe with tinned ends can be used.)

Fig. 234.



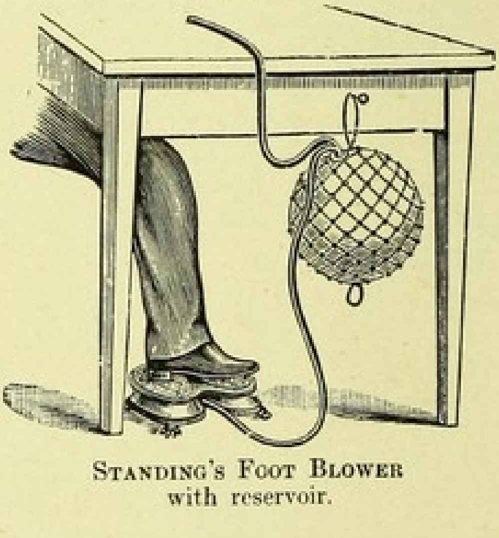
Large Spirit Lamp with ratchet wick-raiser, suitable for use with simple blowpipe and foot blower; very convenient for dentists who reside in places where coal-gas is not obtainable.

Fig. 235.



Fletcher's 9b Foot Blower.

Fig. 236.



Standing's Foot Blower
with reservoir.

SOLDERING BENCH—*continued.*

APPLIANCES FOR SOLDERING.

Fig. 237.

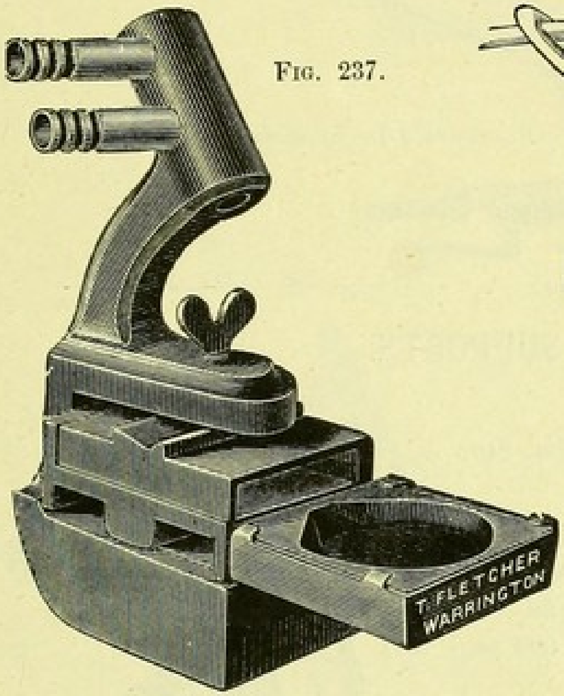


Fig. 238.

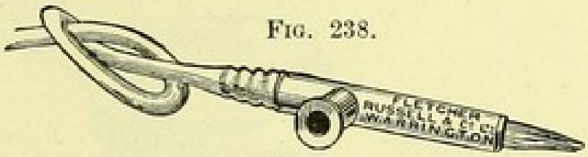


Fig. 239.

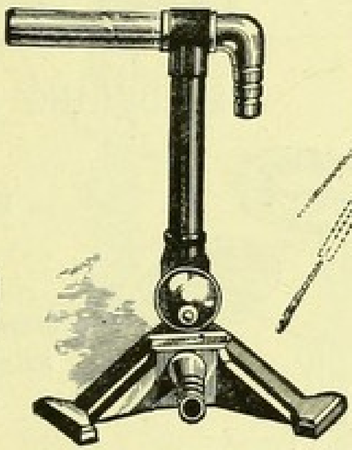


Fig. 240.

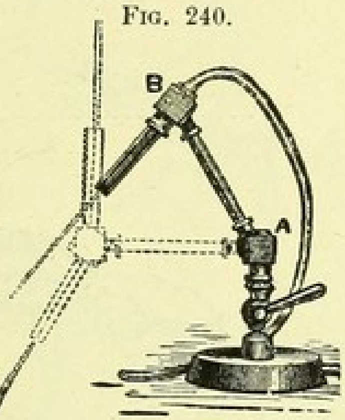


Fig. 237.—Fletcher's Melting Arrangement, slightly under half-size. In this arrangement the two parts of the ingot mould slide on each other to admit of ingots of any width, within its range, being cast; thus both plate and wire ingots can be cast.
„ 238.—Fletcher's Universal Blowpipe—simple form.
„ 239.—Fletcher's Universal Blowpipe—on stand, with swivel joint.
„ 240.—Fletcher's Double-jointed Herapath Blowpipe.

Fig. 241.

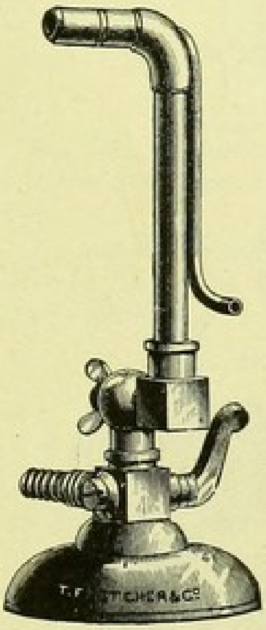


Fig. 242.

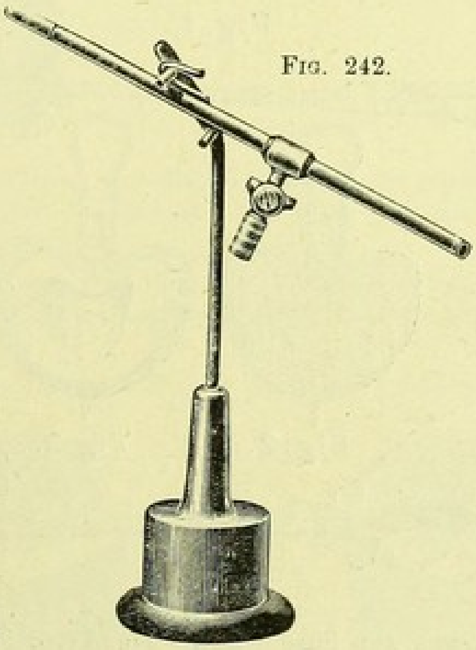


Fig. 243.

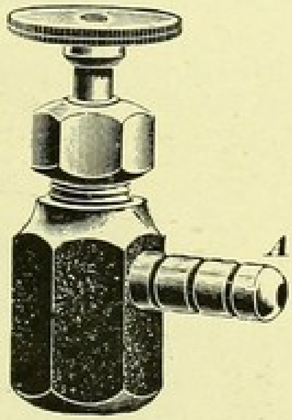


Fig. 241.—Fletcher's No. 1 Dentist's Adjustable Blowpipe.
„ 242.—Mr. Gartrell's Oxygen Blowpipe.
„ 243.—Mr. Gartrell's Fine-Adjustment Valve, for Oxygen Cylinders.

SOLDERING BENCH—*continued.*

APPLIANCES FOR SOLDERING.

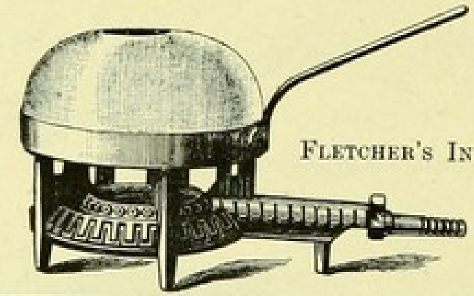


Fig. 244. Fletcher's Investment Heater.

SOLDERING SUPPORTS.

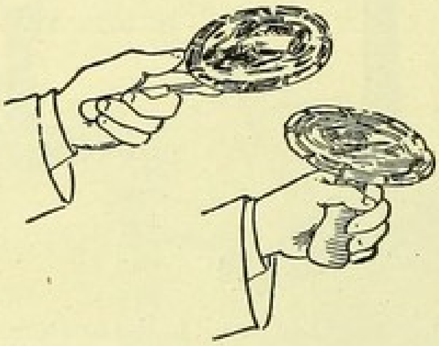


Fig. 245.

Soldering Bosses used by the Author (see page 116).

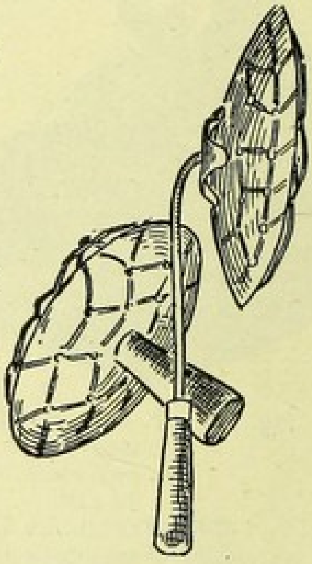
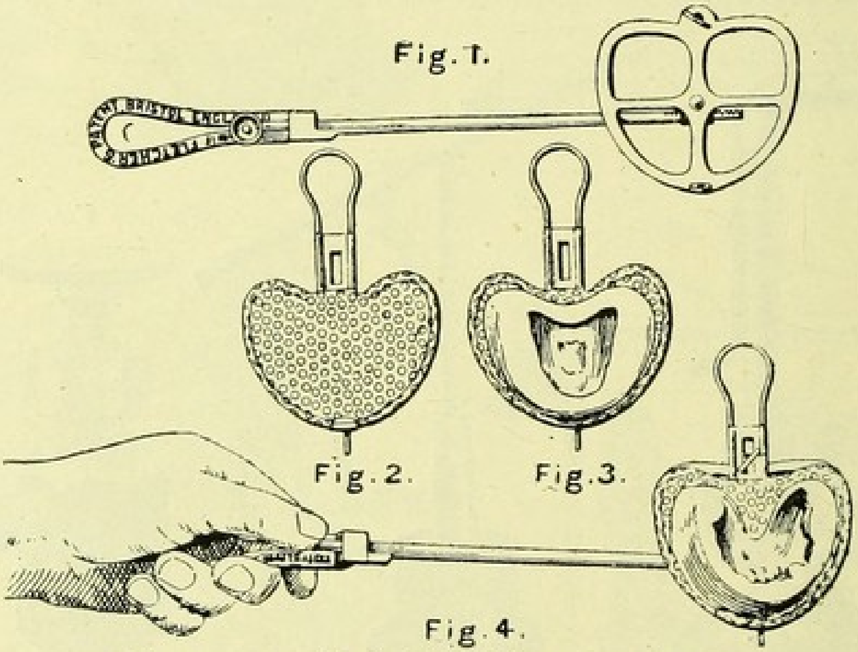


Fig. 246.



Fletcher and Sons' "Roto" Soldering Spoon.

1. Frame without the Tray. 2. Perforated Copper Investing Tray.
3. Case inserted in investing material ready for heating up over a Bunsen burner.
4. Case mounted upon the Spoon and heated up ready for soldering.

SOLDERING BENCH—*continued.*

SOLDERING SUPPORTS.

Fig. 248.

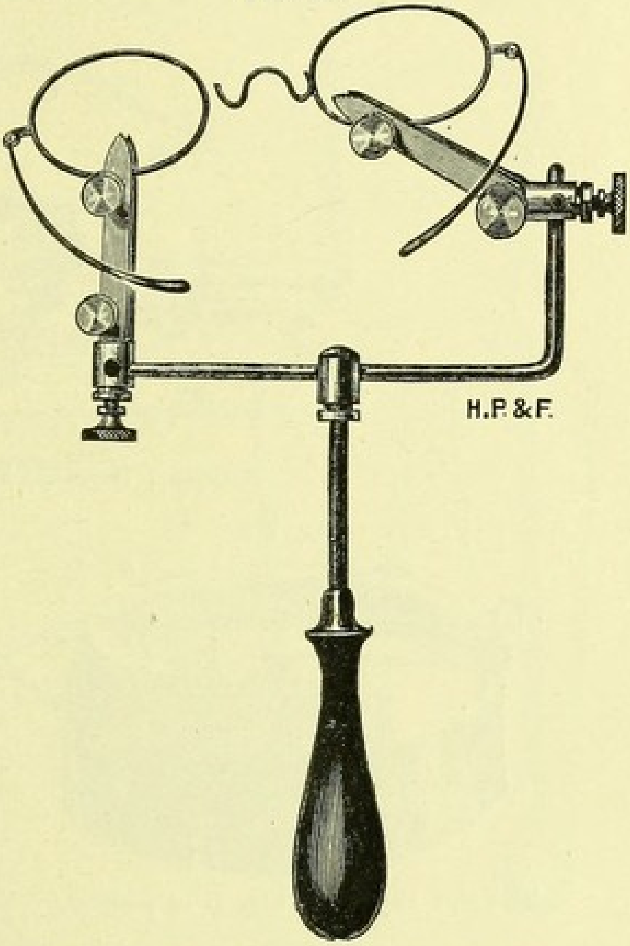


Fig. 247.

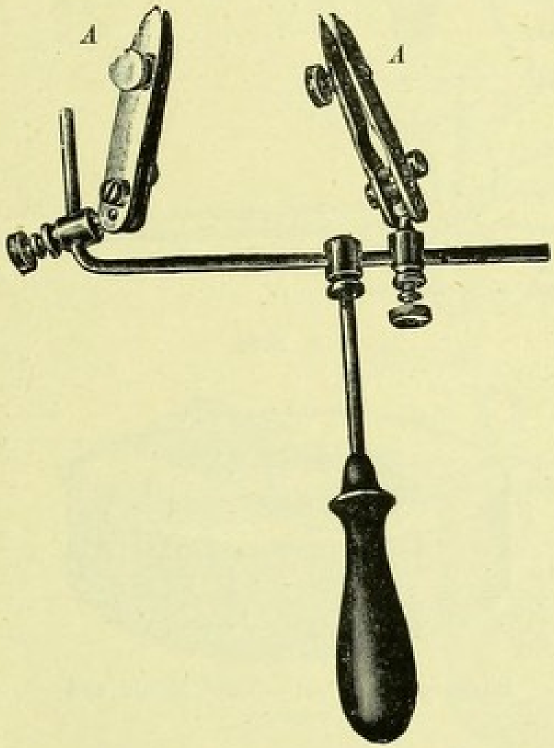
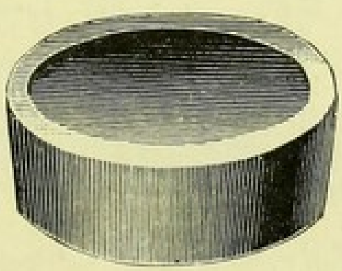


Fig. 247.—Soldering Grip for holding articles in any position. A small object can be conveniently secured between the jaws *A A* when they are set near enough to each other.

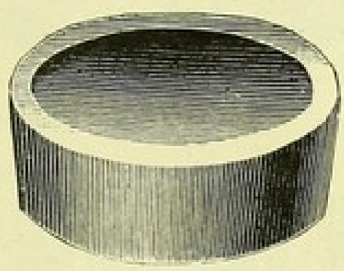
Fig. 248.—Shows the same grip holding a pair of spectacles, from which its value and usefulness, in making regulating appliances with gold or German silver wire, will be clearly understood.

Fig. 249.



Asbestos Soldering Block.

Fig. 250.



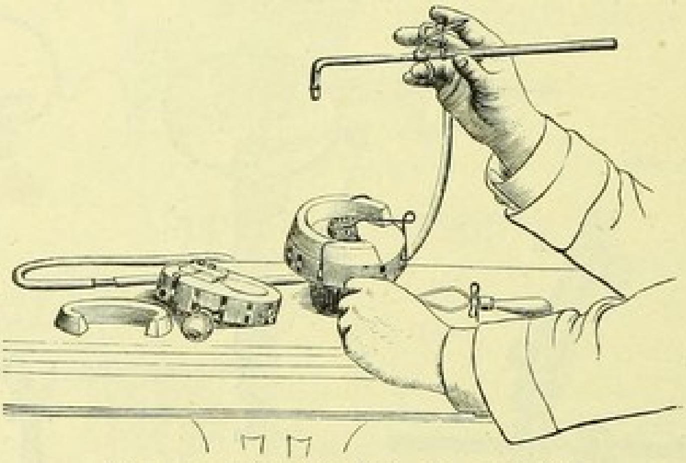
Fletcher's Moulded Carbon Block.

SOLDERING BENCH—CONTINUED.

SOLDERING SUPPORTS.

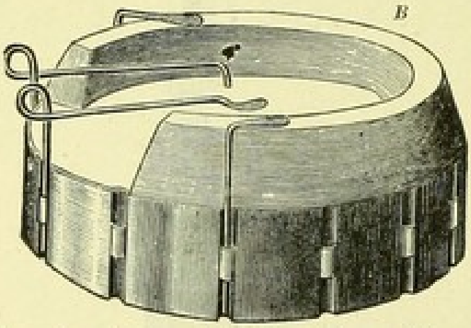
FIGS. 251-255.—DR. MELOTTE'S SOLDERING OUTFIT.

FIG. 251.



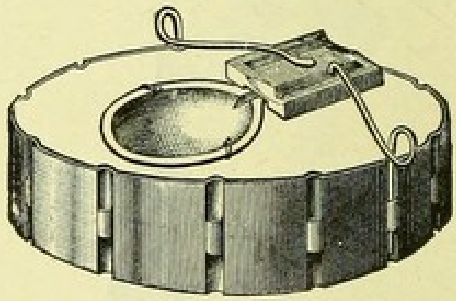
Blowpipe, Blowpipe Pad, etc., complete.

FIG. 252.



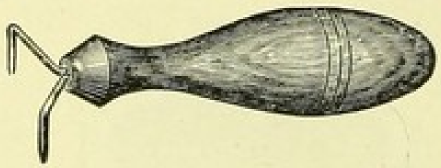
Blowpipe Pad, with Rim *B* in position.

FIG. 253.



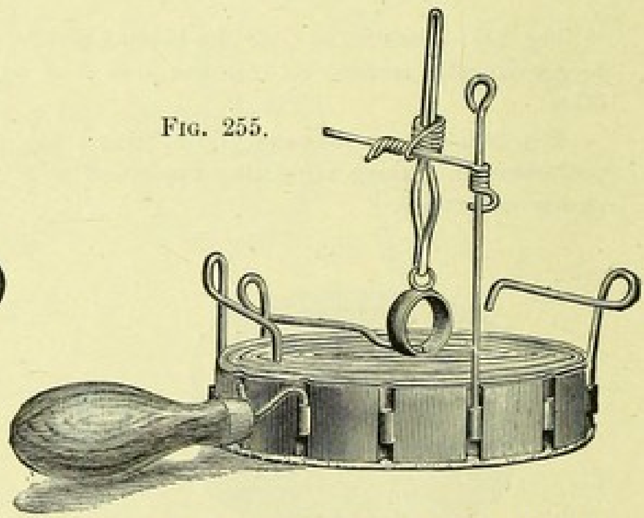
Blowpipe Pad, with Ingot Mould and Crucible.

FIG. 254.



Handle for Lifting the Blowpipe Pad. The points can be inserted in any two of the loops on the metal band, which is fixed round the asbestos.

FIG. 255.



Blowpipe Pad, showing vertical and horizontal wires which support the clamp that holds a band while it is being soldered.

SOLDERING BENCH—*CONTINUED.*

SOLDERING SUPPORTS.

FIG. 256.

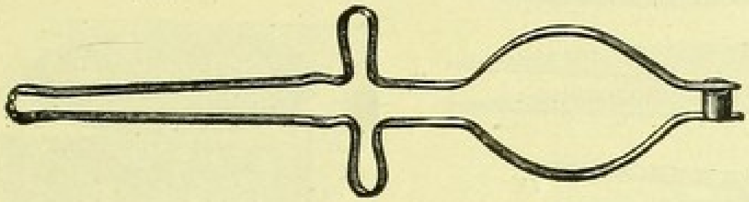


FIG. 257.

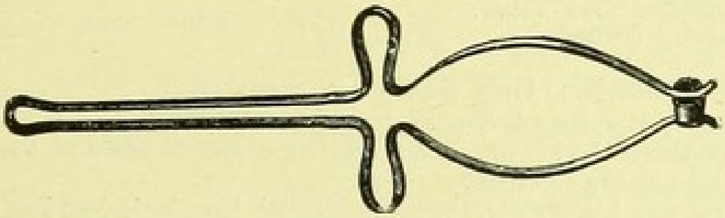
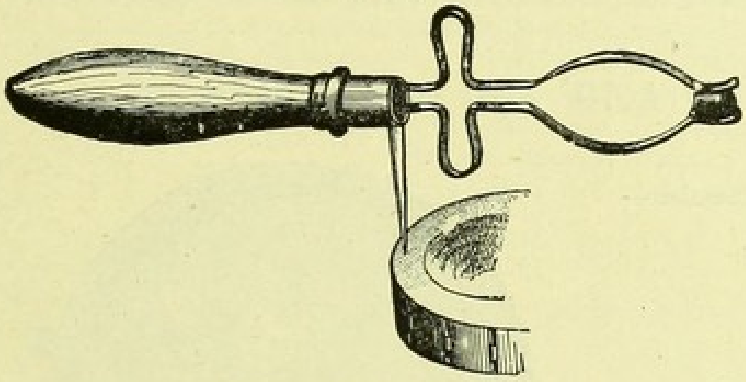


FIG. 258.



TWEEZERS (DR. MELOTTE'S)
for holding the collars and caps of gold crowns; also useful for many other purposes.

FIG. 259.

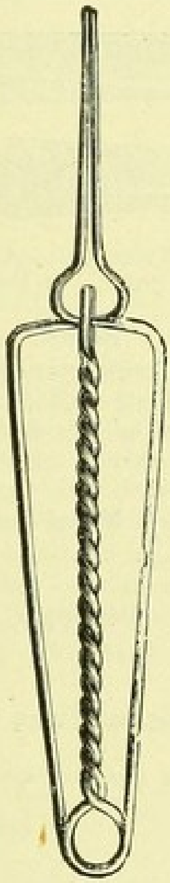
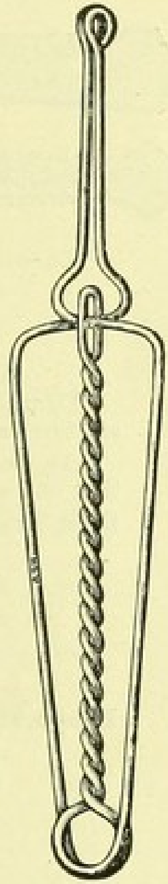


FIG. 260.



SELF-CLOSING TWEEZERS
for holding the collars and caps of gold crowns, etc.

ARTICLES, VARIOUS.

Asbestos Felt or Fibre.

Cramps and Charcoal Blocks.

Pumice Blocks set in Plaster of Paris.

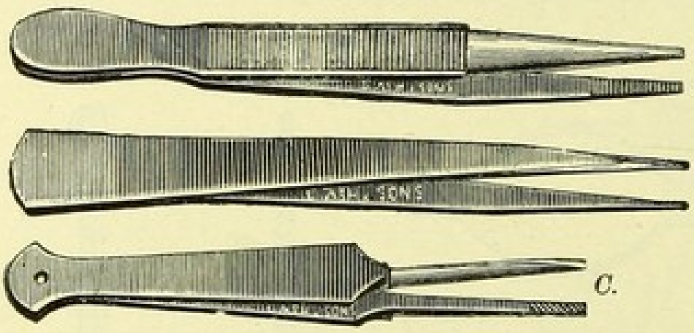
Sand Crock with damp Sand.

Soft Iron Binding Wire.

SOLDERING BENCH—*continued.*

SOLDERING MATERIALS, ETC.

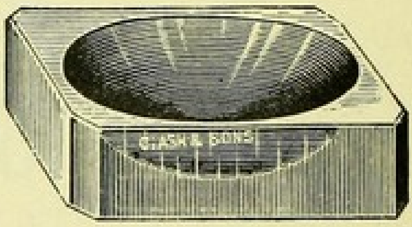
Fig. 261.



A. B. C.

Solder Tweezers.—Also called Corn Tongs.
A Blunt. *B* Pointed. *C* Blunt.

Fig. 262.



Borax Slab.

Borax. **Cadmium, Gold Solder**—*see page* 112.

Crock containing water for cooling plates after soldering.

Drop Bottle holding solution of borax, with notch cut in the cork to admit of the solution being quickly discharged on the borax slab.

An old-fashioned ink bottle, or a jeweller's acid bottle, with wide base, is the best kind that can be used, as it is not readily upset or easily broken.

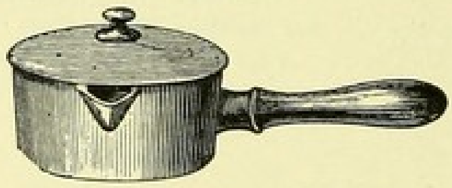
Gold Solder. **Metal Box with compartments for holding Solders.** **Silver Solder.**

PICKLE OR ACID AND APPLIANCES.

Evaporating or Fume Chamber—

see Fig. 4, *page* 9.

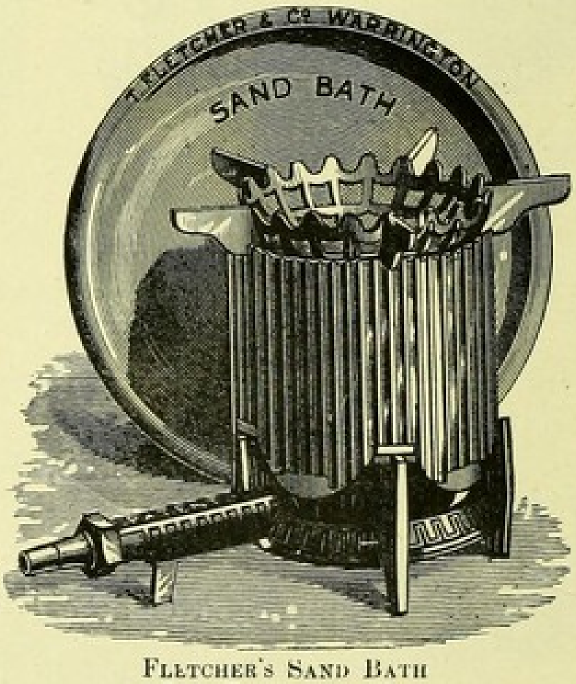
Fig. 263.



Porcelain Pickle Pan.

(The depôts also supply various sizes of round and oval Copper Pickle Pans.)

Fig. 264.



Fletcher's Sand Bath
and Low Temperature Burner.

Acid, Hydrochloric and Sulphuric, diluted. **Crock of Clean Water for Washing off Pickle.**

WAX BENCH.

HEATING, CUTTING AND FASTENING TOOLS, MODELLING MATERIALS.

Bunsen Burner Gas Supply, Vaseline Pot, Copper Tools for Modelling or Cutting Wax, Pointed Nose Pliers or Pin Benders, Straight Forceps for Lifting off Tube Teeth after Melting Cement for Repair, Sulphur Box and Lifter, Callipers, Kirby's Callipers, Dividers, Kirby's Dentist's Square, Wax in Sheet and Sticks, and Small Copper Pot for Melting Wax.

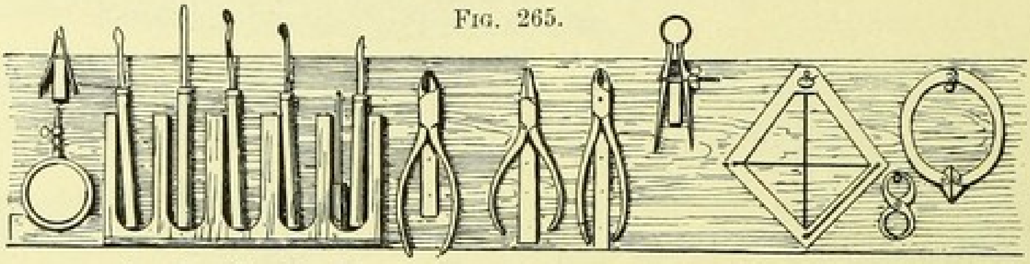
FUSIBLE METAL.

Lennox's Outfit for Casting Fusible Metal.

WAX BENCH—*CONTINUED.*

HEATING, CUTTING AND FASTENING TOOLS, AND MODELLING MATERIALS.

Fig. 265.



A. B. C. D. E.

Fig. 267.

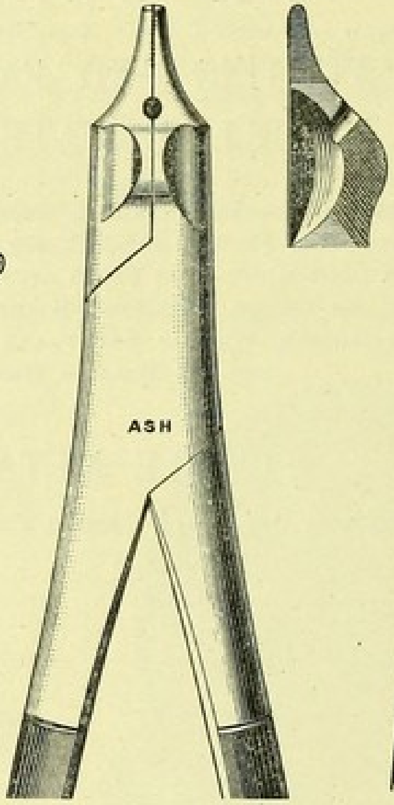


Fig. 268.

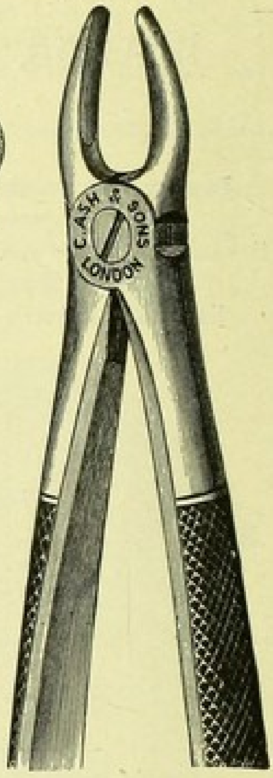


Fig. 266.

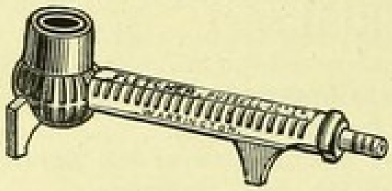


Fig 269.

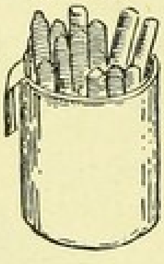


Fig. 265.—Rack designed by the Author, showing Wax-Modelling Tools, etc. *A, B, C, D, E* represent a set of wax-modelling tools, with the metal parts made of copper, which retains heat longer than steel—see pages 22, 290, 372.

Fig. 266.—Fletcher's Argand Bunsen Burner.

Fig. 267.—Pliers for roughening, bending and cutting the pins of teeth—7 inches long.

Fig. 268.—Forceps with straight beaks for lifting off tube teeth in repairs, after the sulphur cement is melted—5¾ inches long.

Fig. 269.—"Sticking-Wax" in holder.

Modelling Wax.

Small Copper Pan for melting wax in.

Sulphur in box.

Vaseline in pot.

WAX BENCH—*continued.*

TOOLS, VARIOUS.

Fig. 270.

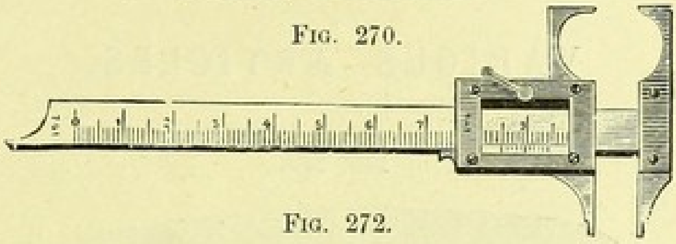


Fig. 271.

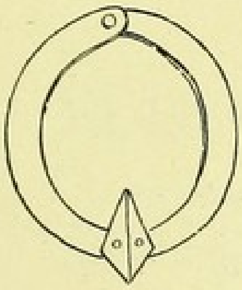


Fig. 272.

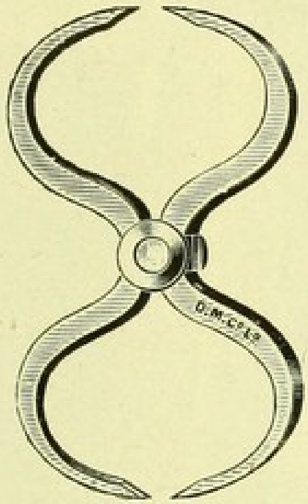


Fig. 273.

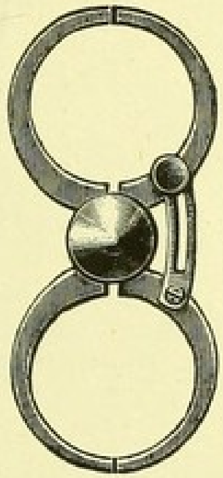


Fig. 274.

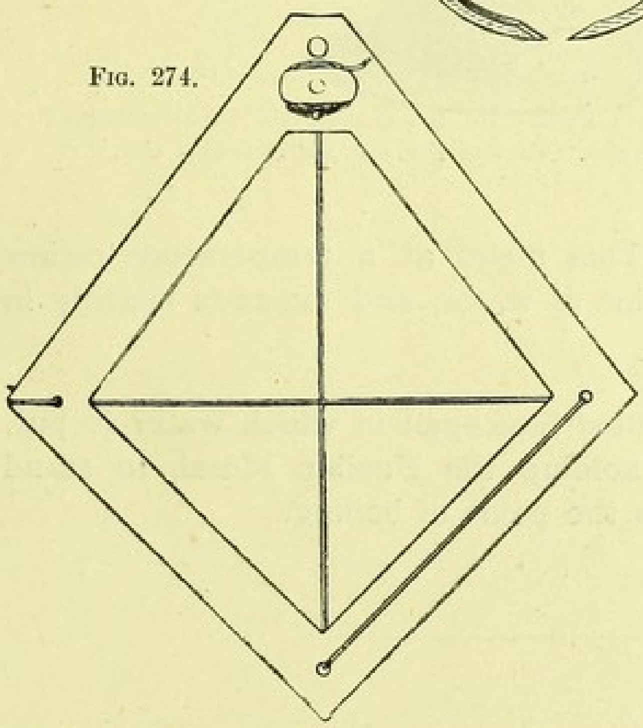


Fig. 275.

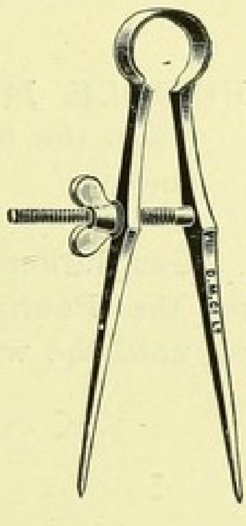
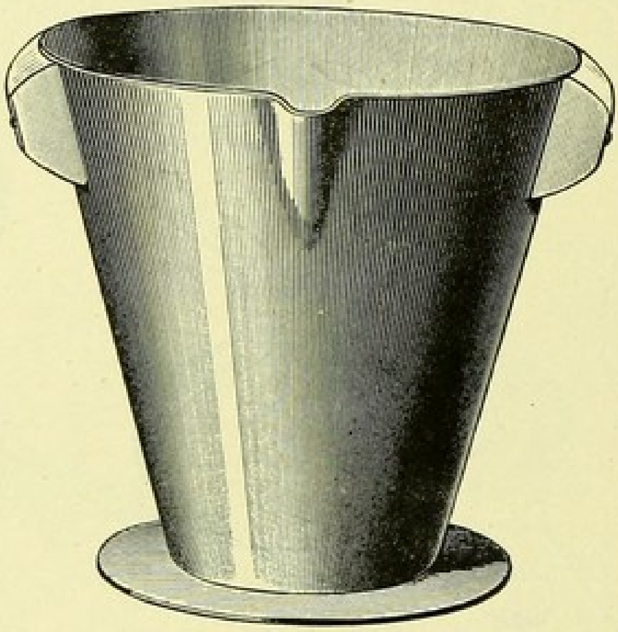


Fig. 270.—Boley's Millimetre Gauge—a most useful tool for making accurate measurements. 131 mm. long; measures up to 100 mm.
„ 271.—Mr. Amos Kirby's Callipers for setting swivels—one-third actual size.
„ 272.—Callipers for general work—3½ inches long.
„ 273.—Callipers with set screw—3½ inches long.
„ 274.—Mr. Amos Kirby's Dentist's Square, half-size.
„ 275.—Dividers, 4½ inches long.

WAX BENCH—*continued.*

VARIOUS ARTICLES.

Fig. 276.



Mr. R. P. Lennox's Pouring Cup for Fusible Metal.—Full size.

FUSIBLE METAL.—This melts at a temperature rather below the boiling point of water, and expands slightly in cooling.

Gas Burner and Shallow Saucepan in which water is put, for the Pouring Cup, holding the Fusible Metal, to stand in, until the water is on the point of boiling.

VULCANITE PACKING BENCH.

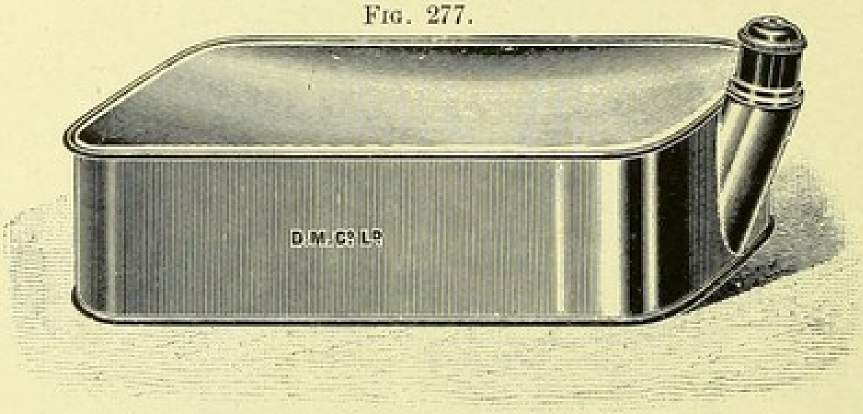
Water Heater for Vulcanite, Packing Cloth for Parting Flasks, Gas Burner for Warming Flasks, Flask Screw Press, Packers, Tweezers, Rubber in Boxes, and Wood Clamp or Support for Holding Vulcanite Flask in any Position.

VULCANITE PACKING.

Hedger's Glove for Left Hand, or Sleep's Cabman's Tan Driving Gloves.

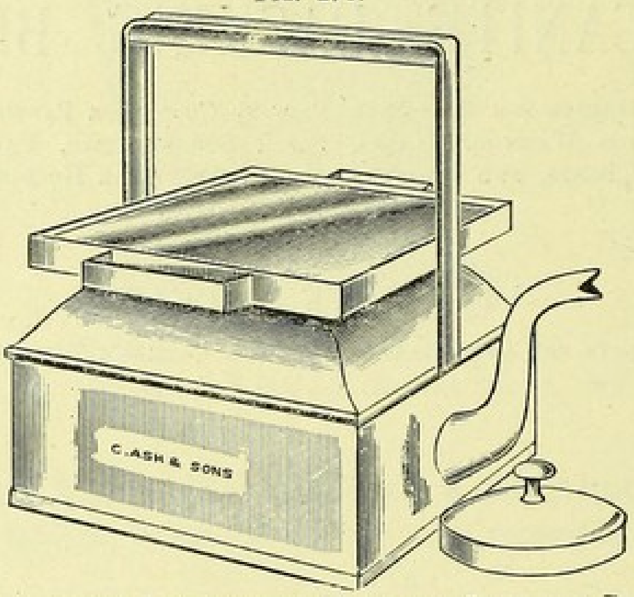
VULCANITE PACKING BENCH—*continued.*

Fig. 277.



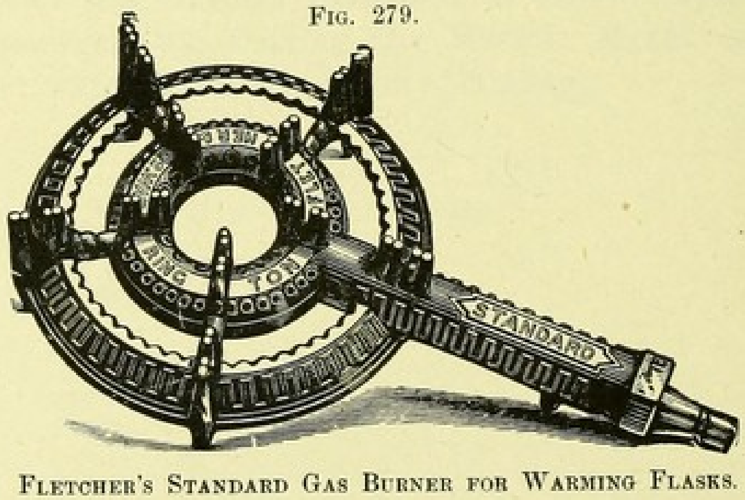
Hot-Water Plate for Softening Dental Rubber.

Fig. 278.



Mr. Vernon Knowles's Kettle with Plate for Softening Dental Rubber.

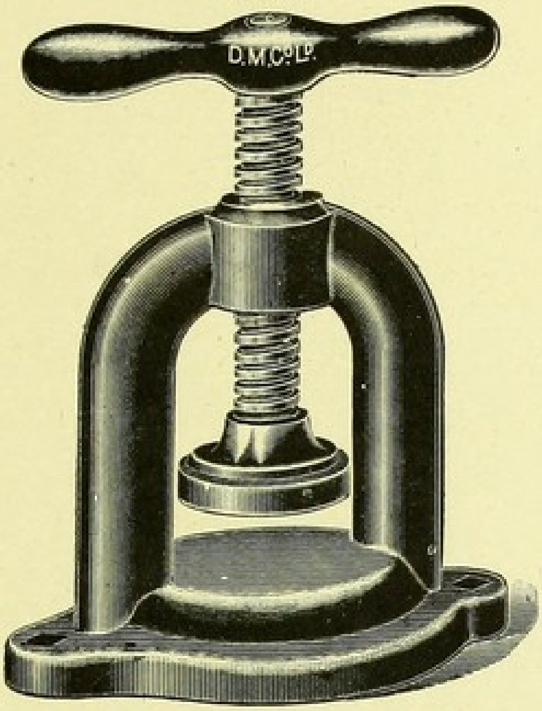
Fig. 279.



Fletcher's Standard Gas Burner for Warming Flasks.

VULCANITE PACKING BENCH—*continued.*

Fig. 280.



Screw Press for Closing Flasks.

Other forms of Flask Presses are made, but in my opinion the one shown is as useful as any.

APPLIANCES FOR DENTAL RUBBER.

Clean Slate or Tile for laying the small pieces of rubber on, which are to be warmed.

Tweezers for lifting the Softened Rubber.

Packing Tools.

APPLIANCES FOR SUPPORTING AND HOLDING FLASKS.

Wooden Clamp or Stand for supporting Flasks during packing.

Packing Cloth for Parting Flasks. This is the cloth in which the manufacturers pack the sheets of rubber.

Rubber or Cloth for holding Hot Flasks with.

A Thick Hedger's Left-Hand Glove for holding Hot Flasks with.

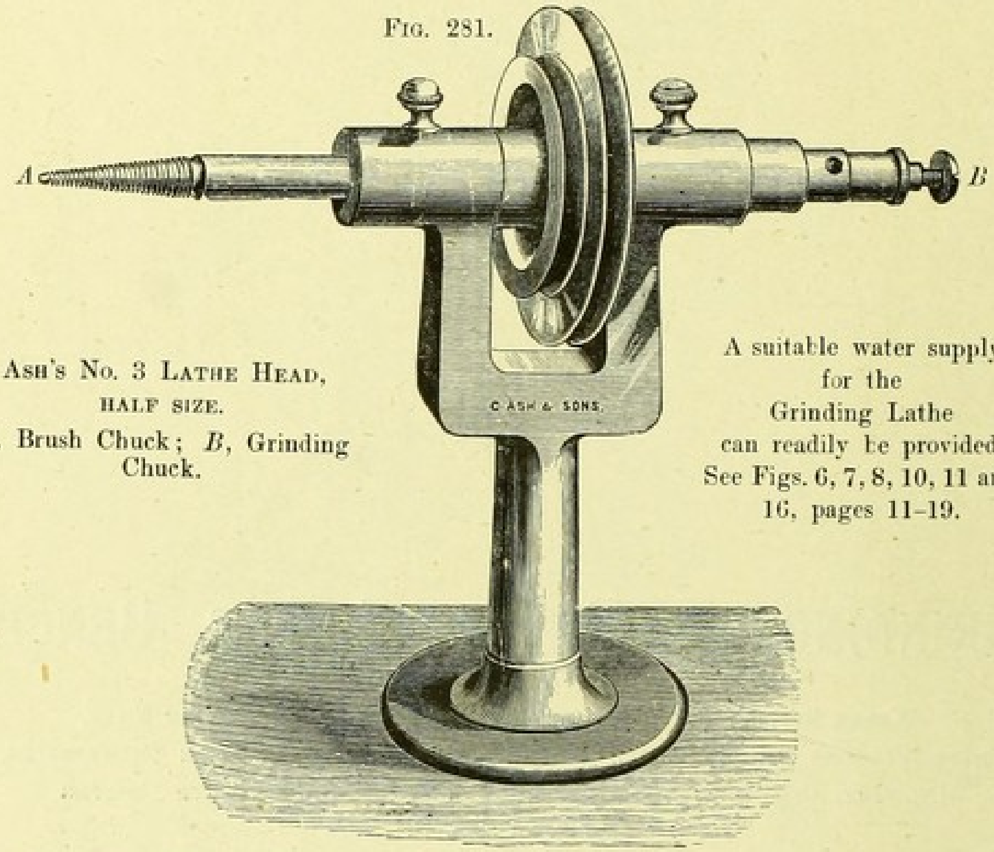
Sleep's Cabman's Tan Driving Gloves for holding Hot Flasks with.

Grinding or Fitting Lathe Bench.

Water Supply, Paint Pot and Brush, Tube Files, Needle Files, Black Diamond for Trimming Corundum Wheels, Steel Wire Countersink, Oil Can, Corundum and Carborundum Wheels, and Tooth Chipper.

GRINDING OR FITTING LATHE BENCH—*continued.*

Fig. 281.

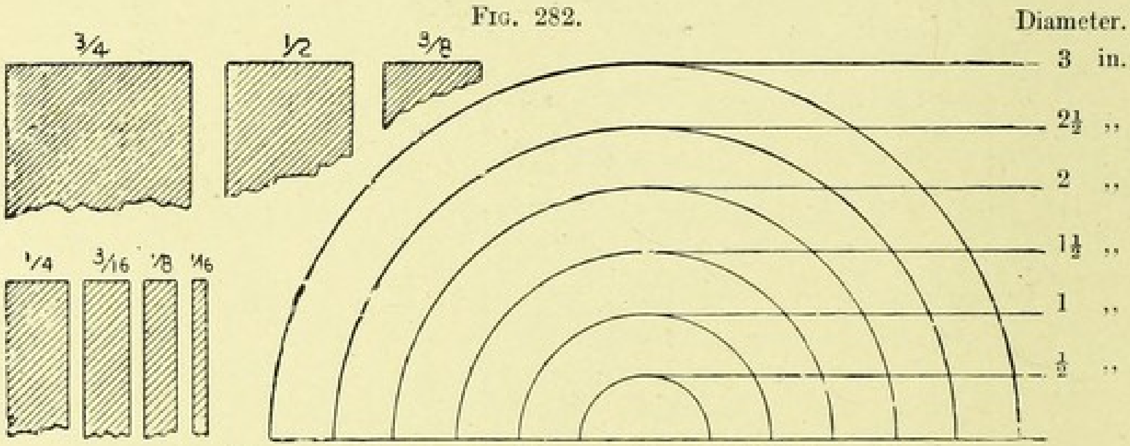


Ash's No. 3 Lathe Head,
half size.
A, Brush Chuck; *B*, Grinding Chuck.

A suitable water supply for the Grinding Lathe can readily be provided. See Figs. 6, 7, 8, 10, 11 and 16, pages 11–19.

Steel Wire Counter-Sink for tube teeth work, for enlarging the opening of the platinum tube when ground, and thus providing for the solder attaching the pin to the plate on which the tube tooth is fitted. If the wire is more than three diameters of the tube, there is a risk of splitting the tooth. The wire is ground true square, *hardened* and used with vaseline. A *globular* handle should be used.

Fig. 282.

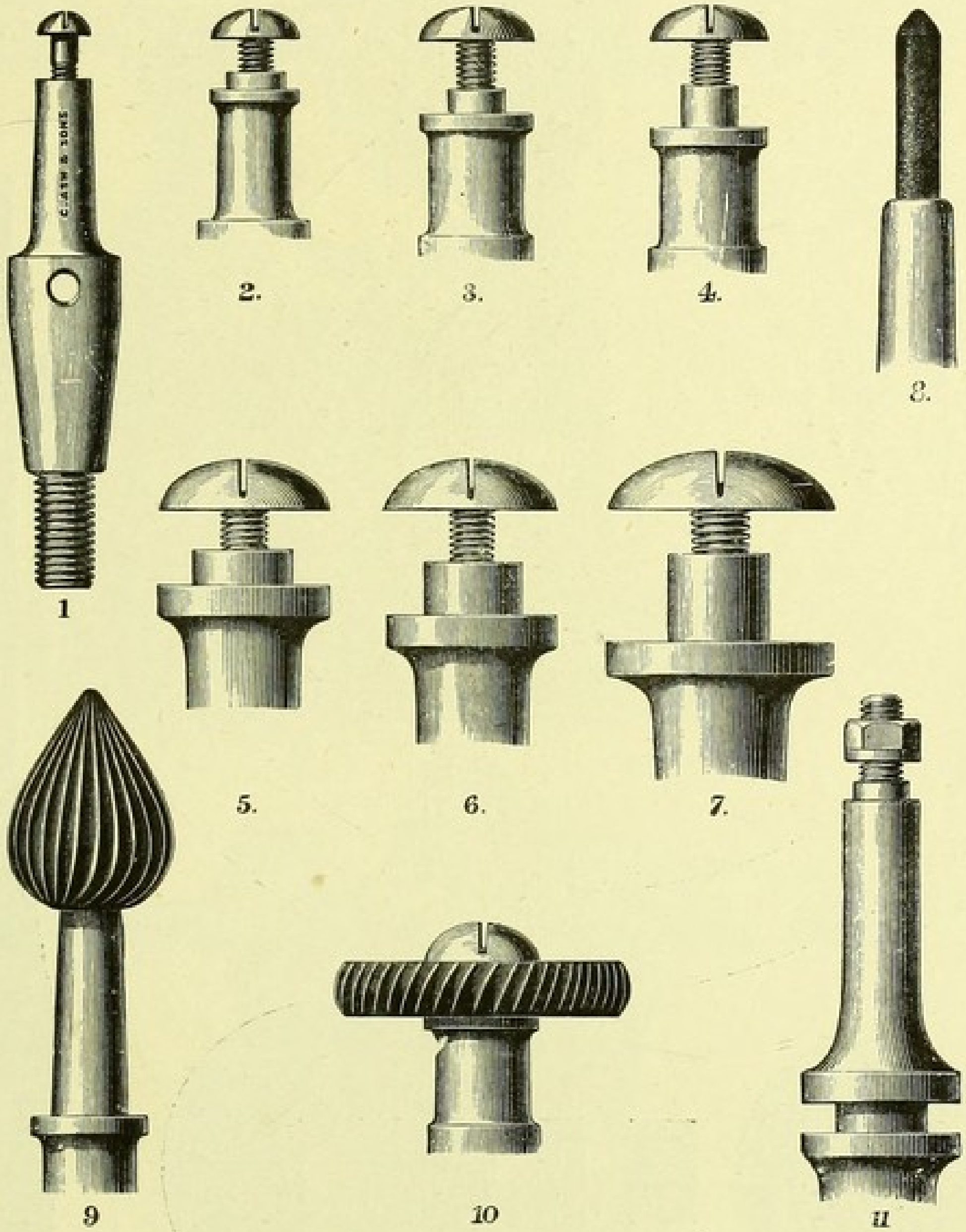


Carborundum Lathe Wheels (Sizes and Thicknesses.)

Made with square edges as shown above, and also with round edges, in the following grits —for cutting or grinding: No. 120, coarse; No. 150, medium; No. 180, medium fine.

GRINDING OR FITTING LATHE BENCH—*continued.*

Fig. 283.



Chucks for Lathe Head, Fig. 281.

No. 1, shown full size, is for button wheels.

Nos. 2, 3, 4 are for wheels of medium size of various thicknesses.

Nos. 5, 6, 7 are for wheels of large size of various thicknesses.

No. 8 is for Corundum Countersinks or "Nipples."

No. 9 is for Steel Cutting Burs.

No. 10 is for Steel Cutting Wheels.

No. 11 will hold two Carborundum Wheels, a medium and a small.

GRINDING OR FITTING LATHE BENCH—*continued.*

CORUNDUM WHEELS AND BLACK DIAMOND POINT.

Fig. 284.

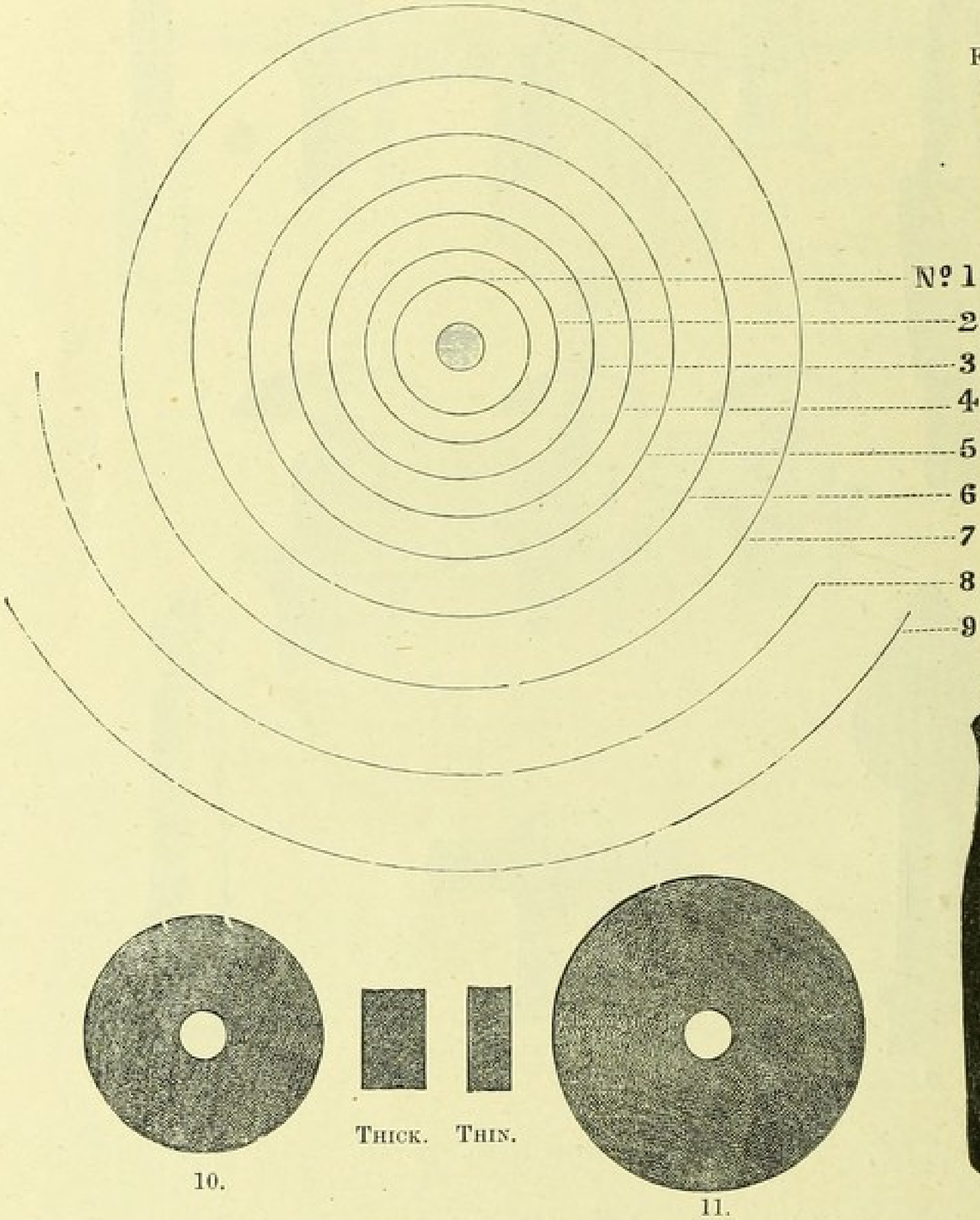


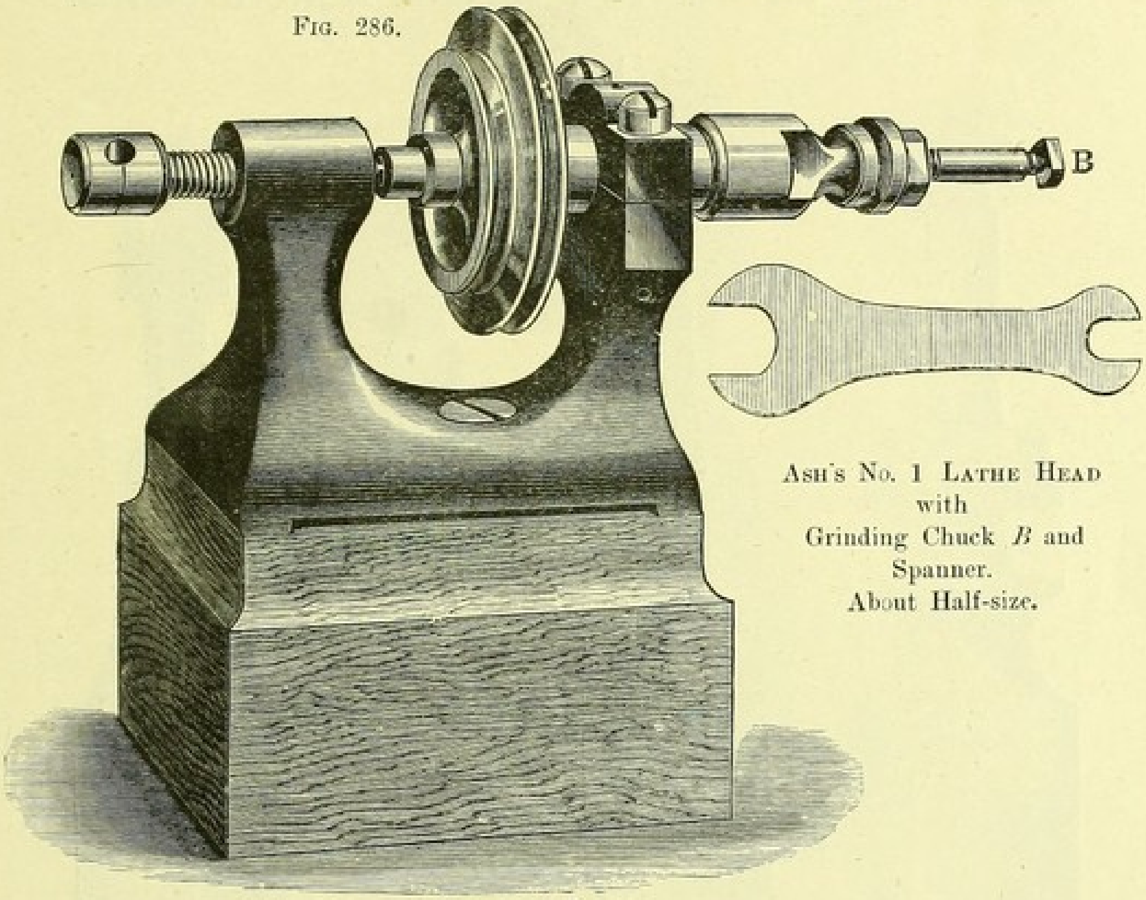
Fig. 285.

Fig. 284.—Nos. 1–9 represent various sizes of **Round-edge,** and Nos. 10 and 11 two sizes and thicknesses of **Square-edge** Corundum Wheels.

„ 285.—Black Diamond Point, for trueing Corundum Wheels, mounted in steel shank with wooden handle, as used by Mr. J. Charters Birch.

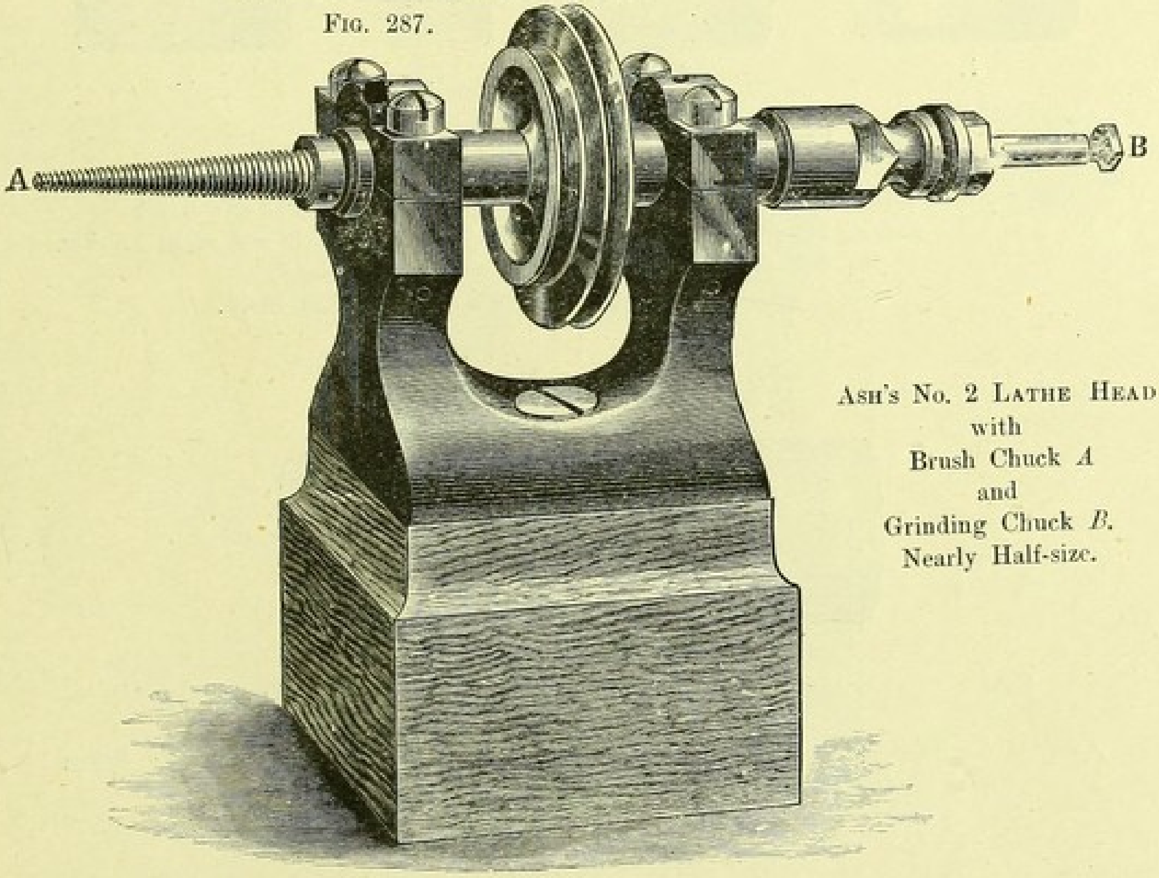
GRINDING OR FITTING LATHE BENCH—*continued.*

Fig. 286.



Ash's No. 1 Lathe Head
with
Grinding Chuck *B* and
Spanner.
About Half-size.

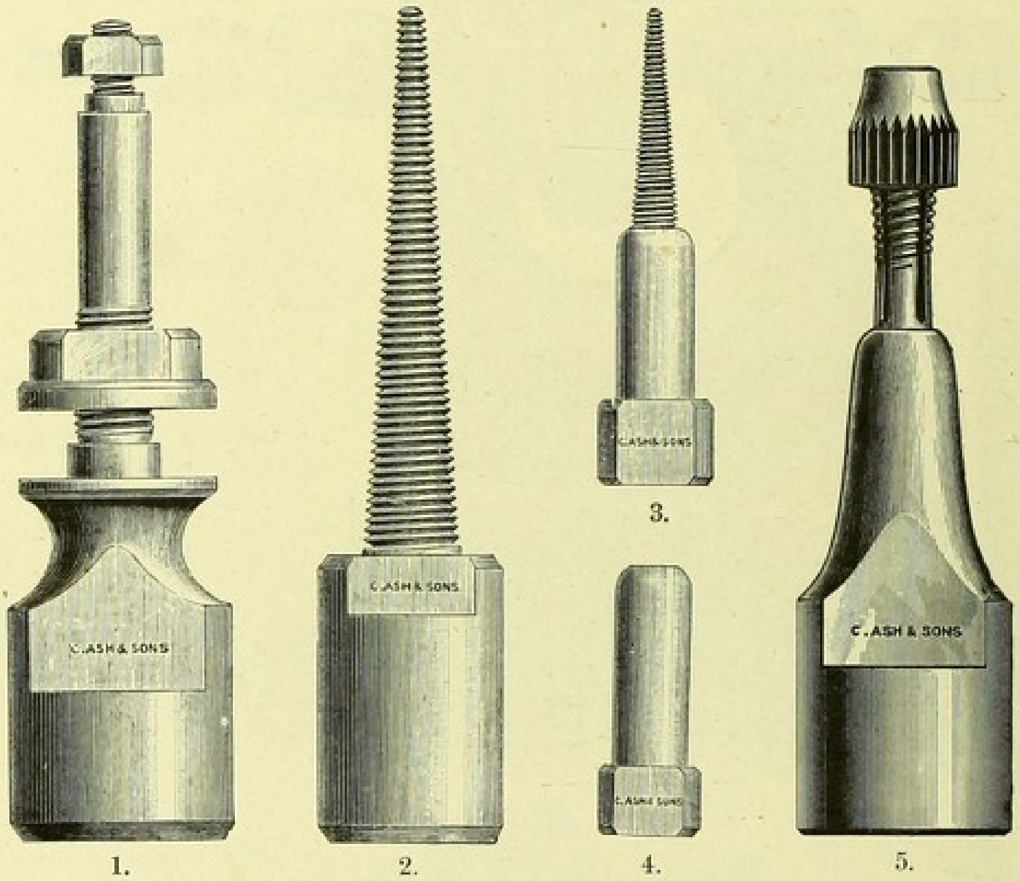
Fig. 287.



Ash's No. 2 Lathe Head
with
Brush Chuck *A*
and
Grinding Chuck *B*.
Nearly Half-size.

GRINDING OR FITTING LATHE BENCH—*continued.*

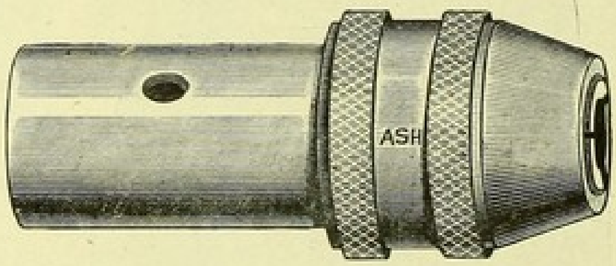
Fig. 288.



Chucks for Lathe Heads. Figs. 286, 287.

No. 1 will carry two Carborundum Wheels, one medium and one large.
No. 2 is for polishing brushes. No. 3 is for small wheels and small brushes.
No. 4 is for Corundum Countersinks or "Nipples."
No. 5, with screw clamp, is for Engine Burs and Drills.

Fig. 289.

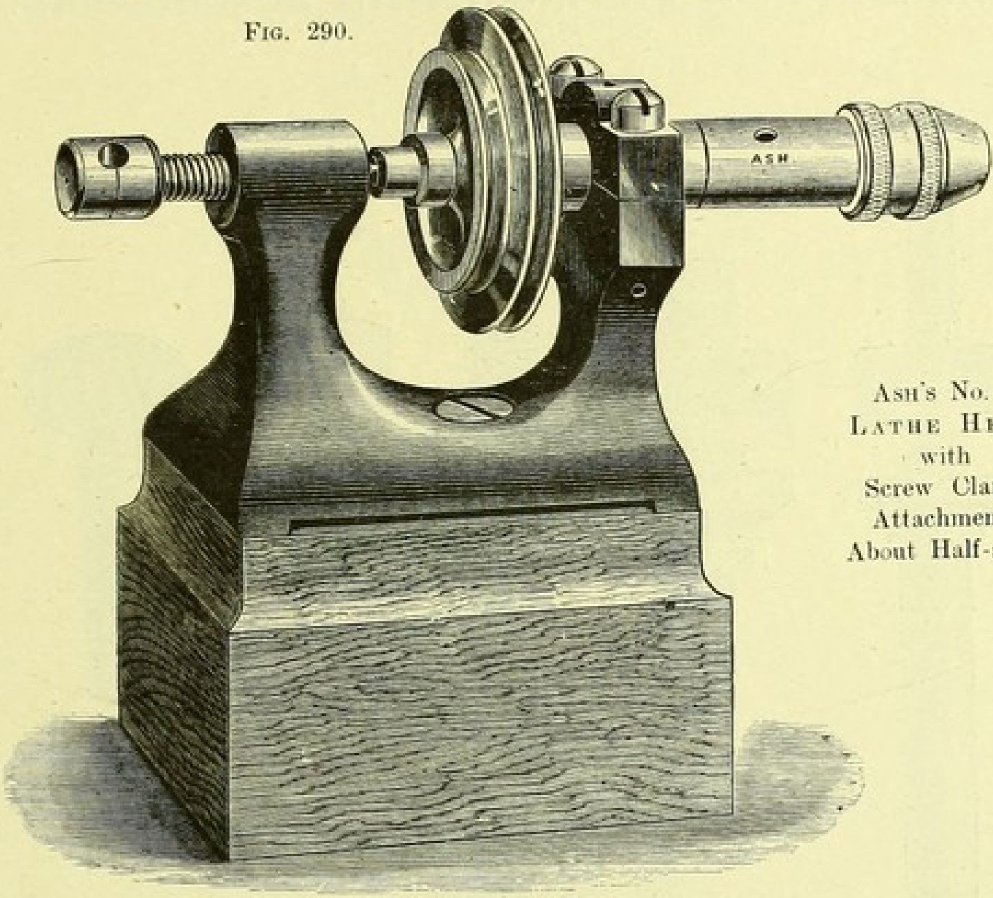


Screw Clamp Attachment, full size, for Lathe Heads, Figs. 286, 287.

Adapted for holding the Chucks with plain stems shown in Fig. 292, page 344. When used on the Lathe Heads referred to, it takes the place of Chuck *B*.

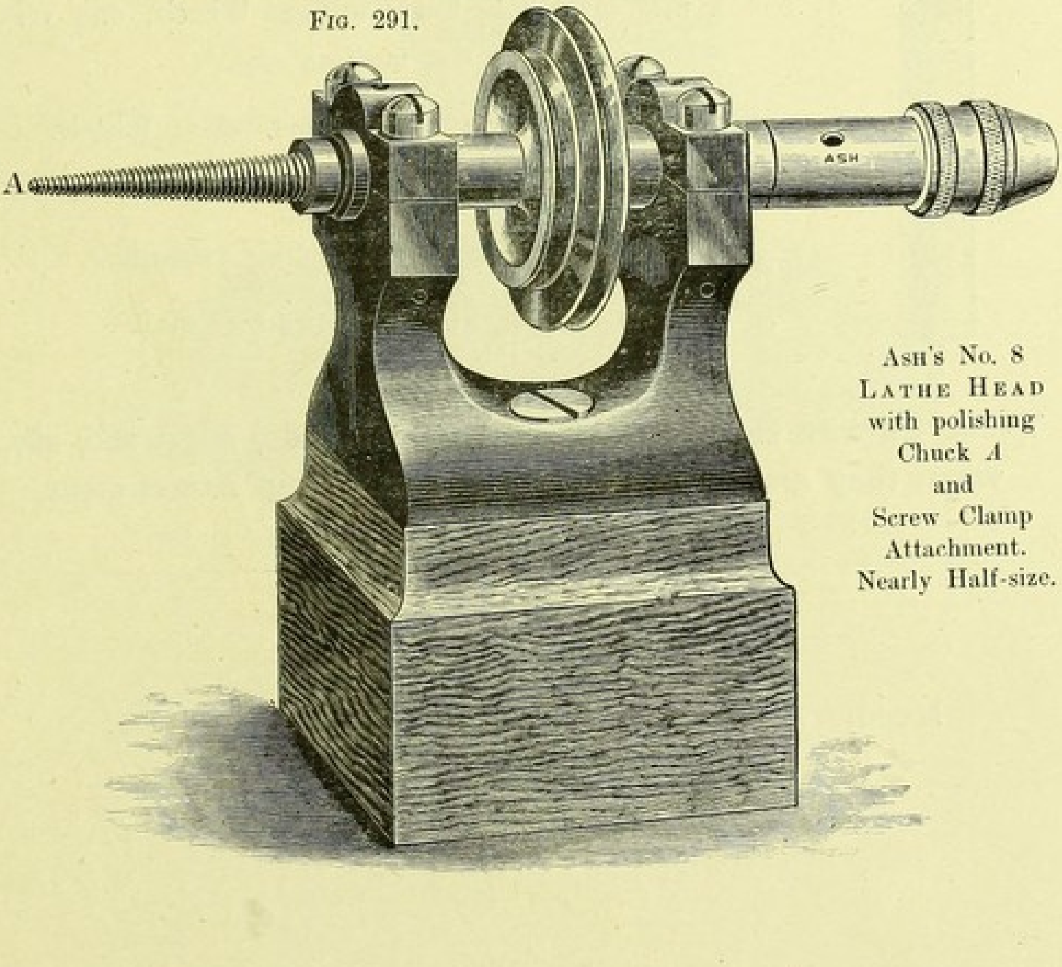
GRINDING OR FITTING LATHE BENCH—*continued.*

Fig. 290.



Ash's No. 7
Lathe Head
with
Screw Clamp
Attachment.
About Half-size.

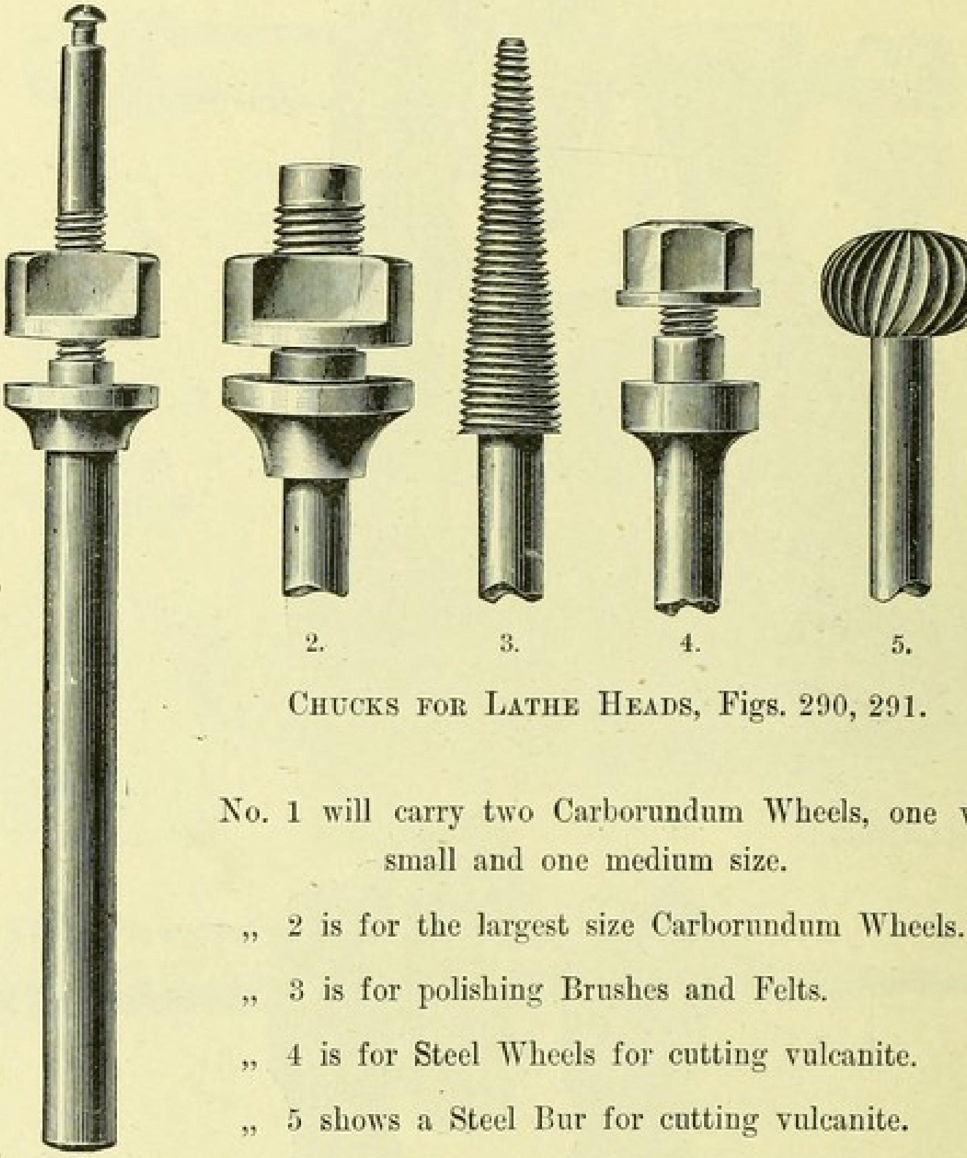
Fig. 291.



Ash's No. 8
Lathe Head
with polishing
Chuck *A*
and
Screw Clamp
Attachment.
Nearly Half-size.

GRINDING OR FITTING LATHE BENCH—*continued.*

Fig. 292.



1. 2. 3. 4. 5.

Chucks for Lathe Heads, Figs. 290, 291.

No. 1 will carry two Carborundum Wheels, one very small and one medium size.

„ 2 is for the largest size Carborundum Wheels.

„ 3 is for polishing Brushes and Felts.

„ 4 is for Steel Wheels for cutting vulcanite.

„ 5 shows a Steel Bur for cutting vulcanite.

These Chucks can be used on Lathe Heads, Figs. 286, 287, when they are fitted with the Screw Clamp Attachment.

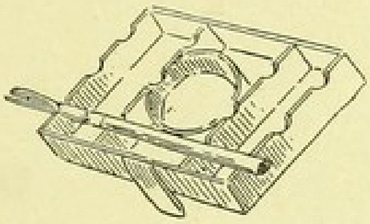
ARTICLES, VARIOUS.

Needle Files. **Tube Files**—see page 141.

Oil Can.

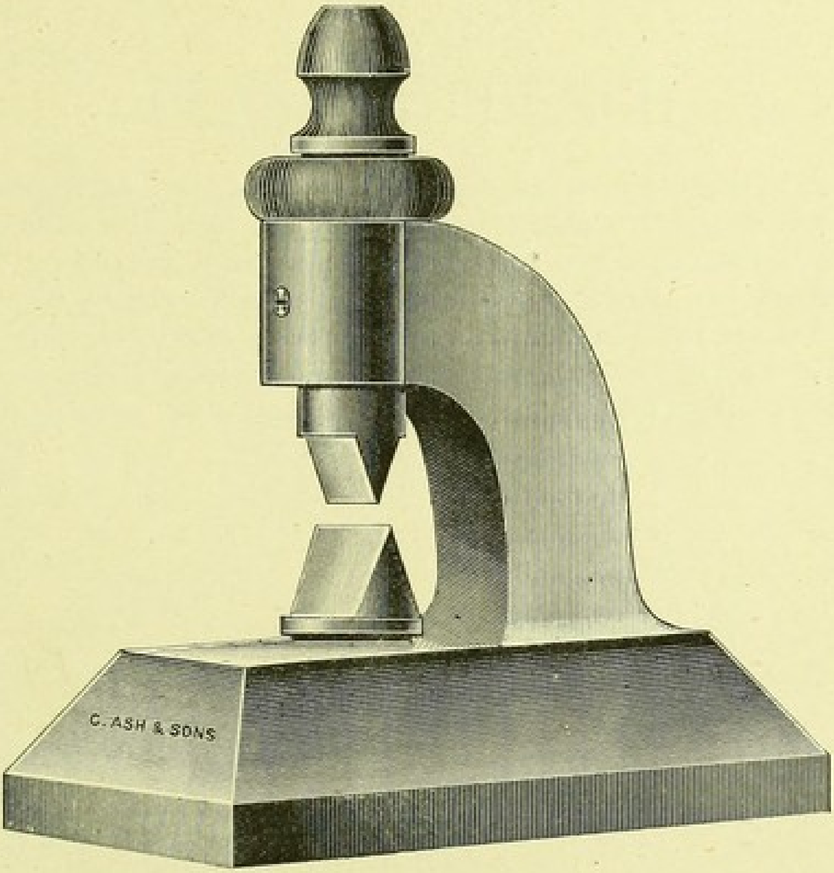
GRINDING OR FITTING LATHE BENCH—*continued.*

Fig. 293.



Paint Pot with Brush—See page 141.

Fig. 294.



Ash's Cutting Tool for Shortening Tube Teeth—Full size.

PLASTER BENCH.

Rubber Bowls, Crockery Bowls, Vaseline Pot, Soap Solution in Bottle, Spatula, Plaster Knives, Screw Press for Vulcanite Flask, Cutting Board, Scorper, Plaster Saw, Vulcanite Flasks and Clamps, Paper for setting Investments on, Pumice in Powder for Investments, Hydraulic Steam or Shot Swager, Meter Metal for Swagers, Galvanized Buckets for Detritus, Plaster Bins for storing Plaster, Stearine Saucepan, Wax Pot, Spirit Varnish, Shellac Varnish, Articulators, Tin Foil, Silicate of Soda.

PLASTER BENCH—*continued.*

TOOLS AND SUNDRIES.

Fig. 295.

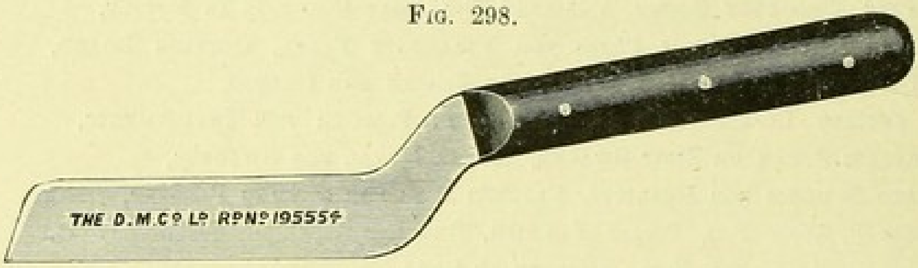
Large

Fig. 296.

Small.

India-Rubber Bowls for Mixing Plaster in.

Fig. 298.



Knife for Trimming Plaster Models—8½ inches long.

ARTICLES, VARIOUS.

Board for cutting plaster models on, from four to six inches square and one inch thick.

Crockery Bowls for mixing plaster in.

Paper in 2½ inch squares, for setting investments on.

Pumice in Powder for investments.

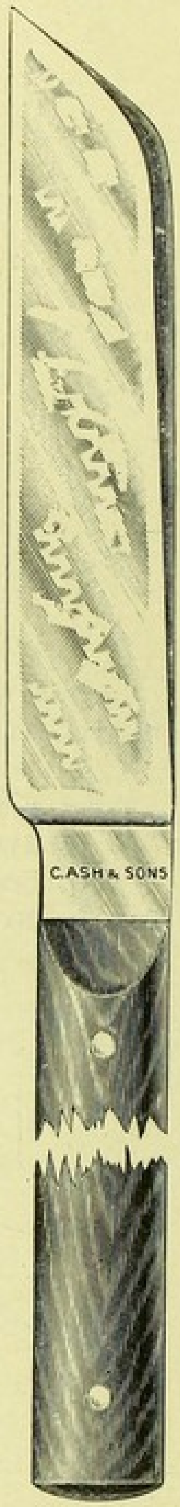
Shellac Varnish or "Finish" for varnishing wax trial-plates before investment in vulcanite flasks.

Soap solution in bottle.

Spatula for mixing and modelling.

Vaseline in pot.

Fig. 297.



Knife for Trimming Plaster Models—7¾ in. long.

PLASTER BENCH—*continued.*

TOOLS AND SUNDRIES.

Fig. 299.

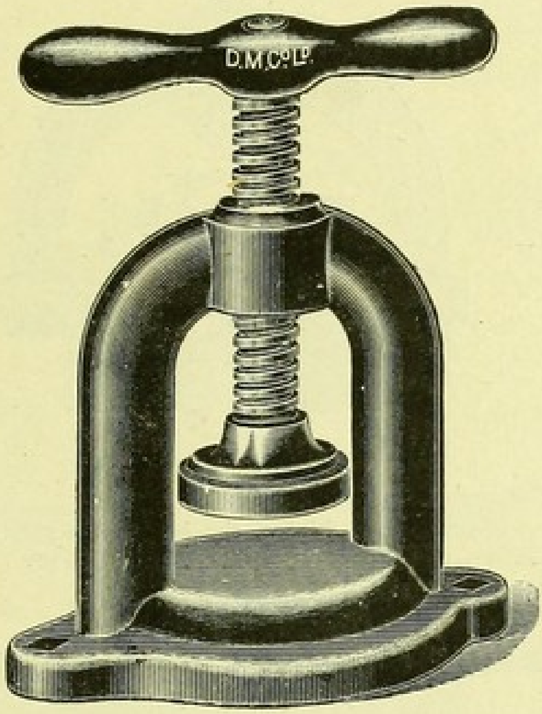


Fig. 300.

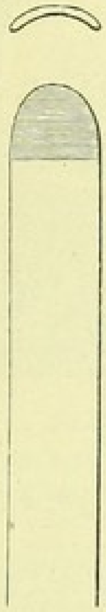


Fig. 301.

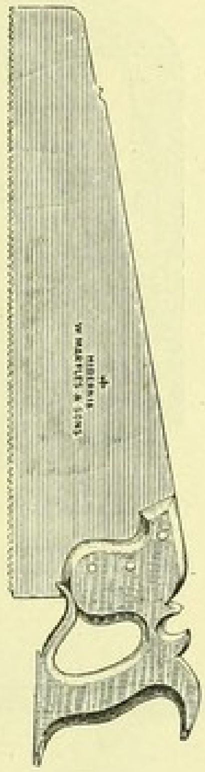


Fig. 299.—Screw Press for closing Vulcanite Flasks.

,, 300.—Gouge or Reeded Sculptor for cutting Plaster of Paris away from a model when making a Plaster Articulator.

,, 301.—Ordinary Hand Saw for cutting Plaster Models.

(Personally, I use a circular saw in a lathe for this purpose—see Fig. 323, page 356.)

ARTICLES, VARIOUS.

Bins for storing Plaster of Paris—see Fig. 19, page 23.

Galvanized Buckets for detritus—see Fig. 19, page 23.

Plaster of Paris.

Silicate of Soda for coating models.

Spirit Varnish for coating models.

Stearine Saucepan. **Stearine for coating models.**

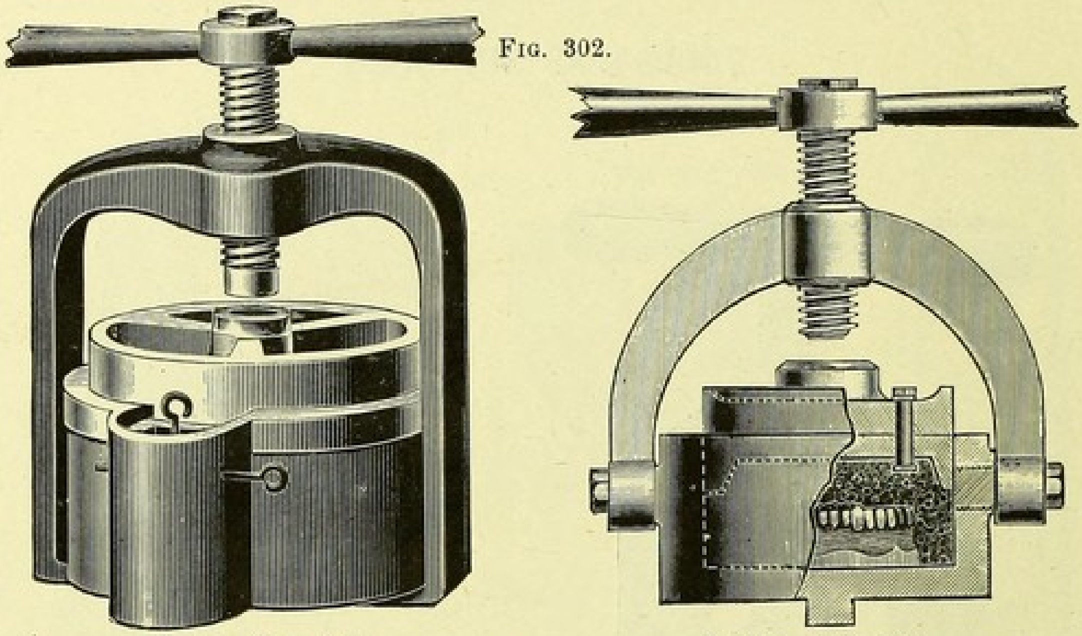
Tin Foil for swaging on the surfaces of models.

Wax Pot.

PLASTER BENCH—*continued.*

SWAGERS.

Fig. 302.

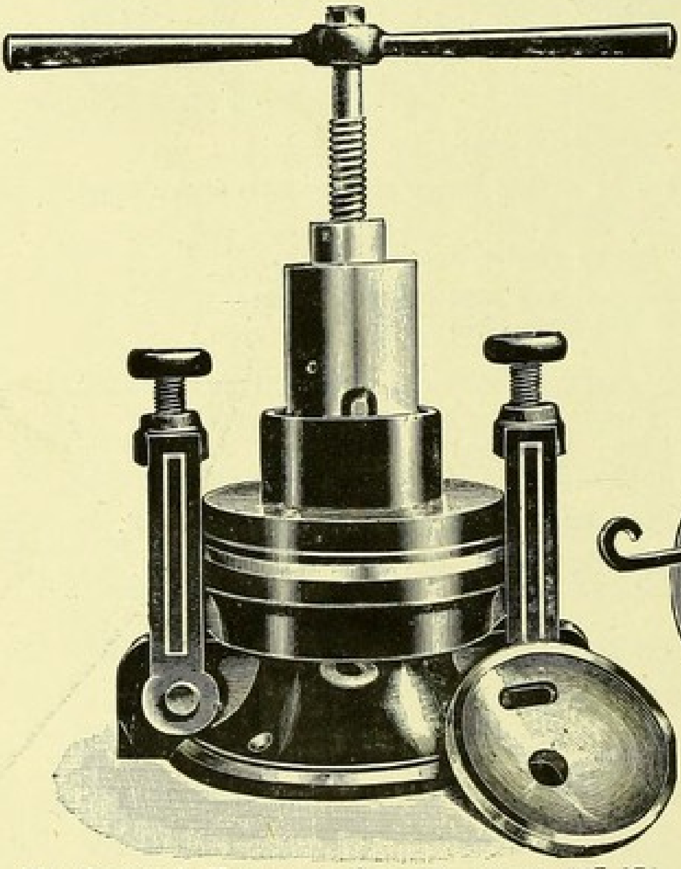


Swager Complete. Section of Swager.

Mr. Gartrell's Shot Swager—see pages 261–263.

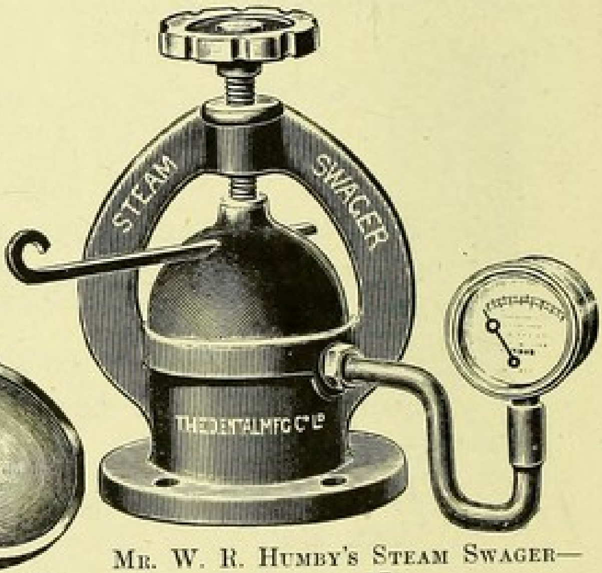
Full Details of this Apparatus, and the numerous Uses to which it can be put, are given on pp. 46–54 of Mr. Gartrell's book on Continuous-Gum Work and Porcelain Crowns.

Fig. 303.



Mr. Grundy's Hydraulic Swager—see pp. 167–170.

Fig. 304.

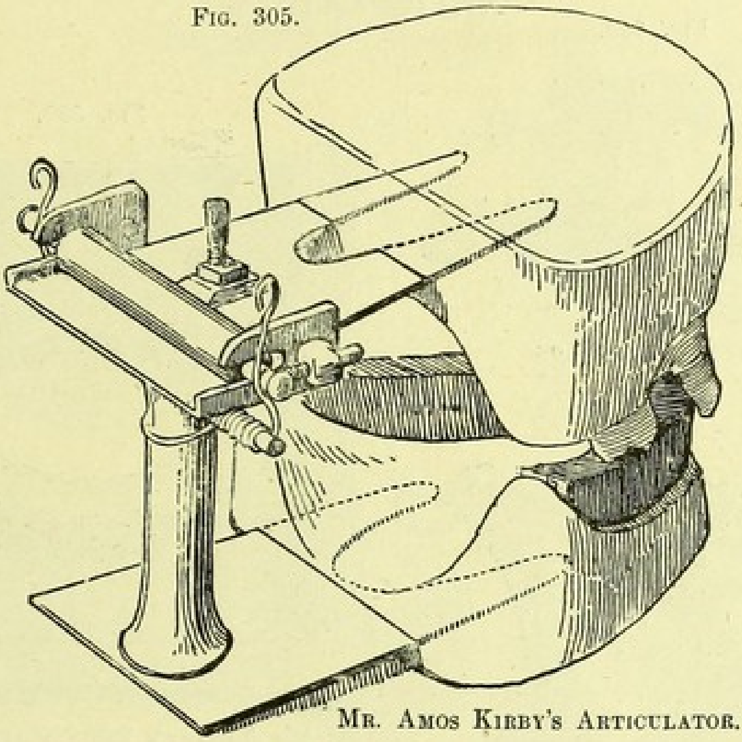


Mr. W. R. Humby's Steam Swager—see p. 170.

PLASTER BENCH—*continued.*

ARTICULATORS.

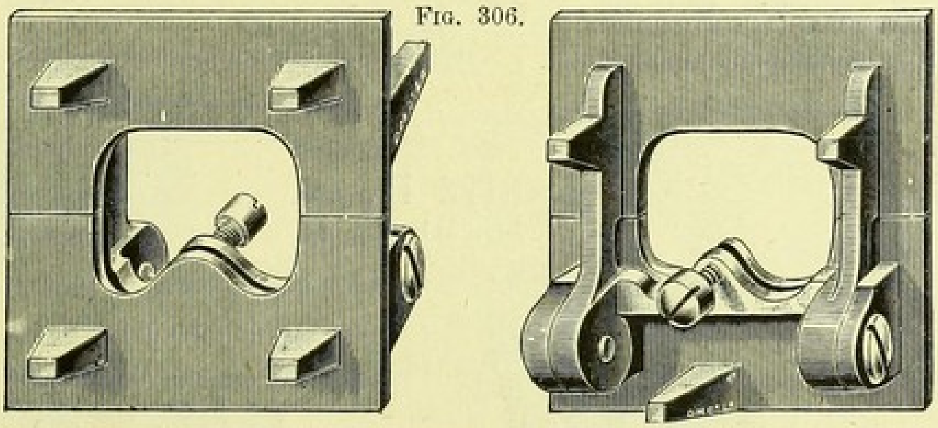
Fig. 305.



Mr. Amos Kirby's Articulator.

Fig. 306.

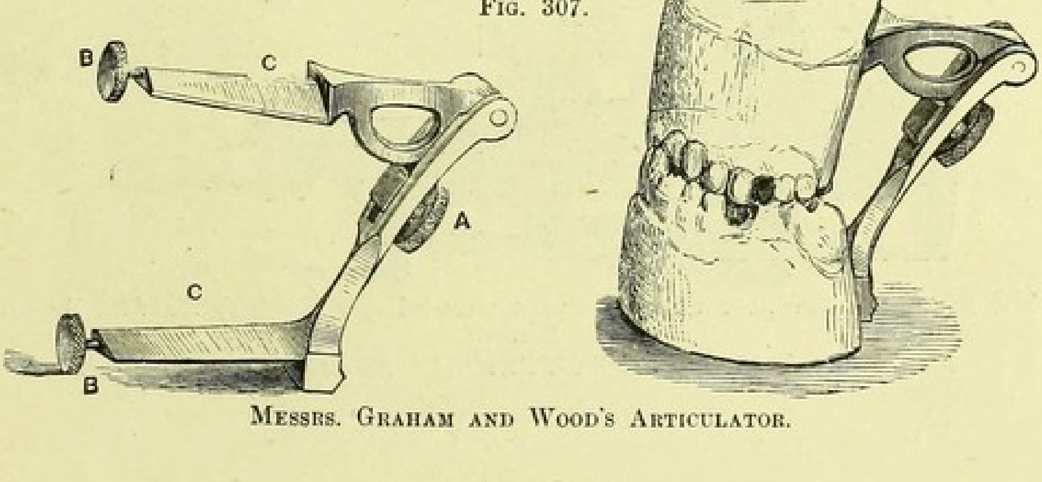
Front.



Back.

Articulator designed by Mr. Prosper Ladmore and Mr. E. J. Ladmore.

Fig. 307.

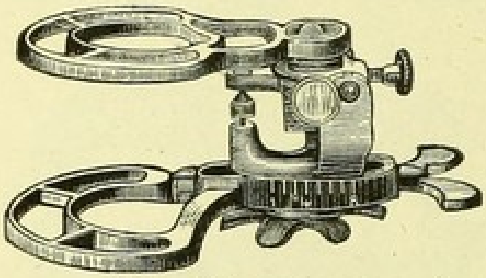


Messrs. Graham and Wood's Articulator.

PLASTER BENCH—*continued.*

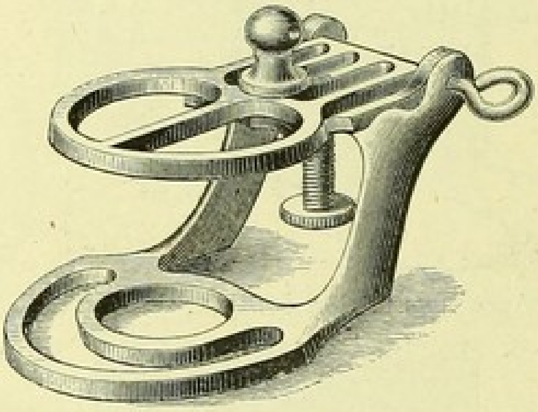
ARTICULATORS.

Fig. 308.



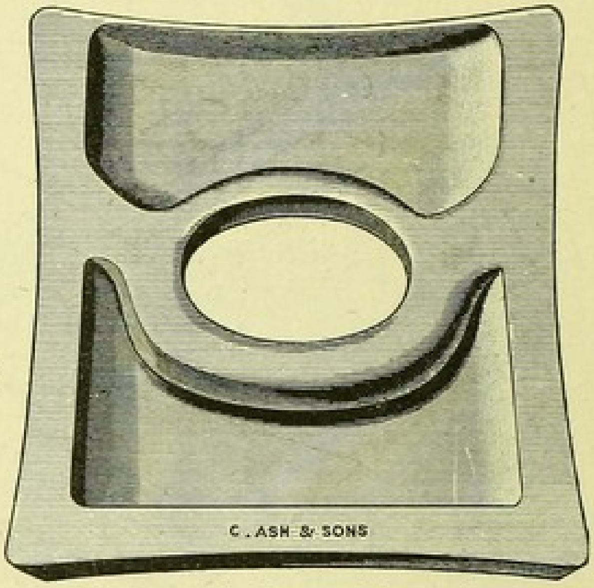
Hayes' Articulator.

Fig. 309.



Plain-Line Articulator.

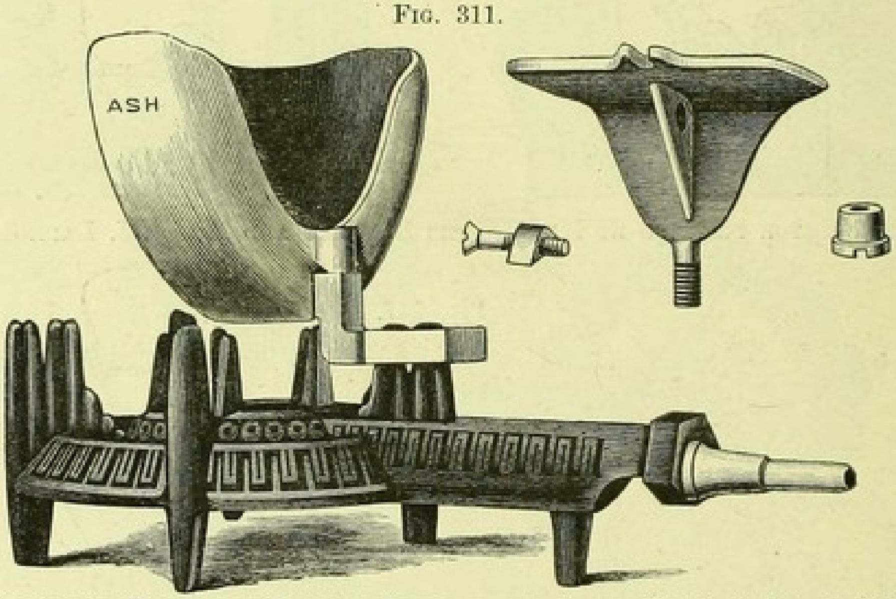
Fig. 310.



Mr. Lennox's Fusible Metal Slab Articulator.

VULCANITE FLASK.

Fig. 311.



Mr. Brunton's Two-part Contour Flask, mounted over Fletcher's Standard Bunsen Burner.

For Mr. A. J. WATTS'S TWO-PART FLASK, see pages 157 *and* 158.

PLASTER BENCH—*continued.*

VULCANITE FLASKS, ETC.

Fig. 312.

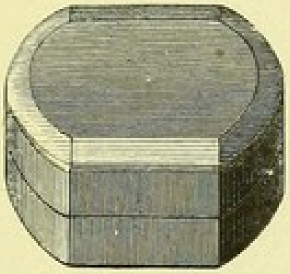


Fig. 313.

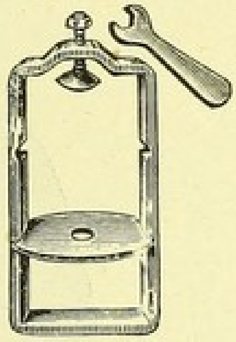


Fig. 314.

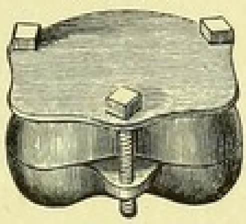


Fig. 317.

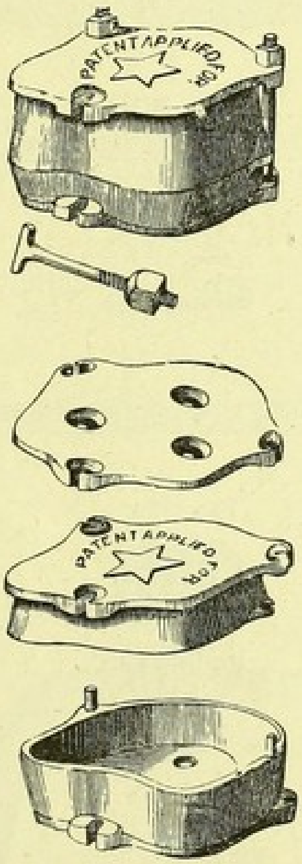


Fig. 318.

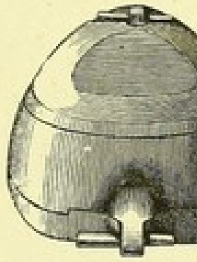


Fig. 315.

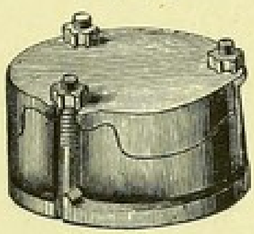


Fig. 319.

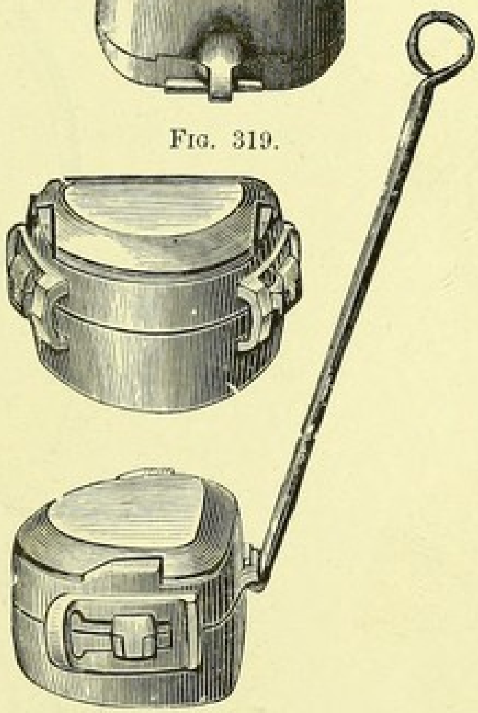


Fig. 316.

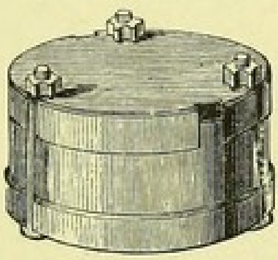


Fig. 312.—Ash's Berlin Pattern Three-part Flask.

,, 313.—Wrought Iron Clamp, with Screw-bolt, Spanner and Iron Plate, for holding one, two or three Ash's Berlin Pattern Flasks.

,, 314.—Whitney's Three-part Bolt and Nut Flask.

,, 315.—Hayes' ,, ,, ,,

,, 316.—Lewis's ,, ,, ,,

,, 317.—Star ,, ,, ,,

,, 318.—Jordan's Three-part Pin Flask.

,, 319.—Ladmore's Three-part Clamp Flasks, large and small sizes, with lifter.

PLASTER BENCH—*continued.*

VULCANITE FLASK, ETC.

Fig. 320.

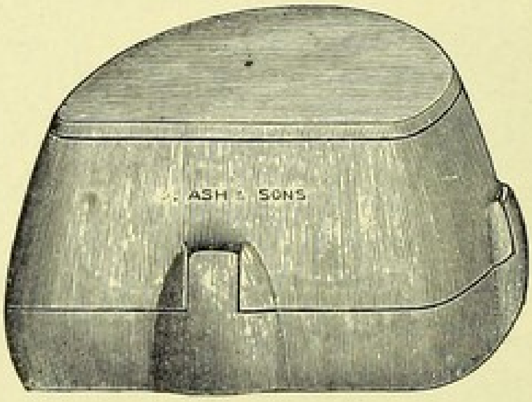


Fig. 321.

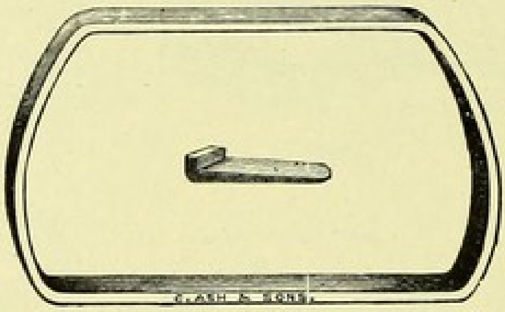


Fig. 322.

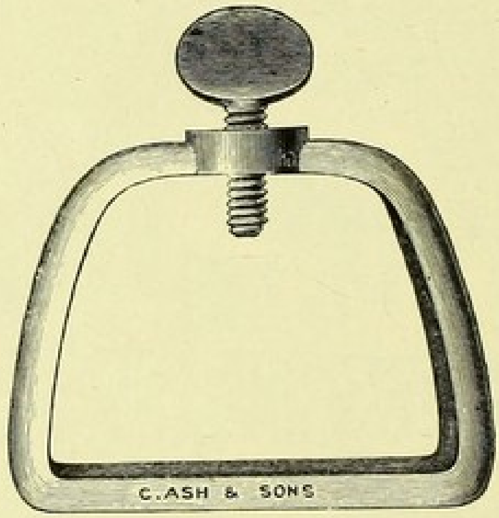


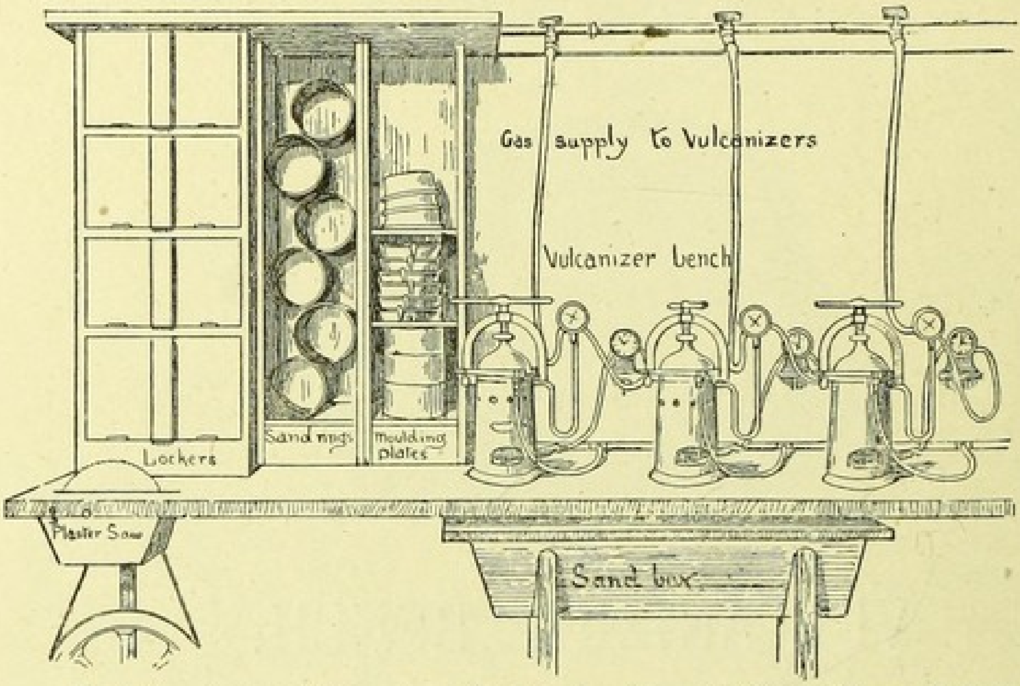
Fig. 320.—Ash's No. 90 Three-part Flask.
" 321.—Clamp and Wedge for Ash's No. 90 Flask.
" 322.—Wrought-iron Ring and Thumb Screw for ditto.

VULCANIZER BENCH.

Gas Supply and Taps,
Compo Pipe leading to external Air connecting with Blow-Off in Boiler,
One or More Vulcanizers,
Vulcanizer Stand screwed to Bench, Spanners, Gas Tongs
Gartrell's Gauge and Syphon for Regulating Steam and Gas Pressure,
Clock-work Automatic Cut-Off, Dental Rubbers.

VULCANIZER BENCH—*continued.*

Fig. 323. Fig. 324.



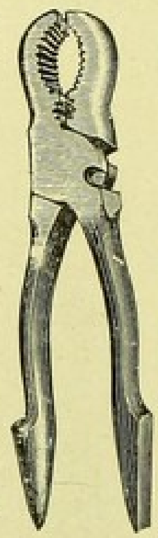
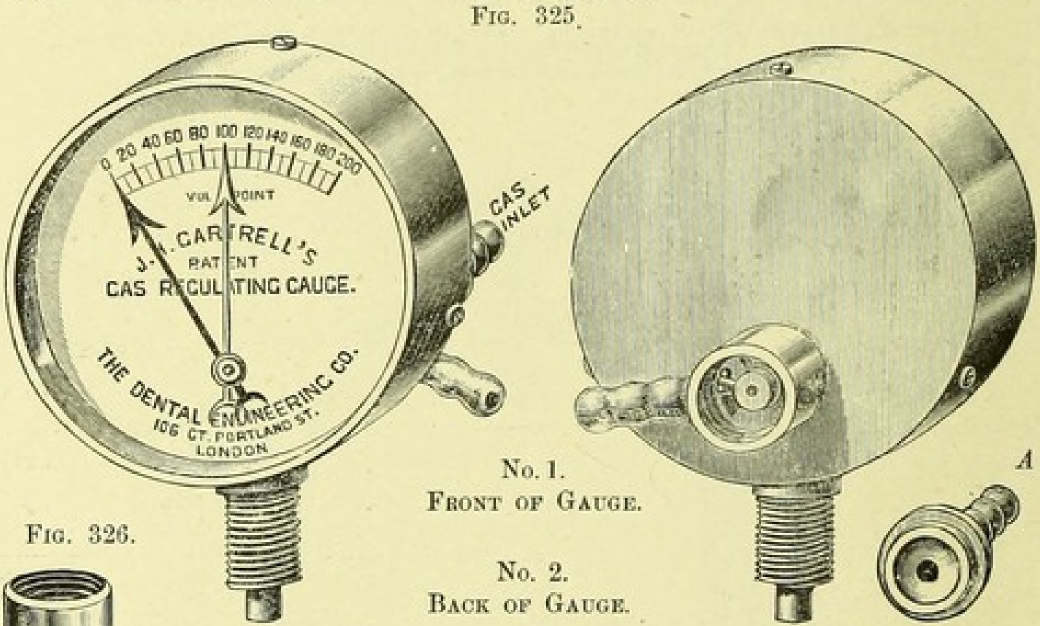


Fig. 323.—Author's Vulcanizer Bench, showing:—(*a*) Plaster Saw; (*b*) Lockers; (*c*) Sand Rings; (*d*) Moulding Plates; (*e*) Sand Box; (*f*) Gas Supply and Taps; also Vulcanizers, the Stands of which are screwed to Bench, and Compo Pipe leading to external air, connected with Screw Taps for blowing off steam from the Vulcanizer boilers.
Fig. 324.—Gas Pliers, with wire cutter, compo pipe opener and turnscrew combined.

Fig. 325.



No. 1.
Front of Gauge.

No. 2.
Back of Gauge.

No. 1. No. 2. Gas Inlet.

Fig. 326.

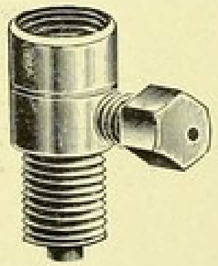


Fig. 325.—Mr. Gartrell's Steam-pressure and Gas-regulating Gauge—see pages 165–167. The Syphon which is supplied with the Gauge is shown in the illustration of the Author's Vulcanizer Bench above, and also in Fig. 326, Copper Disc Safety Valve referred to on page 167.

VULCANIZER BENCH—*continued.*

Fig. 327.

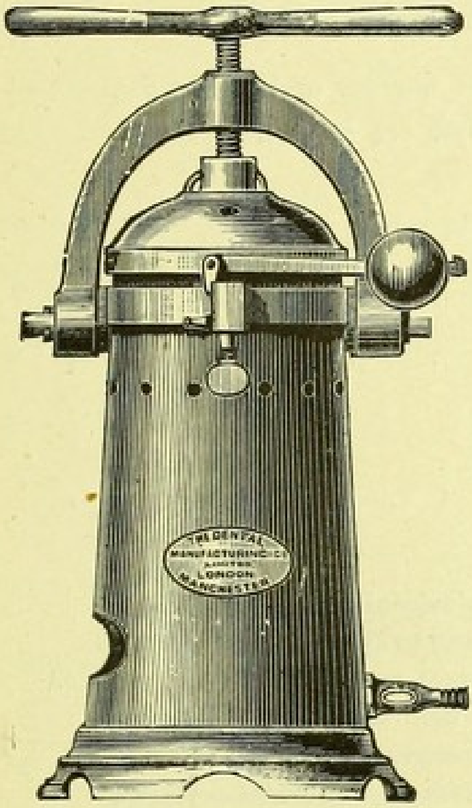


Fig. 328.

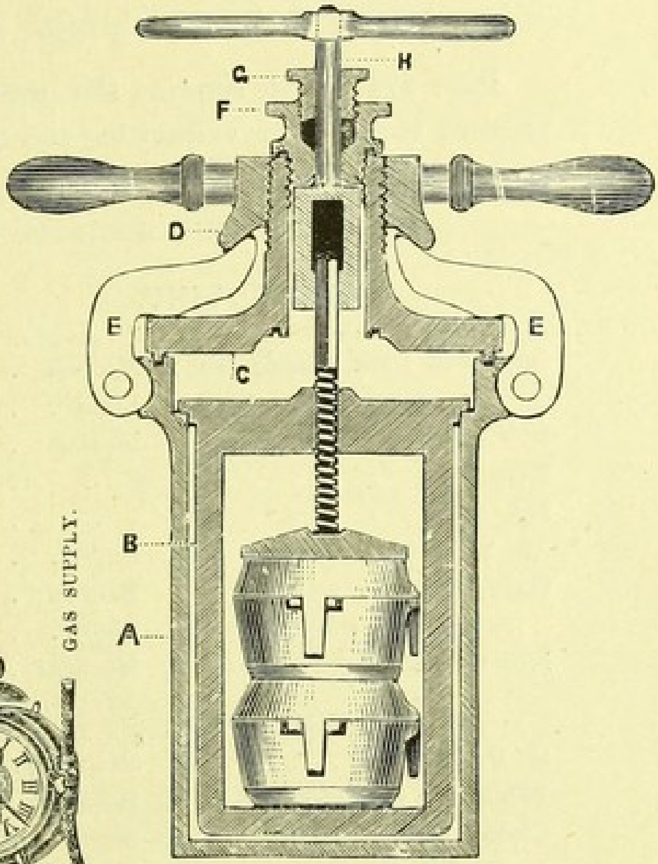


Fig. 329.

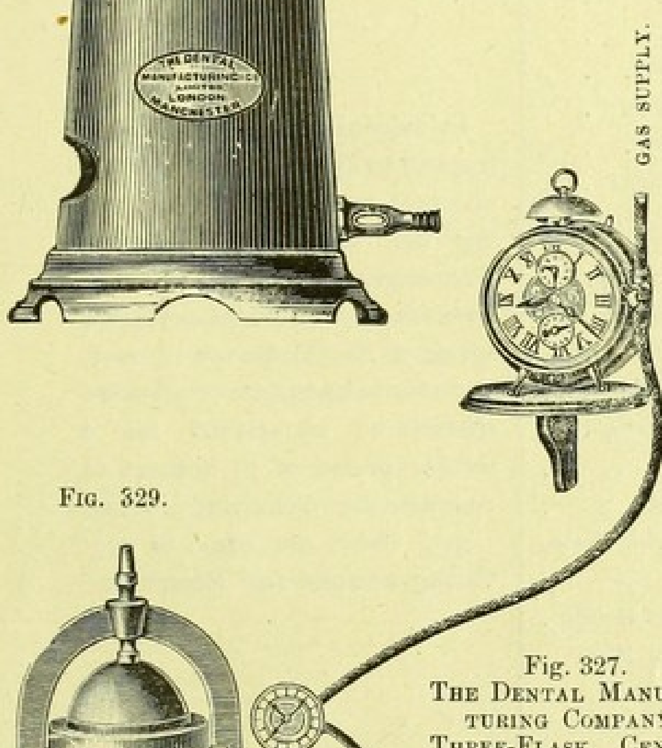


Fig. 330.

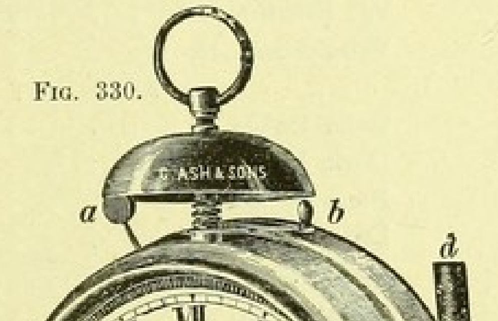


Fig. 327.
The Dental Manufacturing Company's Three-Flask Centre-closing Vulcanizer with Gun-metal Boiler with Safety Valve, Blow-off Top and Gas Burner.

Fig. 328.
Section of Mr. Gartrell's Vulcanizer.
See also Fig. 84, page 150.

Fig. 329.
Ash's Three-Flask Vulcanizer with Wrought-copper Chamber, Clock-work, Automatic Cut-off, Gartrell's Gauge and Gas Burner (Spanner not illustrated).

Fig. 330.—Clock-work Automatic Cut-off.

VULCANIZER BENCH—*continued.*

FROM OAKLEY COLES' DENTAL MECHANICS.

Page 274—Table showing the names, colours, degrees of heat or lbs. pressure required for vulcanizing the rubbers that are most used at the present time.

C. ASH & SONS' RUBBERS. (Revised to end of 1897.)

FOR COATING.

Names.	Colours.
Improved Pink, Shade No. 1	Medium
" " " " 2	Light
N.V., without Vermilion	Medium
New Pink	"
No. 1x "	"
" 1 "	Light
Gum Pink	Medium
" "	Light
No. 2x Pink	Medium

FOR BASE.

Names.	Colours.
S. P.	Deep Pink
White, for Side Blocks, &c.	Bone
Child's G.	Bright Red
A. E. Elastic	Dark Brown
W. Elastic	" "
Whalebone, No. 1	" "
" " 2	Light "
Solid Base	Pinkish Brown
Dark Red	——
Flexible Base	Light Brown
Dark Elastic	" Horn
Red	——
Orange	——
Black	Dark Horn
Dark Brown	——
Brown	——
Improved Black	Jet Black

In vulcanizing these rubbers, from 30 to 45 minutes should be occupied in very gradually raising the temperature to 315° Fahrenheit, when a Thermometer is used, or 100 lbs. pressure, when a Steam Gauge is used, and this temperature or pressure should be maintained for a further period of 75 minutes to complete the vulcanizing process.

315° Fahr. are equal to 157° Centigrade and 126° Réaumur.

SPECIAL—FOR TENDER GUMS, &c.

	Time. H.	Time. M.	Degrees Fahrenheit.	Degrees Centigrade.	Degrees Réaumur.
Soft Pink, for lining Palates	1	15	310	154	124
Soft Dark Red " "	1	15	310	154	124
Vela, for making artificial Palates	6	0	270	132	106

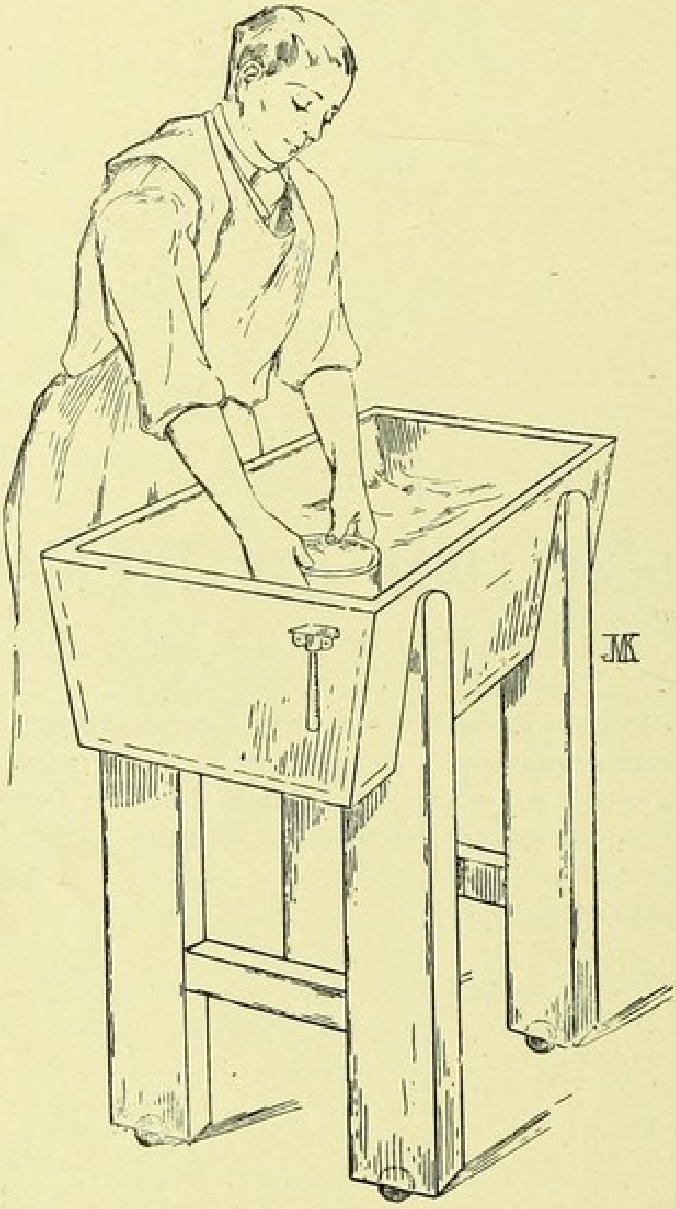
Sand-Moulding and Die-Making Appliances.

Sand Box, Moulding Sand, Moulding Rings, Moulding Flasks, Hammer, Lifting Pin, Wire Sieve, Piece of Wood for working Sand, Shelf in Box for moulding on, French Chalk in Dredger, Formulæ for making Die-Metals.

SAND-MOULDING AND DIE-MAKING APPLIANCES—

CONTINUED.

Fig. 331.



Author's Sand-moulding Trough, with shelf in it for moulding on.
A Moulding Ring is shown inside the Trough, and a Hammer is hung in a convenient position within reach on the outside of the right-hand end.
For description, see page 68 *et seq.*

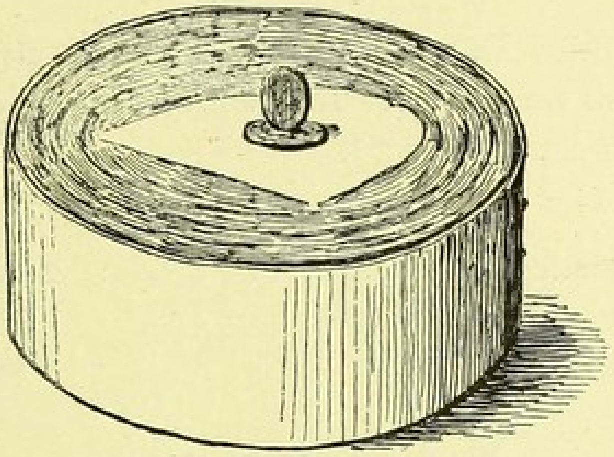
ARTICLES, VARIOUS.

Dredger holding French Chalk. Moulding Sand.
Piece of Wood for working Sand. Spike or "Sand Point."
Wire Sieve.

SAND-MOULDING AND DIE-MAKING APPLIANCES—

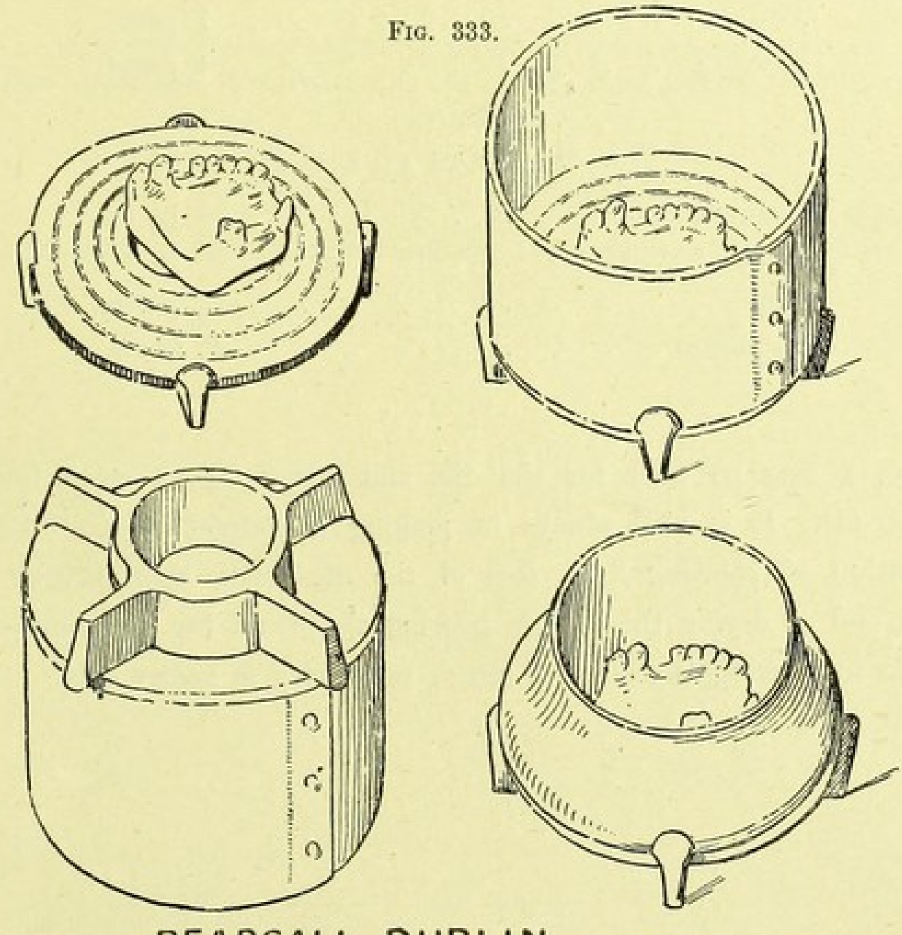
CONTINUED.

Fig. 332.



Moulding Ring with Mr. Lennox's Lifter attached to Plaster Model.
See page 72.

Fig. 333.



The Author's Sand-moulding Flask. See page 76 *et seq.*

FORMULÆ FOR MAKING DIE-METALS.

FROM CHUPEIN'S DENTAL LABORATORY.

Page 63.—Below are given formulæ for making die-metals which melt at different temperatures. They will be found serviceable for the die and counter-die.

No. 1. Melts at 212° F.

Bismuth	2 parts.
Lead	1 part.
Tin	1 part.

No. 2. Melts at 176° F.

Bismuth	20 parts.
Lead	12 parts.
Tin	7 parts.
Mercury	4 parts.

No. 3. Melts at 151° F.

Bismuth	$7\frac{1}{2}$ parts.
Lead	4 parts.
Tin	$1\frac{1}{2}$ parts.
Cadmium	2 parts.

No. 1 may be used for the die, and either No. 2 or 3 for the counter-die. It is well always in making a counter-die to take the precaution of painting "the face of the die" with thin whiting and water, and of drying this before pouring the metal for the counter-die, as also in pouring the counter metal, when this is nearly cold.

Striking Block, Anvil and Tools.

Striking Stake or a Smith's Anvil, Drilling Machine Vice, Striking Hammers, Horn Hammers, Mr. J. Charters Birch's Drop Hammer, an Ollifer.

SWAGING PRESS.

Ash's Swaging Press with Duchscher's Differential Lever Action.

STRIKING TOOLS—*continued.*

Fig. 335.

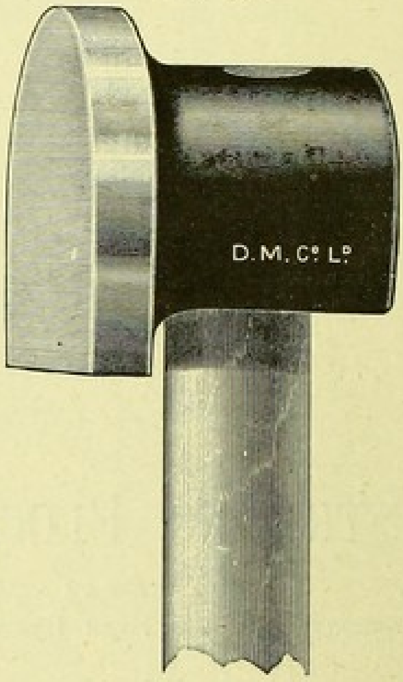


Fig. 334.

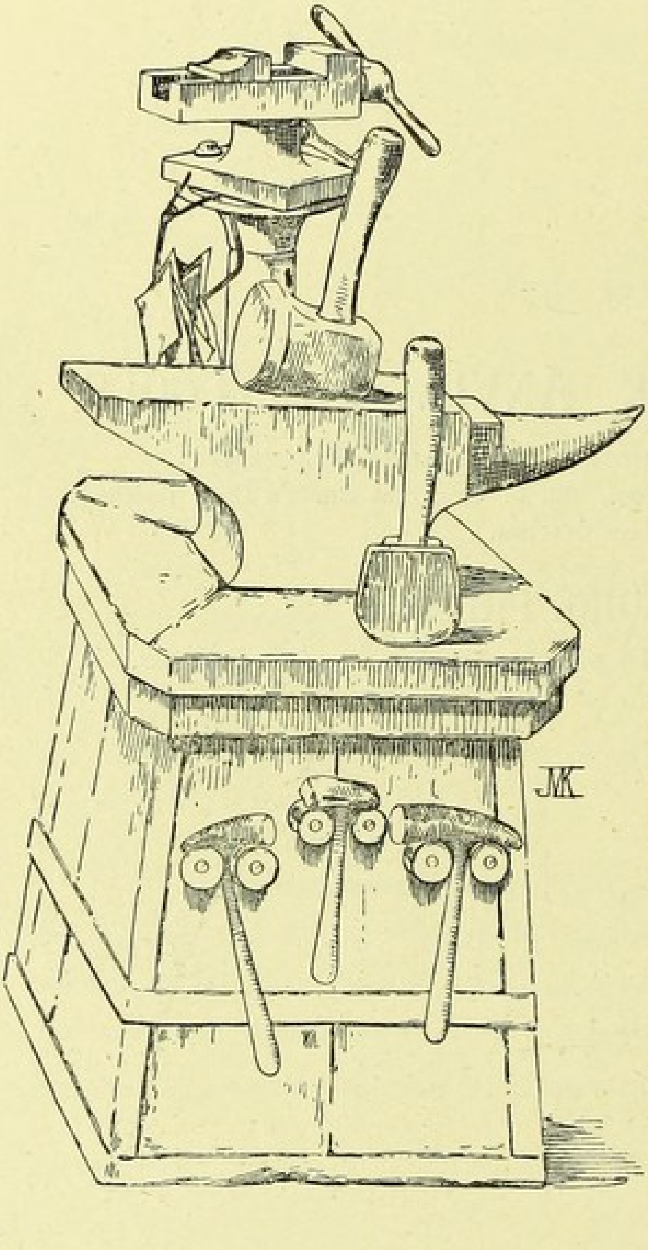


Fig. 336.

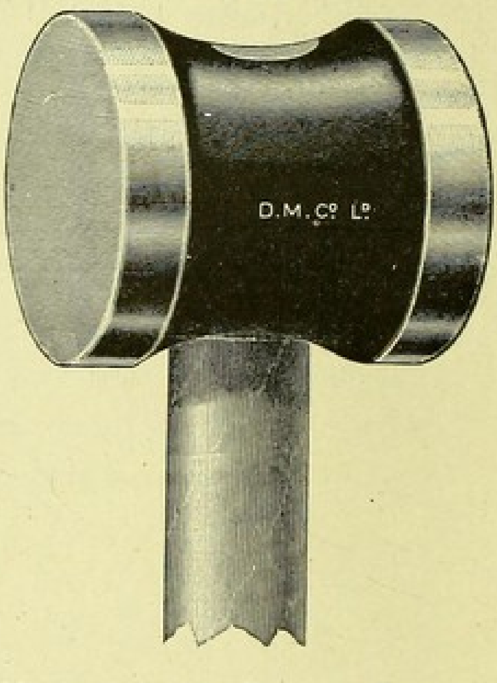
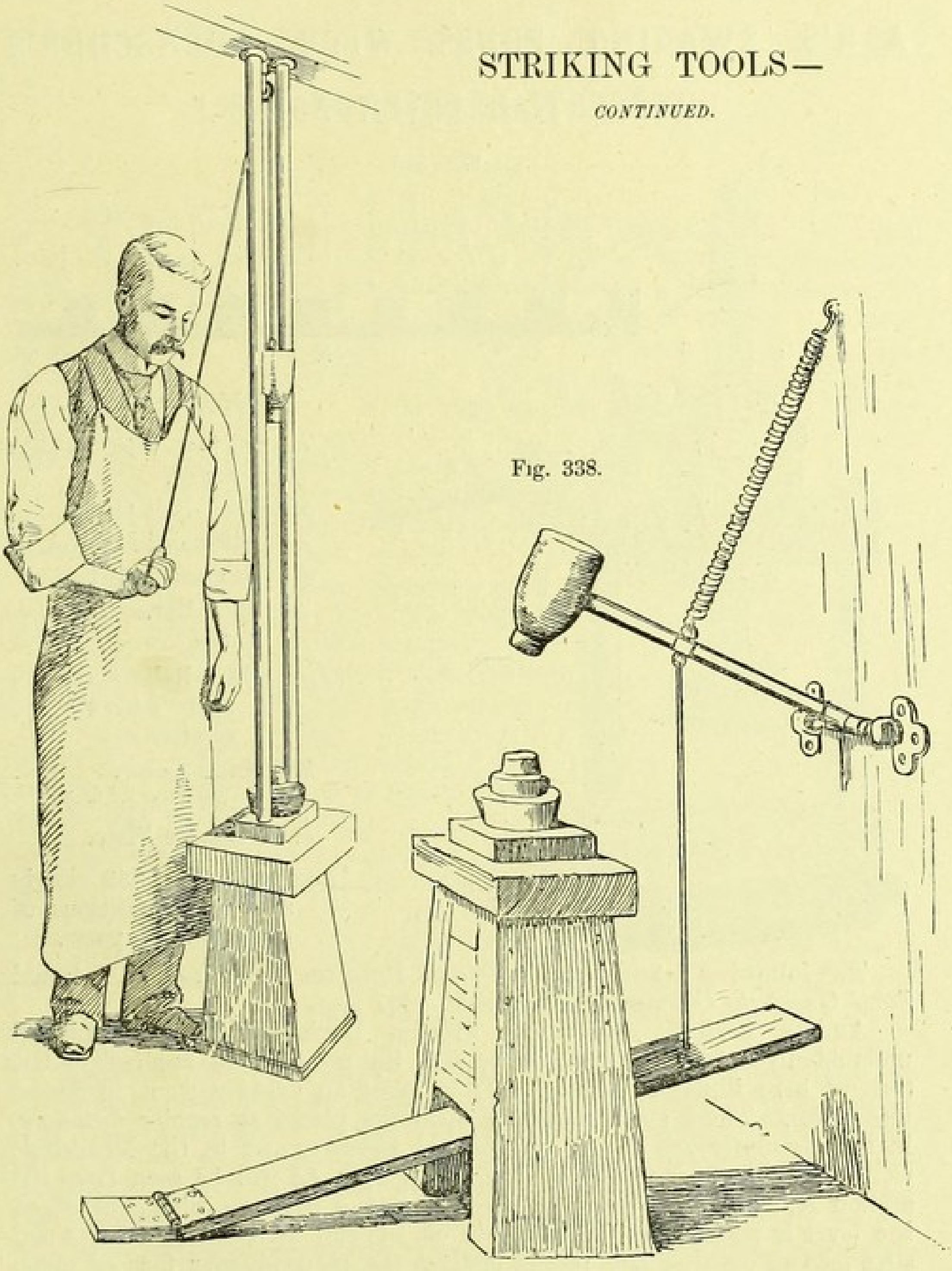


Fig. 334.—Author's Striking Block, with Smith's Anvil, Striking Hammers, Horn Mallets and Drilling Machine Vice—see also Fig. 54, page 91.

„ 335.—Striking Hammer, weight 3 lbs.

„ 336.—Striking Hammer, weight 4½ lbs.

Fig. 337.



STRIKING TOOLS—

CONTINUED.

Fig. 338.

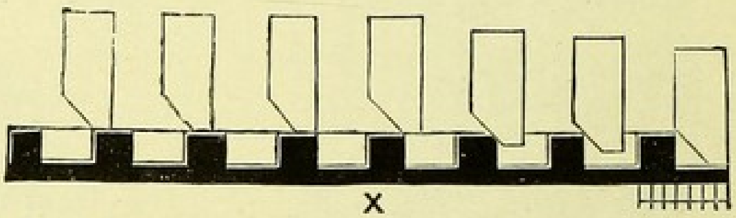
Fig. 337.—Mr. Charters Birch's Drop Hammer (see page 96).

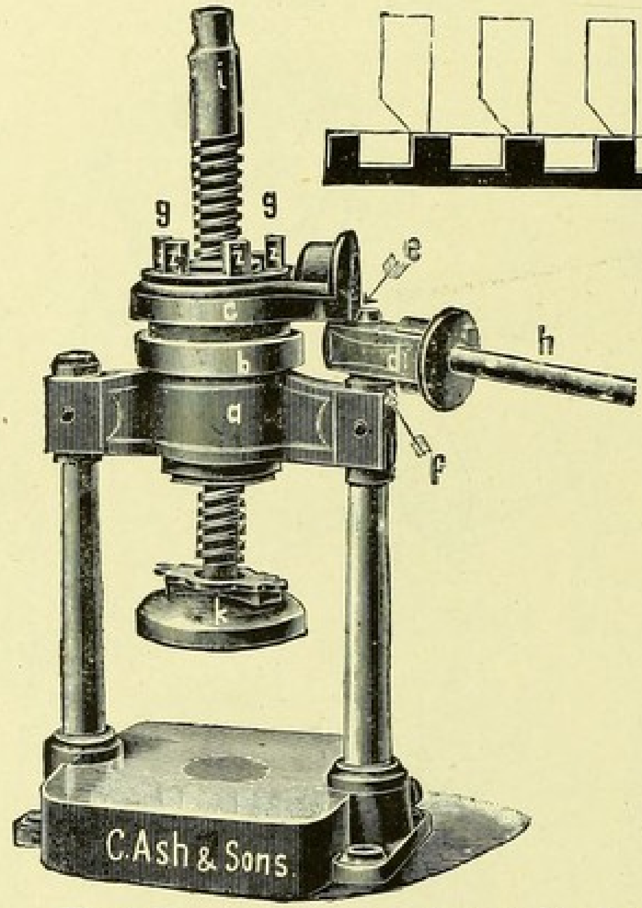
Fig. 338.—Spring Forge Hammer—commonly knowm as an "Olliver" or "Ollifer" (see page 97).

SWAGING PRESS.

ASH'S SWAGING PRESS WITH DUCHSCHER'S DIFFERENTIAL LEVER ACTION.*

FIG. 339.





DESCRIPTION:

- *a.* Stirrup with female screw.
- *b.* Drop-Bolt Collar.
- *c.* Differential Lever.
- *d.* Intermediate Lever.
- *e.* Slide Bar.
- *f.* Bolt.
- *g.g.* Drop-Bolts (shown also above in section).
- *h.* Hand Lever.
- *i.* Screw Piston-rod.
- *k.* Pressure Plate.

Illustration Fig. 339 clearly shows the positions of these several parts.

The following details relating to this Press are taken from C. Ash and Sons' *Quarterly Circular* for December, 1897 :—

Among modern mechanical Presses, Duchscher's "Differential" undoubtedly takes the first place, and its principle is applied in the Swager here illustrated (Fig. 339) to meet an existing want in dental mechanics. There are rectangular openings, placed at regular distances, in the circumference of the Differential Lever *c*, and in the Drop-Bolt Collar *b*, into which the Drop-Bolts *g g* grip. As will be seen from the section X, these Drop-Bolts are bevelled at the bottom; when, therefore, the lever is pushed round, they slide on the rim of *c*, until one of them slips into an opening and presses against the perpendicular face of same. Connection is thus established with the Piston Rod *i*, which revolves and "presses."

* Differential here signifies "an arrangement by which a regular, powerful, and slow movement is obtained for carrying forward a tool from the motion-work whereby the tool is rotated."

SWAGING PRESS—*continued.*

ASH'S SWAGING PRESS WITH DUCHSCHER'S DIFFERENTIAL LEVER ACTION—

CONTINUED.

After the lever has been pushed its full distance—about an arm's length—it is drawn back, and with this reversal of its direction the half sunk or entirely sunk bolts, owing to their bevelled edges, slide out of the openings, and the motion is repeated as often as may be necessary.

The number of openings in *c* and of Drop-Bolts is one each less than the number of openings in *b*; this variation forms the key of the Differential-Lever system. If for each opening in *b* there were a Drop-Bolt and an opening in *c*, all the bolts would grip at the same time, and would thus only produce the same effect as a single bolt. But by having the number of openings in *c* and the number of Drop-Bolts one each less than the number of openings in *b*, bolt after bolt grips successively when the lever is advanced.

Section **X** shows this difference in the number of openings in *b* and in the Drop-Bolts—hence the name "Differential"—from which it will be seen that it is only necessary to move the Lever *h* a distance equal to one-seventh of the distance between two openings.

This need of so slight a movement renders it possible, without increase of muscular effort, to obtain greater leverage with the "Differential" than with any other form of Press. For instance, with the Press represented in Fig. 339 the enormous pressure of over 14,000 lbs. to the square inch can be applied in a most gradual and satisfactory manner.

The Press is eminently adapted for swaging all kinds of metal plates, crowns, &c., with zinc or with other suitable die metals; the pressure exercised with it is regular and continuous, not jerky, sudden, or irregular, like that applied by hammering or with a centrifugal press.

DIRECTIONS FOR USE:

For the screwing-up motion of the Press, place the Drop-Bolts *g g* in position with the grooved face *z* of each outwards. Turn the screw Plunger *i* right home on to the dies with the hand before applying pressure with the Lever Handle *h*. To release the pressure, reverse the Drop-Bolts in the slots—*i.e.*, place face *a* of each outwards—and raise the Plunger from the dies with the Lever Handle *h*.

Make both the die and the counter-die of zinc where possible, or the die of zinc and the counter of tin. A zinc counter can be poured on a zinc die, and will part from it if the face and sides of the die be painted over with whiting or if they be thickly blackened over an ordinary gas flame.

Anneal the plate three or four times during the process of swaging, as is usually done when striking up with the hammer.

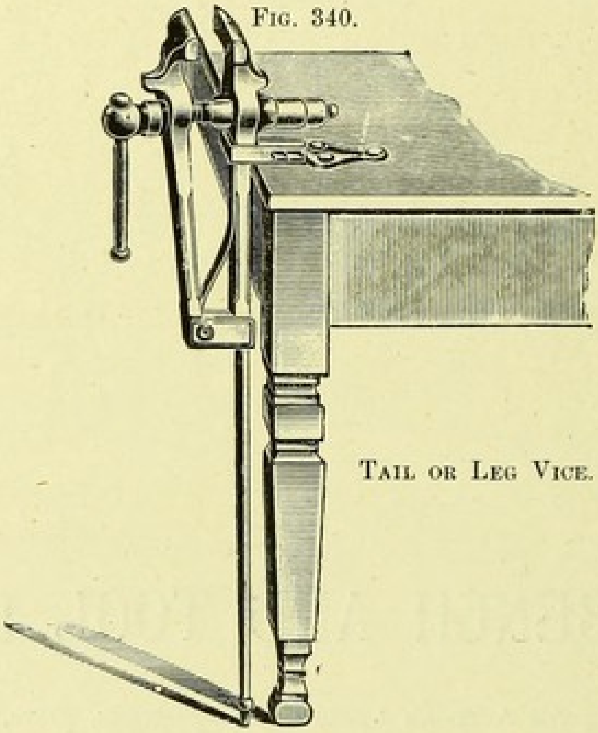
VICE BENCH AND TOOL RACKS.

Tail or Leg Vice, the Author's Large Copper Punches, Files, Rasps, Hammers, Saws, Cold Chisels, Turn Screws, Draw Plates, Draw Tongs.

VICE BENCH—*continued.*

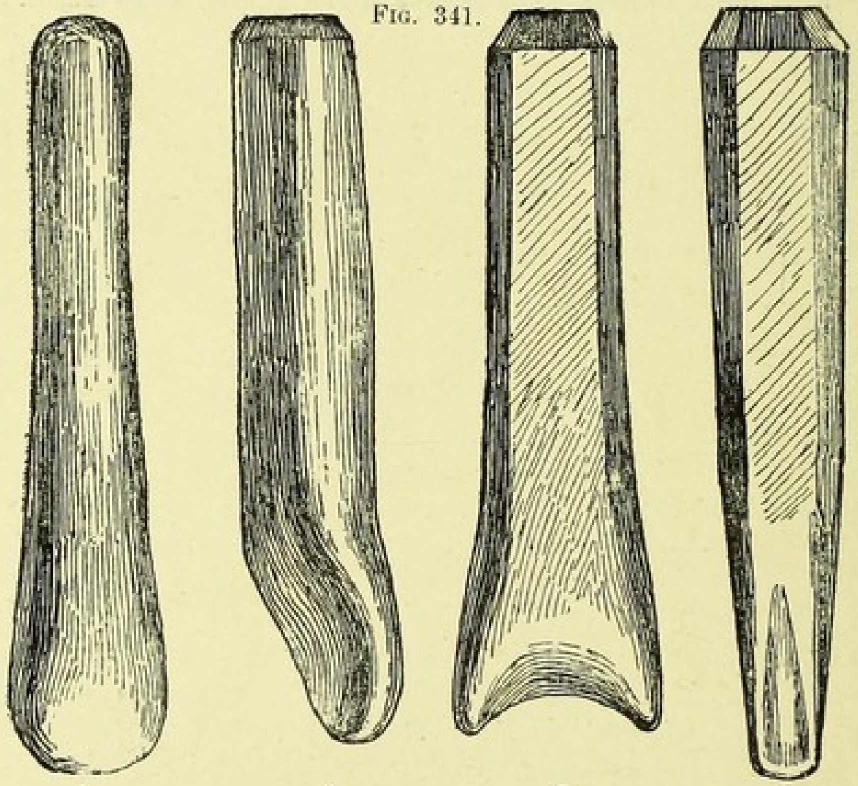
TOOLS VARIOUS.

Fig. 340.



Tail or Leg Vice.

Fig. 341.



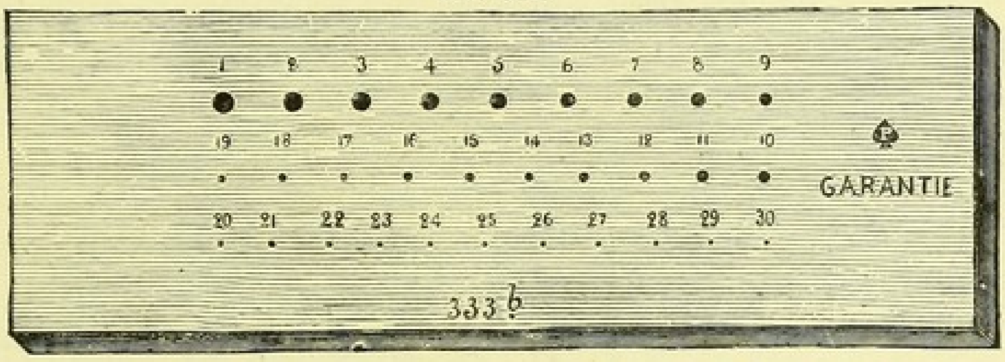
1. 2. 3. 4.

Copper Plate Punches, designed by the Author—see description on page 301.

VICE BENCH—*continued.*

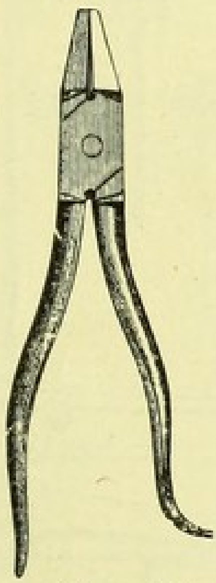
DRAWPLATE AND BENCHES.

Fig. 342.



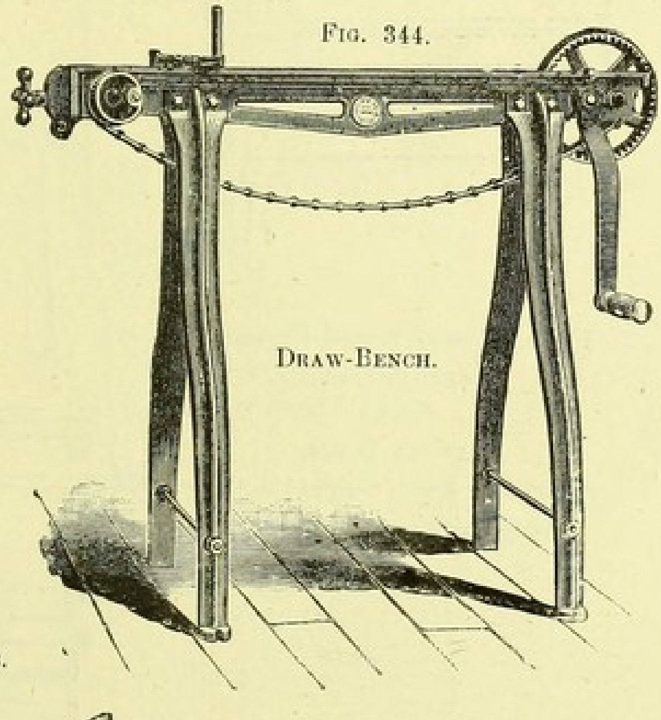
Drawplate, with 30 holes for round wire. (Drawplates with half-round and with square holes are also very useful.)

Fig. 343.



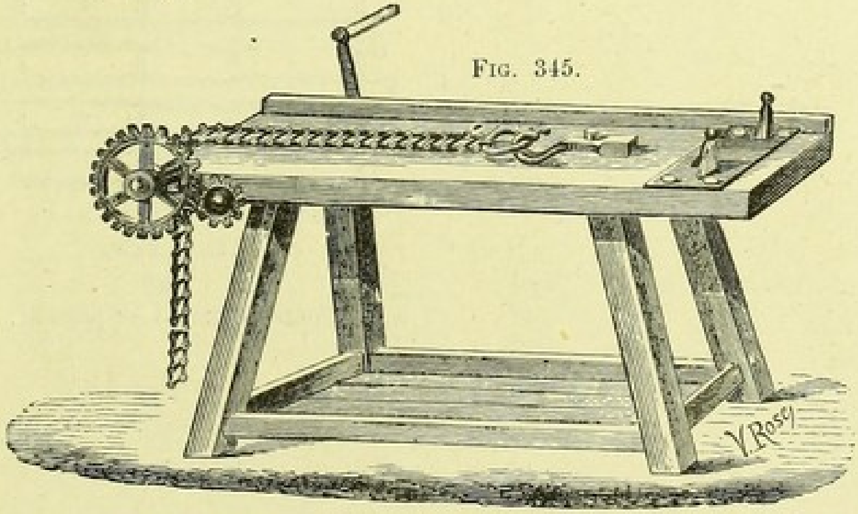
Drawing Tongs, 7 in. long. (I use a much heavier pair than this. See next page.)

Fig. 344.



Draw-Bench.

Fig. 345.

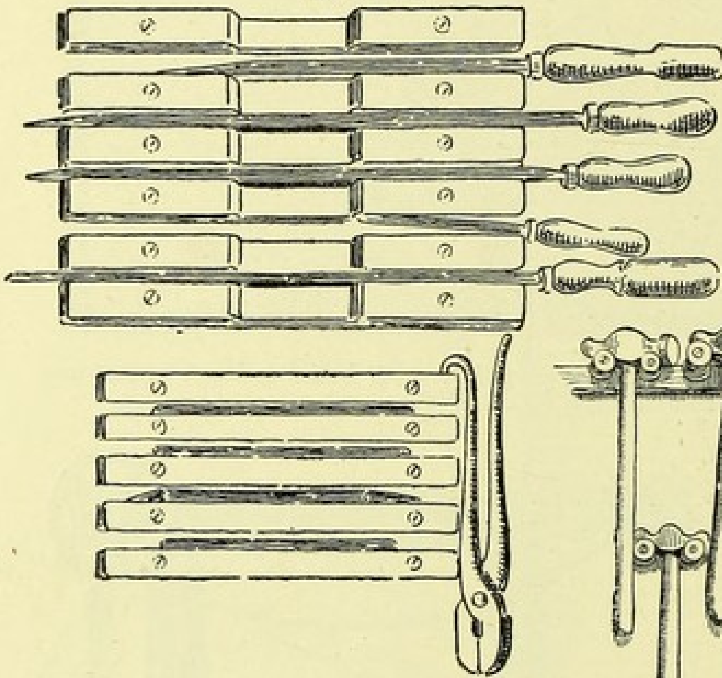


Draw-Bench.

VICE BENCH—*continued.*

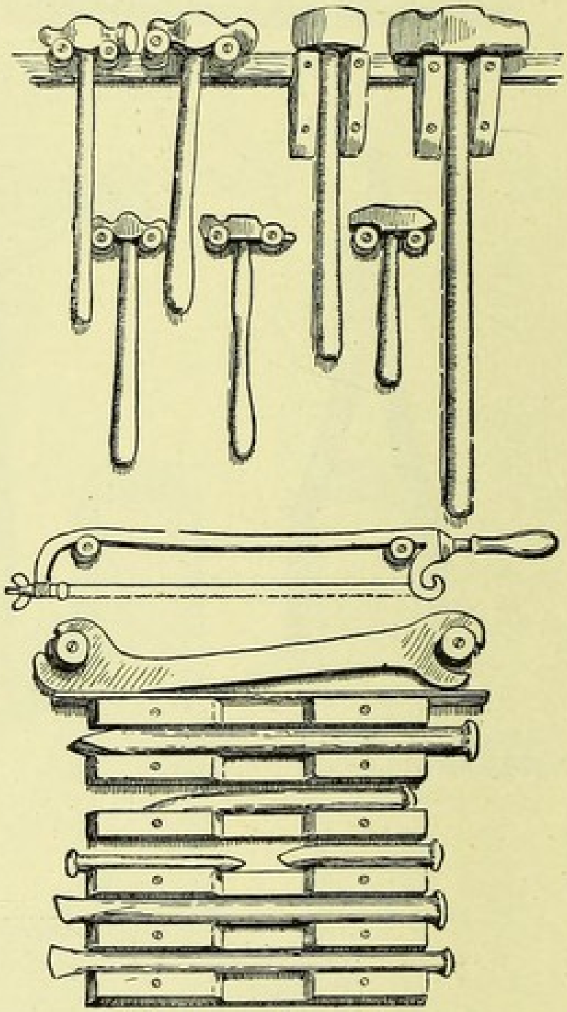
TOOLS AND RACKS.

Fig. 346.



Files, Rasps, Screw-Drivers,
Draw-Plates,
and
Drawing Tongs,
arranged in Racks designed by the
Author—see pages 22, 290, 330.

Fig. 347.



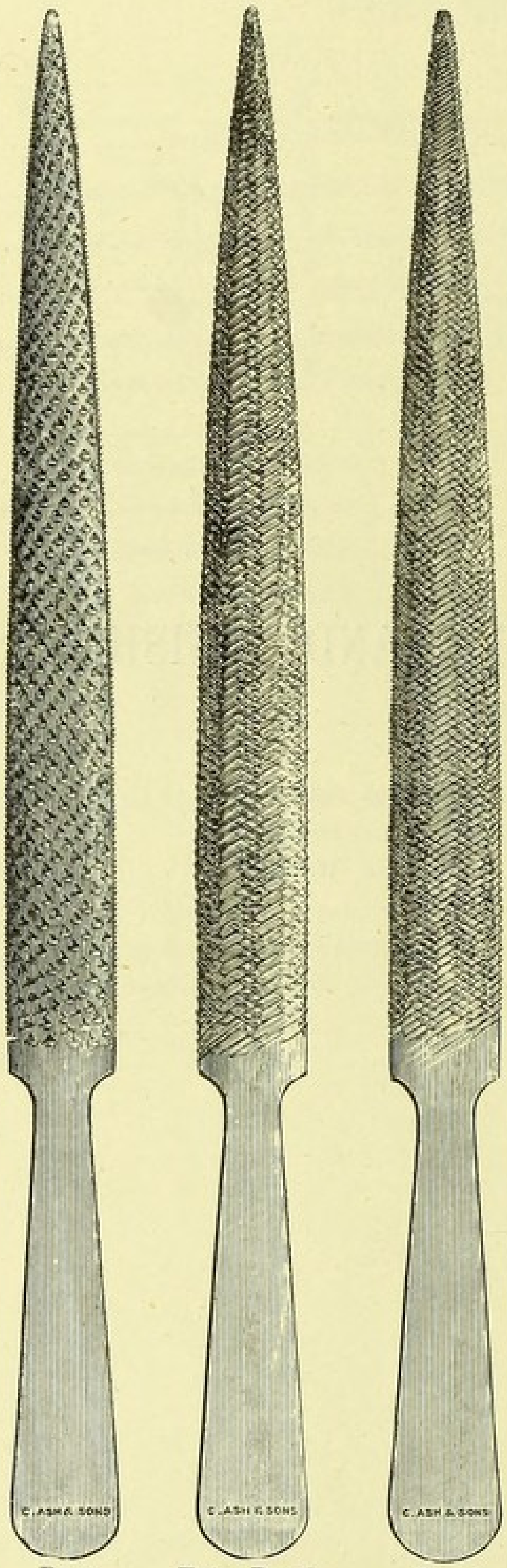
Hammers, Metal Saw,
Turnscrew,
and
Cold Chisels—see page 21.

Vulcanite Trimming and Finishing Bench.

Files, Scorpers, Rifflers, Reeded Sculptors,
Glass Cloth of Various Roughnesses,
Oil Stone, Cutting Burs and Wheels.

VULCANITE TRIMMIMG AND FINISHING BENCH—*CONTINUED.*

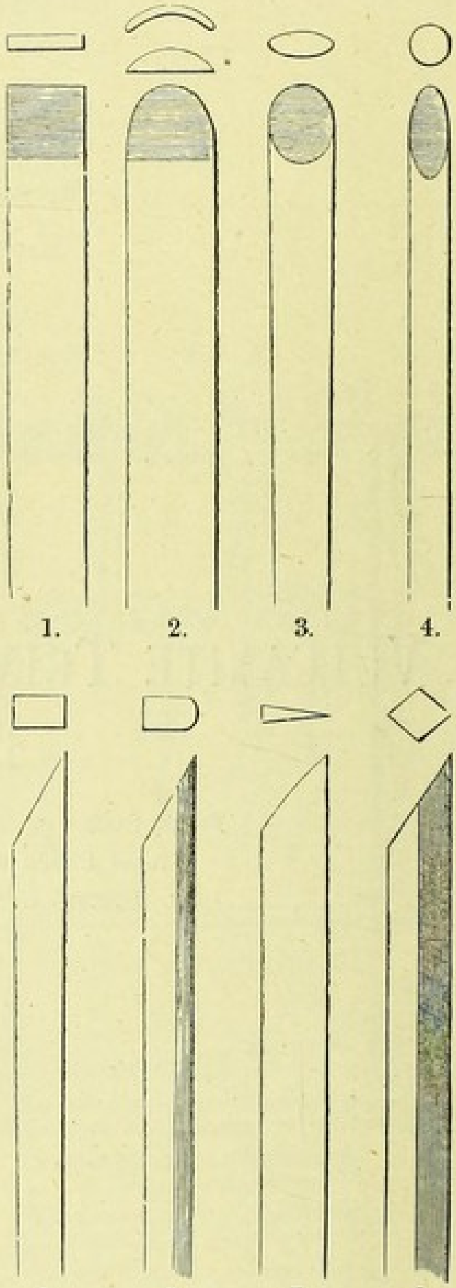
Fig. 348.



Rasp. Extra Rough. Rough.

Stubs' Files for Vulcanite Work.

Fig. 349.

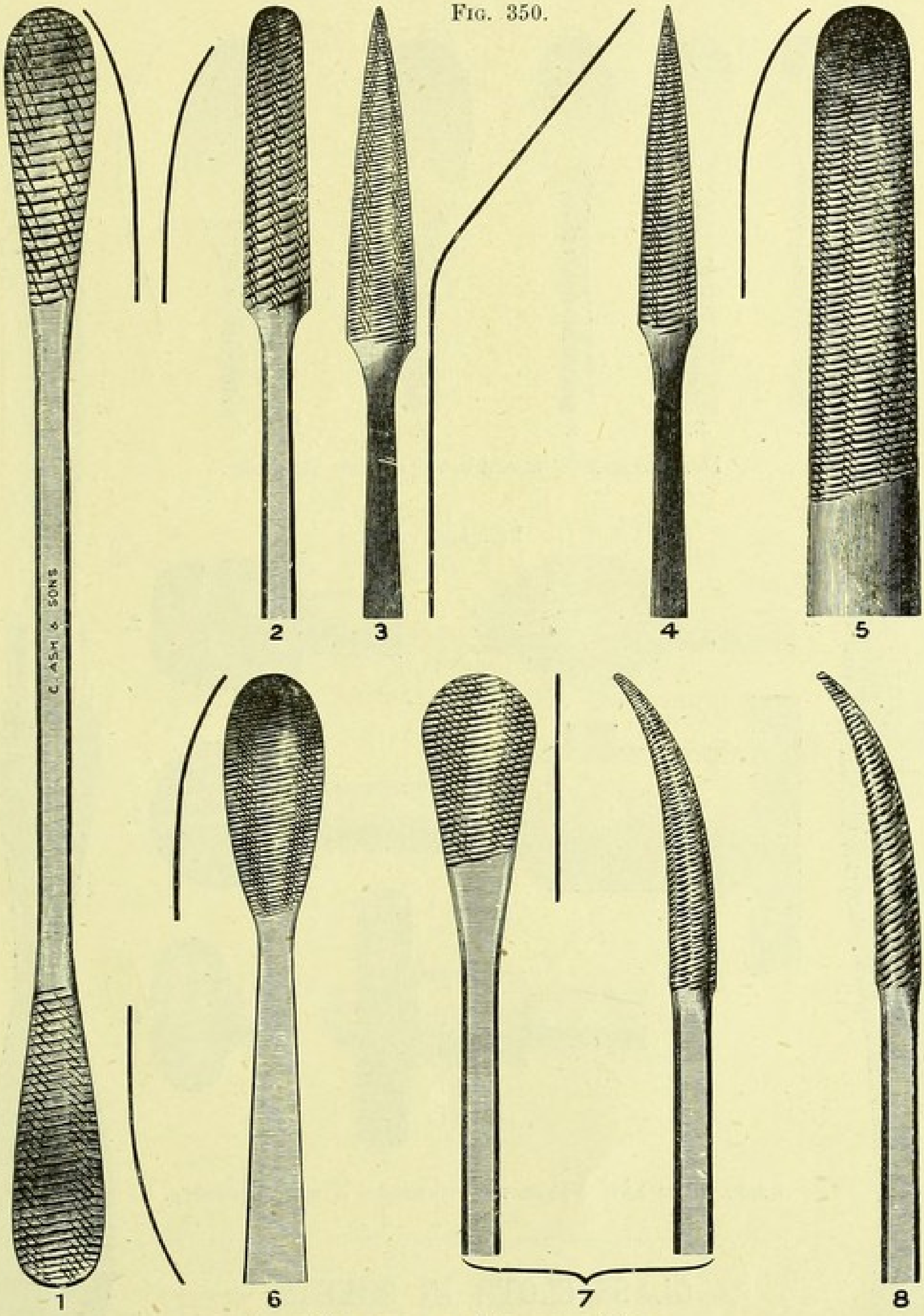


Sculptors or "Scorpers," made in broad, medium, and narrow, the broad being represented in the illustrations.

No. 1.—Flat.
,, 2.—Half-round.
,, 2.—Reeded or Gouge.
,, 3.—Oval.
,, 4.—Round.
,, 5.—Flat-edge.
,, 6.—Round-edge.
,, 7.—Sharp-edge or Picking.
,, 8.—Graver.

VULCANITE TRIMMING AND FINISHING BENCH—*CONTINUED.*

Fig. 350.

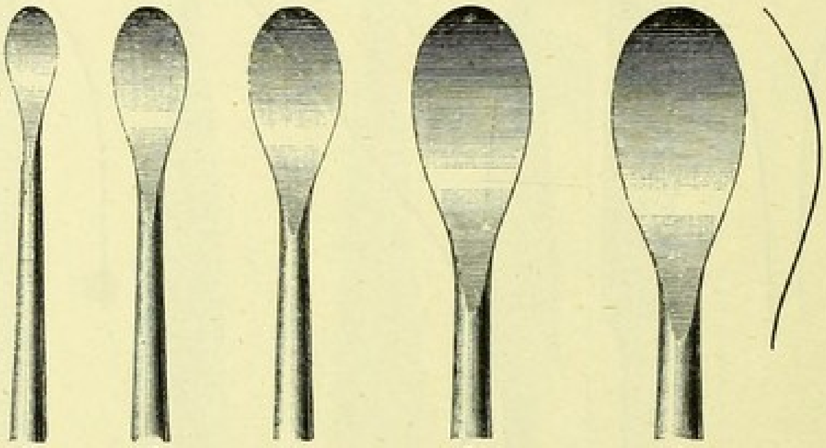


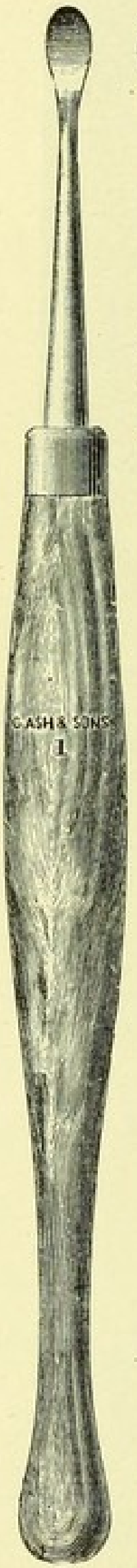
Stubs' Rifflers for Vulcanite Work.

NO.		NO.	
1.	Oval, thin, curved, cut all over.	5.	Half-round, thick, curved, cut on one side.
2.	Half-round, curved, cut on one side.	6.	,, thin, ,, ,, ,,
3.	,, thin, bent, cut on one side.	7.	Round one end, flat the other, cut all over.
4.	,, ,, ,, ,, ,,	8.	both ends and curved, ,,

VULCANITE TRIMMING AND FINISHING BENCH—*CONTINUED.*

Fig. 351.





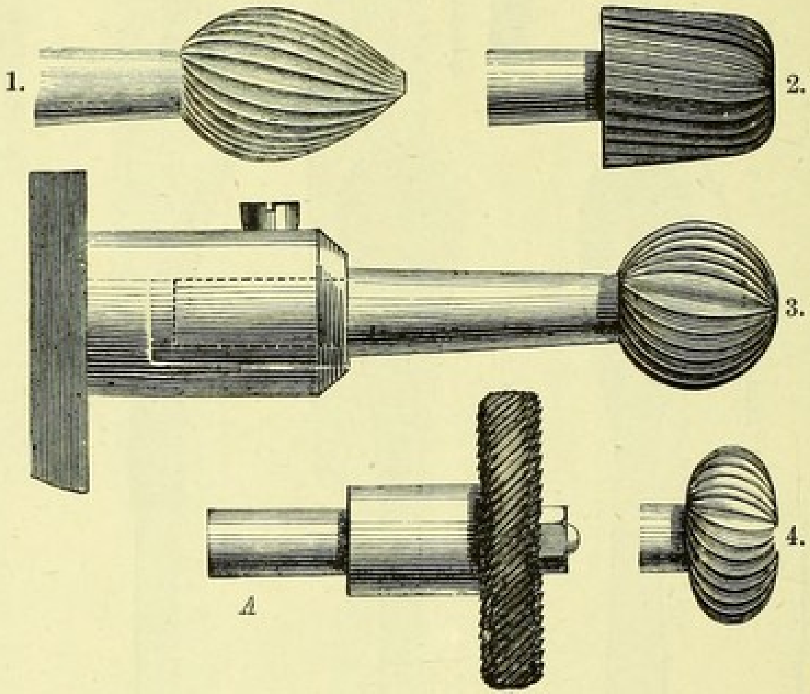
1. 2. 3. 4. 5. 6.

Dr. Norman Kingsley's Vulcanite Scrapers.

Fig. 352.

Bayonet Scraper.

Fig. 353.



Steel Burs and Wheel for trimming down Vulcanite.

GLASS CLOTH IN SHEETS.

No. 0, Extra Superfine; No. 1, Superfine; No. 1½, Fine. F/2, Medium; M/2, Coarse; S/2, Extra Coarse.

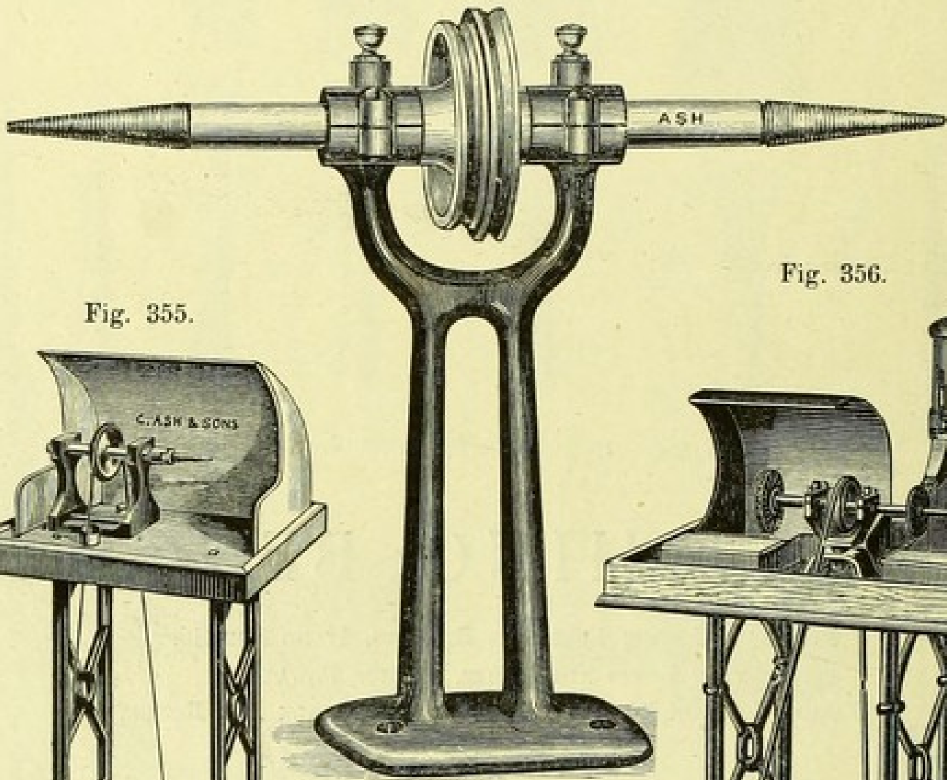
OIL STONES.—Turkey, Arkansas.

POLISHING BENCH.

Polishing Lathe, Polishing Brushes, Hard and Soft,
Felt Buffs and Cones, Pumice Powder,
Washed London Whiting, Precipitated Chalk and Rouge.

POLISHING BENCH—*continued.*

Fig. 354.



Nearly half-size.

Fig. 355.

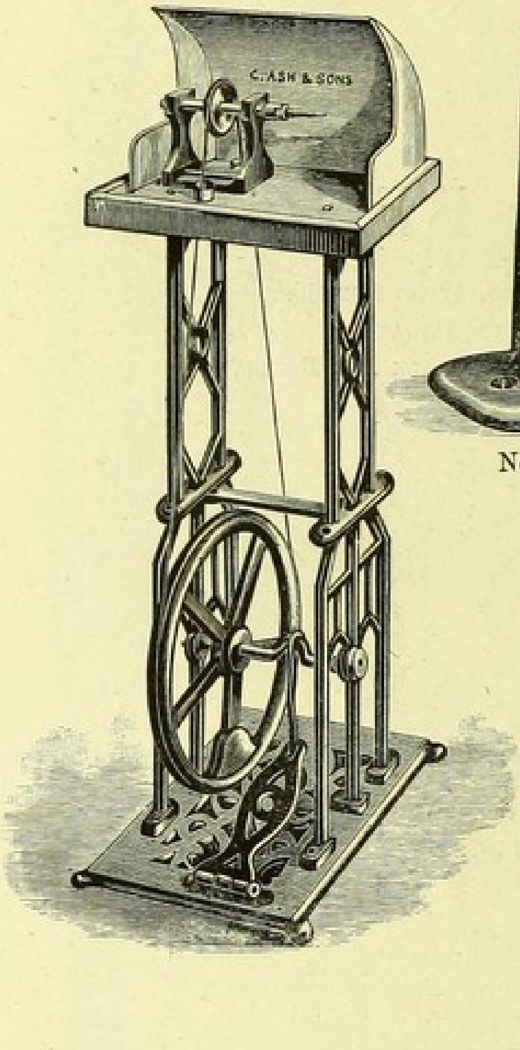


Fig. 356.

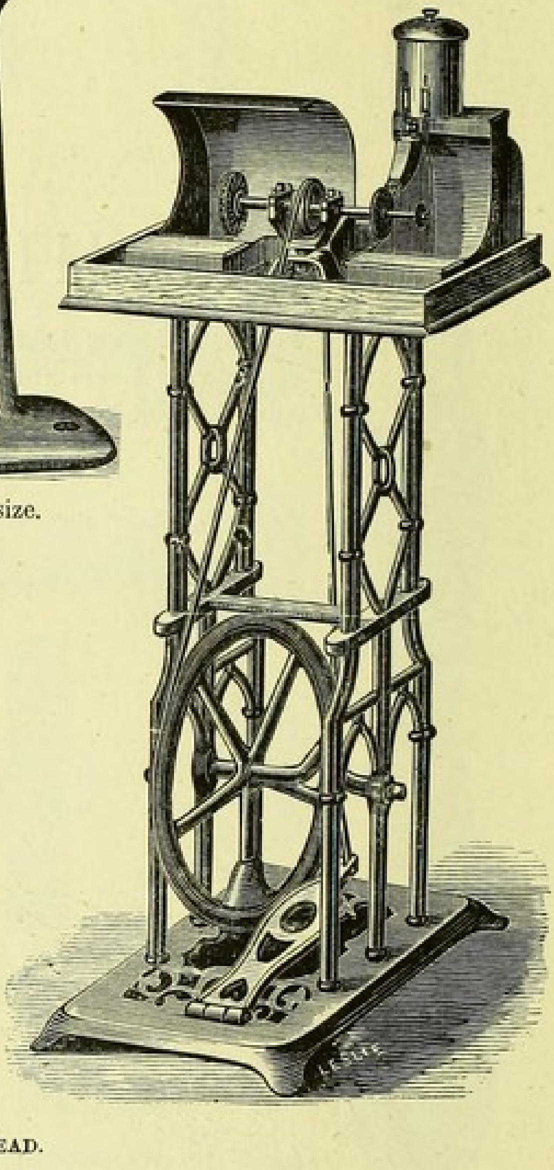


Fig. 354.—Ash's (No. 6) Polishing Lathe Head.

,, 355.—Ash's (No. 4) Polishing Lathe.

,, 356.—The Dental Manufacturing Company's Lathe, with Rising Head, Grinding and Polishing Chucks, and Water Apparatus.

POLISHING BENCH—*continued.*

Fig. 357.

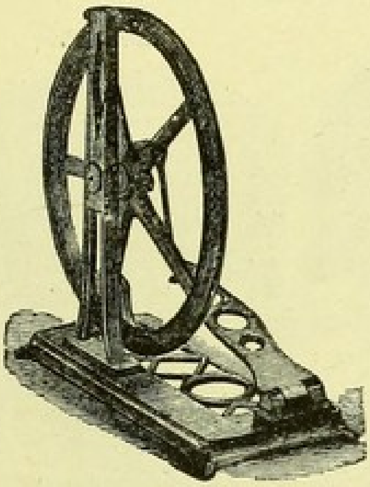


Fig. 358.

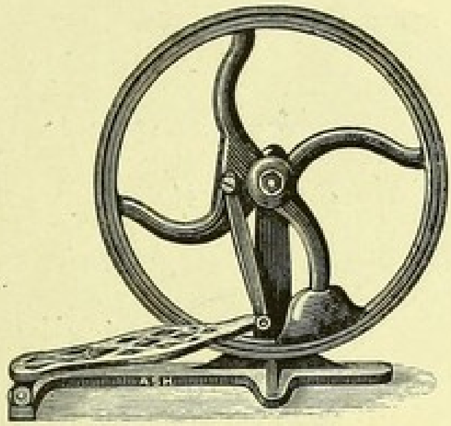


Fig. 359.

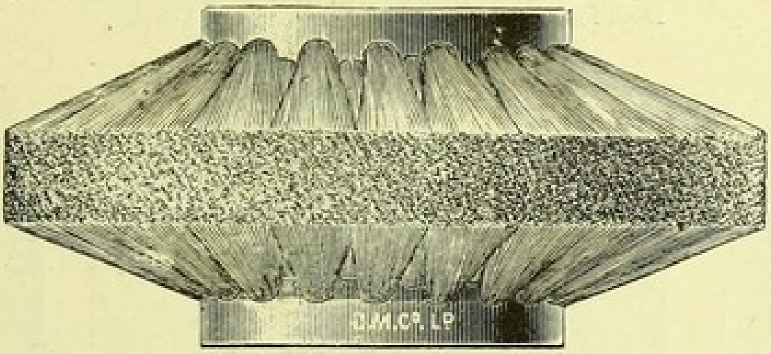


Fig. 360.

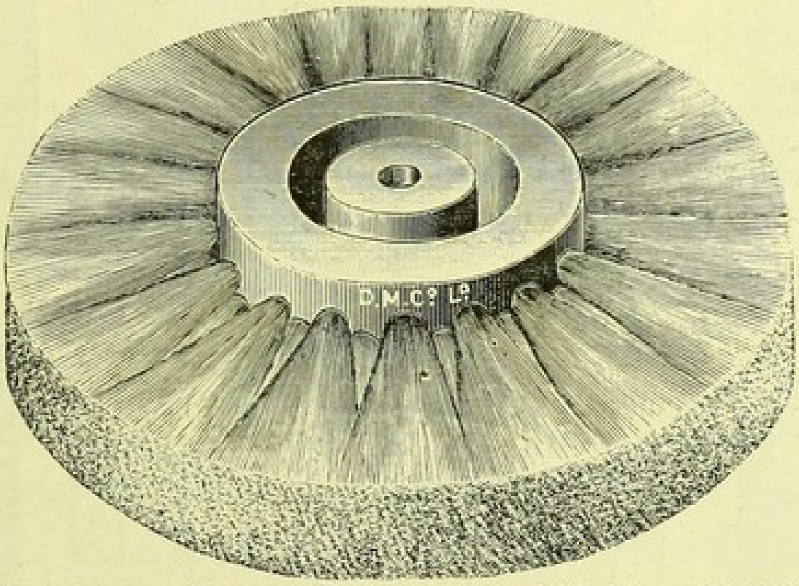
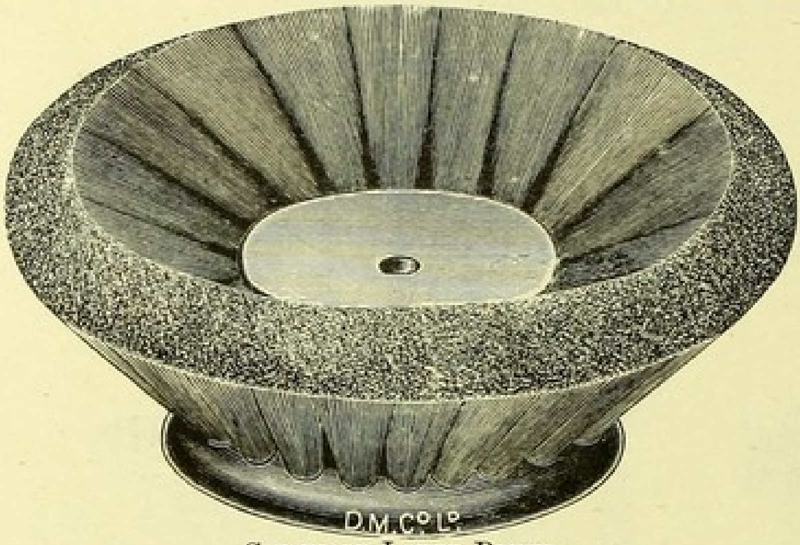


Fig. 357.—Heavy Driving Wheel with iron base, 21 ins. high, 9 ins. wide, 22 ins. long.
,, 358.—Driving Wheel for screwing to floor, 19 ins. high, 11 ins. wide, 21 ins. long.
,, 359.—Lathe Brush with converging bristles, hard or soft.
,, 360. ,, ,, straight ,, ,,

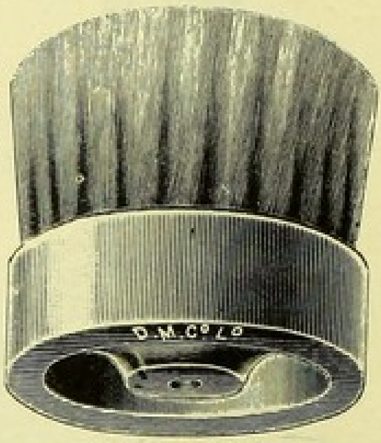
POLISHING BENCH—*continued.*

Fig. 361.



Cup-shape Lathe Brush.

Fig. 362.



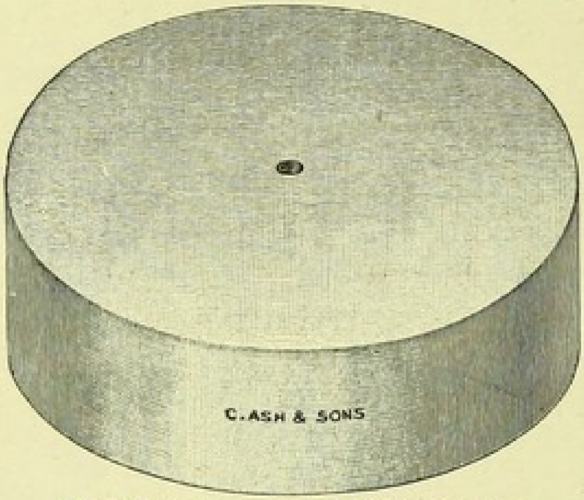
Hub-shape Lathe Brush.

Both forms are made with hard and soft bristles.

Fig. 363.

Pointed Felt Cone.

Fig. 364.



Felt Wheels—diameters as under.

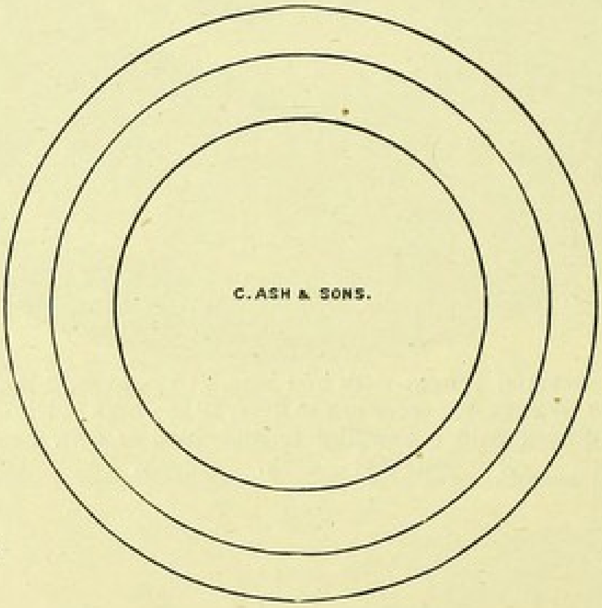
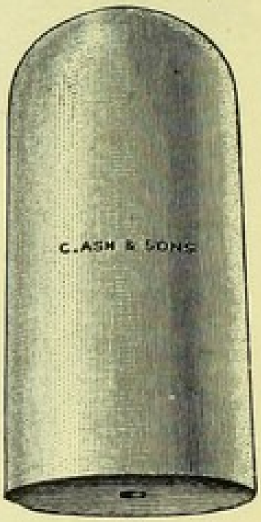


Fig. 365.



Rounded Felt Cone.

Fig. 366.

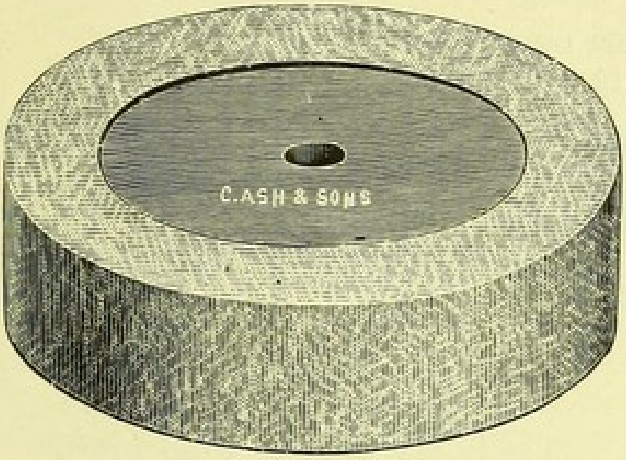
Pointed Felt Cone.

Fig. 367.

Rounded Felt Cone.

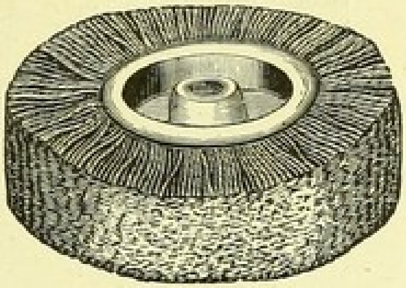
POLISHING BENCH—*continued.*

Fig. 368.



Felt Wheel, with wooden centre.

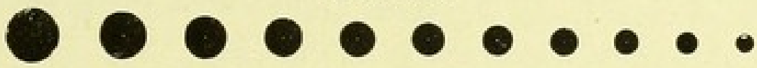
Fig. 369.



Cotton Wheel.

DIAMETERS OF GUT FOR LATHE BANDS.

Fig. 370.



6 7 8 9 10 11 12 13 14 15 16

This is usually supplied in hanks 20½ ft. long—sufficient for two workroom lathe bands.

Hooks and Eyes for each of the sizes of gut here illustrated can be obtained from the dental depôts.

Leather Band, with suitable hooks for joining the ends, is used by many dentists in preference to gut for workroom lathes.

ARTICLES, VARIOUS.

Precipitated Chalk. Pumice Powder. Rouge.

Scratch Brushes, brass wire, for lathe, fine and coarse.

Sratch Brushes, brass wire, for hand, fine and coarse.

Washed London Whiting.

FORMULÆ AND RECIPES.

FROM FLETCHER'S PRACTICAL DENTAL METALLURGY.

Page 13.—POWER OF CONDUCTING HEAT.

Gold	53	Zinc	36
Platinum	8	Tin	14
Silver	100	Lead	9
Copper	74	Brass	24
Iron	12	Bismuth	2

DILATION BY HEAT.

	Expansion between the freezing and boiling point of water.
Platinum expands 1 in.	1097
Palladium ,, ,,	1000
Antimony ,, ,,	923
Iron (cast) ,, ,,	901
Gold ,, ,,	667
Copper ,, ,,	557
Brass ,, ,,	524
Silver ,, ,,	499
Tin ,, ,,	424
Lead ,, ,,	350
Zinc ,, ,,	336

The contraction in cooling from castings corresponds to the above; the contraction of zinc being the greatest, nearly three times that of cast iron.

Pages 26, 27, 28.—The English sovereign weighs 123¼ grains, and contains 113 grains of pure gold.

To reduce sovereigns from 22 carats to lower standards, add for each coin—

For 16 carat 46 grains alloy.
,, 18 ,, 27½ ,, ,,
,, 20 ,, 12½ ,, ,,

HARD SPRINGY GOLD SIXTEEN CARAT.

Gold	36	Silver	6
Copper	12		

GOLD SOLDERS.

For 22 carat—take 22-carat gold 24 parts, silver 2, copper 1.
For 18 carat—take 18-carat gold 24 parts, silver 2, copper 1.
For 16 carat—take 16-carat gold 24 parts, silver 8, copper 6.

Brass is generally used—*i.e.* the alloy of 7 copper, 3 zinc—in preference to copper for all gold solders. The presence of a trace of zinc causes the solder to flow much more freely. It may be taken as a general rule that the use of zinc in a gold solder is not acknowledged, and yet, curiously enough, the zinc is to be found in nearly if not all good solders. The following three formulas are taken from Oakley Cole's "Manual of Dental Mechanics":—

16-Carat Solder for 18 or 20 carat plate.—Fine gold 6, copper 2, fine silver 1 (the previous remarks as to brass will also apply to this).

15-Carat Solder.—Gold coin 144, silver 30, copper 20, brass 10. (It is not stated if silver coin is to be used or fine silver.)

18-Carat Solder.—Gold coin 30, silver 4, copper 1, brass 1. Some dentists who make their own solder simply add 1 part of zinc to 12 parts of the gold for which the solder is required.

It may be taken as a rule that ordinary fine silver and fine gold should never be used for alloying. They are frequently sufficiently impure to be utterly unfit for any of the requirements of the dentist, containing metals in small quantities (such as lead) which spoil the alloy and make it brittle. It is much safer always to take coins, as the fact that the coin has been rolled from the ingot and stood the blow of the dies is always a proof that the metal can be trusted not to produce a brittle ingot. Many samples of gold almost chemically pure are quite unworkable. Before the process of refining by chlorine gas was discovered, this fact caused very serious difficulties and losses at the English Mint.

False Coinage.—In melting sovereigns care is requisite in examining each coin. A very large number of splendid imitations are made of platinum, heavily gilt. I have had large quantities of these, purchased along with platinum scrap, and so long as the gilding is perfect, they can only be detected with the greatest difficulty.

An alloy of 16 platinum, 7 copper, 1 zinc also makes imitation of gold coinage so perfect as to be beyond ordinary detection. The falsification of gold coinage is not confined to English coins, but is, if anything, more frequent with French, Spanish, and American coinage.

A pasty alloy of gold and mercury is used for heavy gilding, the mercury being driven off by heat.

Pages 6 and 7—A ROUGH METHOD OF ESTIMATING HIGH TEMPERATURES.

Degrees Centigrade.		Degrees Centigrade.	
411	Zinc melts.	1102	Fine gold melts (1250 Bayley).
525	Slight glow in the dark.	1173	Fine copper melts (1050 Bayley).
700	Dark red.	1300	White.
900	Cherry red.	1350	Steel melts.
1000	Bright cherry red.	1500	Dazzling white.
1023	Fine silver melts.	1600	Wrought iron melts.
1150	Orange.	2534	Platinum melts.

BEHAVIOUR OF METALS WITH ACIDS.

Not Attacked by Dilute Sulphuric Acid at Ordinary Temperatures.

Gold, Platinum, Antimony, Lead (Copper very slightly), Mercury, Silver, Bismuth, Tin (Palladium slightly attacked).

Soluble in Dilute Sulphuric Acid.

Iron, Zinc, Cadmium, Aluminium, Nickel (Tin with the assistance of heat).

Not Attacked by Dilute Nitric Acid.

Gold, Platinum, Aluminium, Palladium.

Soluble in Dilute Nitric Acid.

Lead, Cadmium, Iron, Copper, Nickel, Mercury, Silver, Bismuth, Zinc, Antimony and Tin are oxidized but not dissolved.

Not Attacked by Hydrochloric Acid.

Antimony, Gold (Copper if air is excluded), Mercury, Platinum.

Slightly Attacked.

Lead, Palladium, Silver, Bismuth.

Soluble in Hydrochloric Acid.

Aluminium, Cadmium, Iron, Nickel, Zinc, Tin.

Soluble in Solutions of Soda and Potash.

Aluminium, Zinc (Tin when heated).

Attacked by Fused Alkalis at High Temperatures.

Platinum, Palladium.

Page 12.—**Contraction of Castings in Cooling**—*i.e.*, the amount of difference between the size of the impression in sand and the casting produced.

Cast Iron	·125
Copper	·193
Brass	·210
Lead	·319
Tin	·278

The superiority of iron castings for exact work in making dies is clearly demonstrated by the above, irrespective of the fact that one die will do all necessary in a far superior manner to a die made with any other metal. Iron runs perfectly in open sand in the usual manner of casting dentists' dies. A little sawdust or charcoal powder should be sprinkled over the surface of the metal in the crucible.

Tenacity of Metals.—A wire of the same diameter will support the following comparative weights without breaking :—

Iron	549 lbs.
Copper	302 lbs.
Platinum	274 lbs.
Silver	187 lbs.
Gold	150 lbs.
Zinc	109 lbs.
Tin	39 lbs.
Lead	27 lbs.

PAGES 50, 51.—TEMPERING STEEL.

	Fahrenheit.	Centigrade.
Light straw colour	430°	221°
Dark straw	470°	243°

The above for wood, ivory, and vulcanite tools.

	Fahrenheit.	Centigrade.
Brown yellow	500°	260°

For gravers and tools for metal cutting.

	Fahrenheit.	Centigrade.
Bright blue	550°	288°

For springs and saws.

Forging Fine Steel Instruments.—These must never be heated in an ordinary blowpipe flame, as it ruins the quality of the steel. Direct the jet downwards on a block of charcoal, and heat the steel with the rebound of the flame from the charcoal, which gives a saturated bath of carbonic acid. In the absence of charcoal, heat in the white part of the flame of a common lighting burner ; do not heat too quickly, and work at the lowest temperature possible, hammering until nearly cold. Harden by sticking the point into a tallow candle. A thin coating of soap prevents scaling in hardening to a great extent, but not entirely. Polished instruments may be hardened and tempered without losing their polish by wrapping tightly with thin soft platinum foil. Chronometer springs are coiled on an iron or steel mandril, covered with platinum foil and hardened in the same manner without losing their polish.

FURNACES.

Coke, Crucible Tongs, Blower, Crucibles, Gas Furnace for Zinc and Lead,
Ingot or Skillet for Casting Gold, Fletcher's Injector,
Zinc and Lead Ladles, Small Injector, Blowpipes, Zinc,
Tin, Babbitt Metal, Gartrell's Die Metal, Lead,
Ash's Crown Furnace, Ash's Bridge Furnace,
Ash's Bridge Furnace arranged for Air-Gas, Dall's Crown Furnace,
Gartrell's Continuous-Gum Furnace, etc., with Petroleum Blast,
Gartrell's Continuous-Gum Furnace for Coal-Gas,
Gartrell's Crown and Bridge Furnace for Coal-Gas,
Gartrell's Crown and Bridge Furnace arranged for Air-Gas,
Ash's Mineral Bodies and Gum Enamels,
Close's Porcelain Enamels and Bodies,
Gartrell's Porcelain Enamels and Bodies,
Rose's Porcelain Enamels and Bodies,
Mitchell's Electric Crown Furnace,
Mitchell's Electric Continuous-Gum Furnace, etc

FURNACES, ETC., AND BLOWPIPES.

Fig. 372.

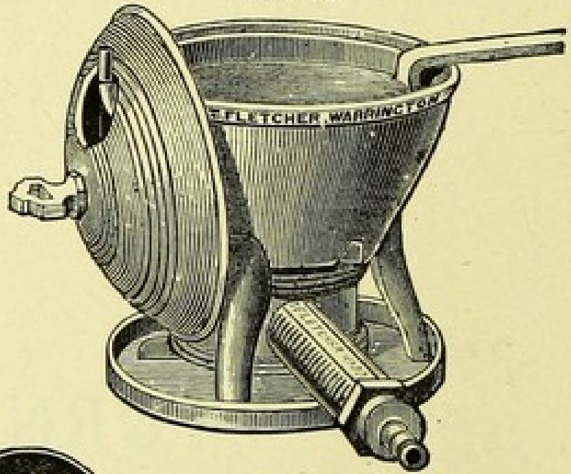


Fig. 371.

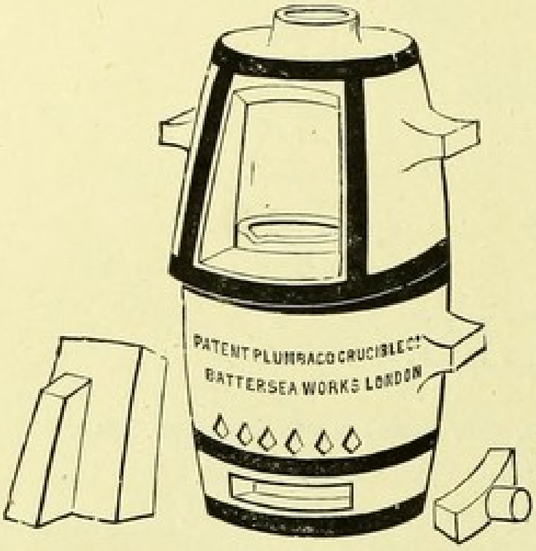


Fig. 373.

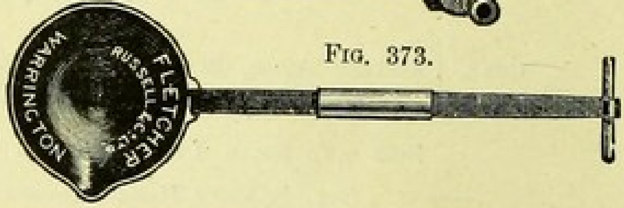


Fig. 371.—Draft Crucible Furnace for melting gold, silver, etc., for use with Foundry Coke and Charcoal.
„ 372.—Fletcher's Gas Furnace for melting lead, zinc, Babbitt metal, Gartrell's die metal and tin.
„ 373.—Fletcher's Ladle with malleable iron bowl for zinc, etc.
„ 373.—Fletcher's Ladle with cast-iron bowl for lead, etc.

BLOWPIPES.

Fig. 374.

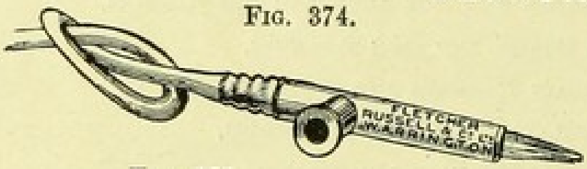


Fig. 377.

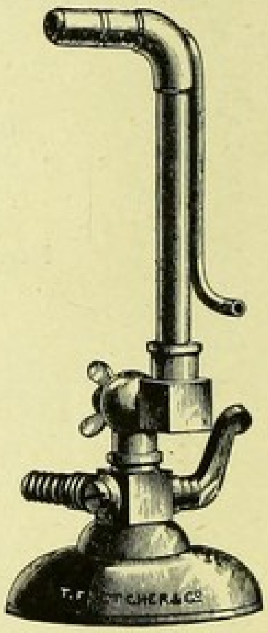


Fig. 375.

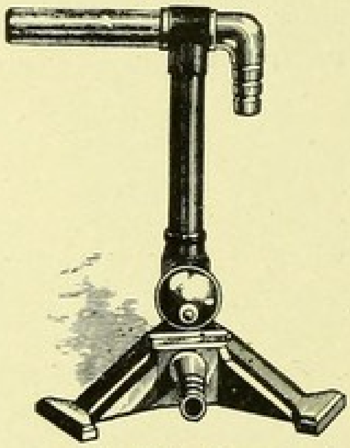


Fig. 376.

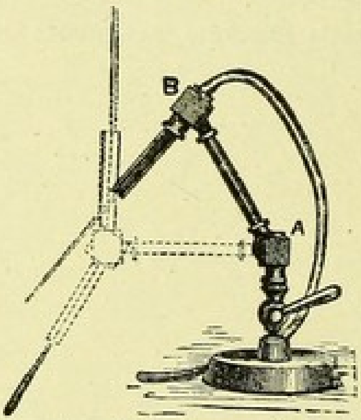


Fig. 374.—Fletcher's Universal Blowpipe—simple form.
„ 375.—Fletcher's Universal Blowpipe on Stand with swivel joint.
„ 376.—Fletcher's Double-jointed Herapath Blowpipe.
„ 377.—Fletcher's No. 1 Dentist's Adjustable Blowpipe.

For Mr. Gartrell's Oxygen Blowpipe and Fine Adjustment Valve—see page 323.

FURNACES, ETC.—*CONTINUED.*

Fig. 378.

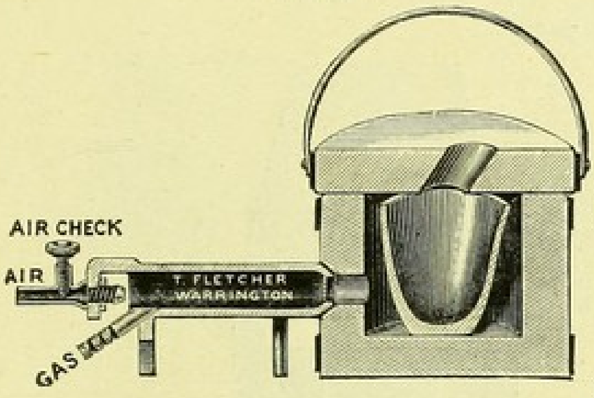


Fig. 379.

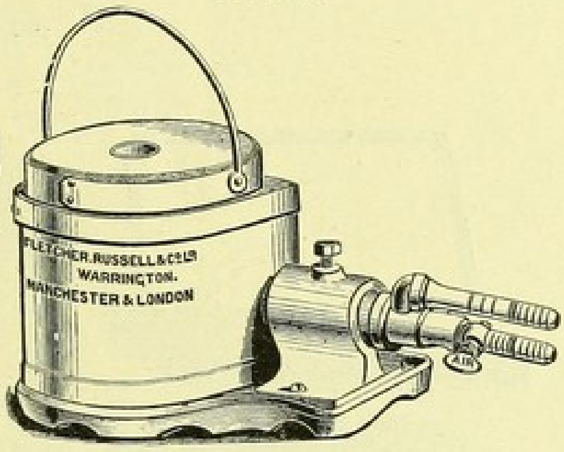


Fig. 380.

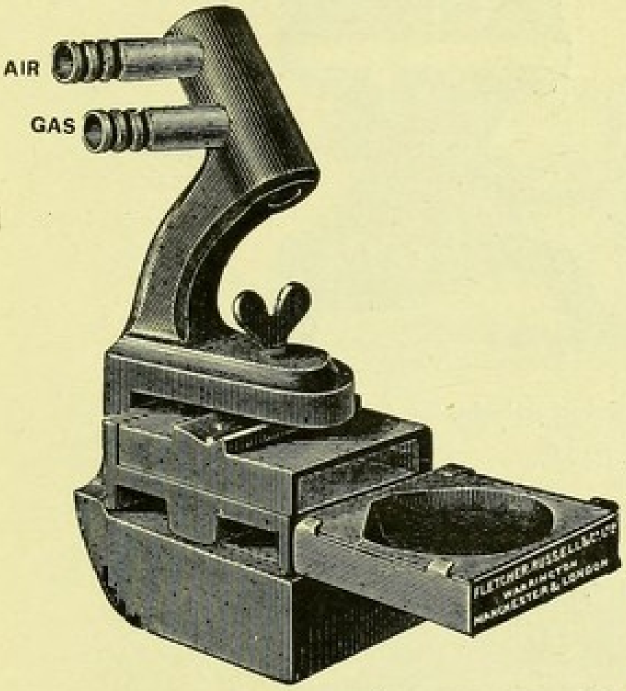
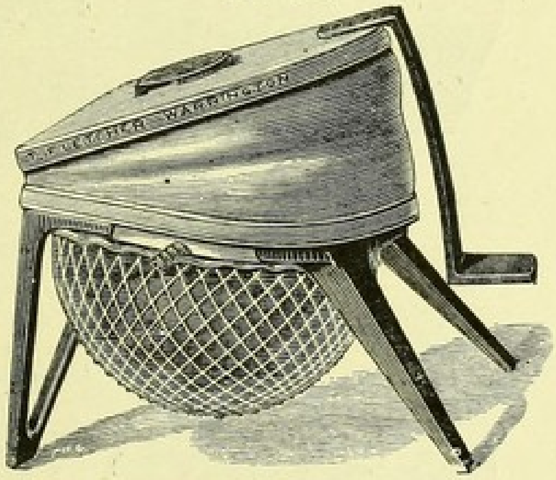


Fig. 381.



Blast Furnaces, etc., for Melting Gold and Silver.

Fig. 378.—Fletcher's Injector Furnace.

,, 379.—Fletcher's Concentric Jet Furnace.

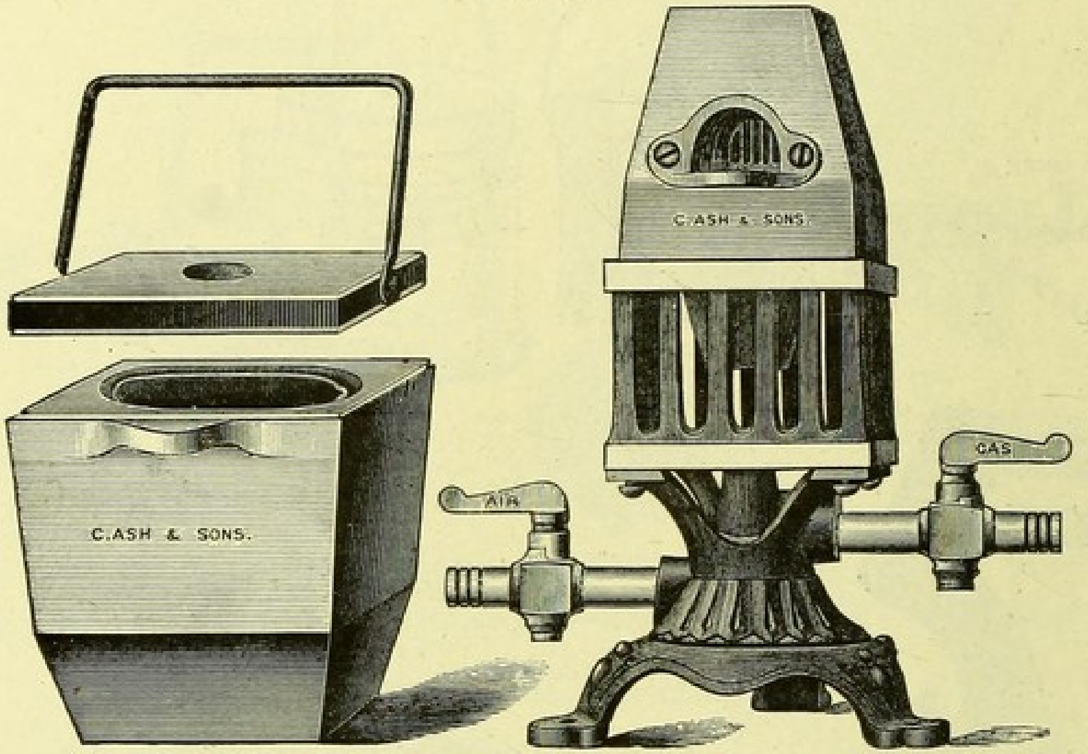
,, 380.—Fletcher's New Melting Arrangement, 3-ounce size. In this arrangement the two parts of the ingot mould slide on each other, to admit of ingots of any width within its range being cast. It thus serves for both plate and wire.

Fig. 381.—Fletcher's Bellows.

Crucibles and Crucible Tongs for use with the above Furnaces, etc.

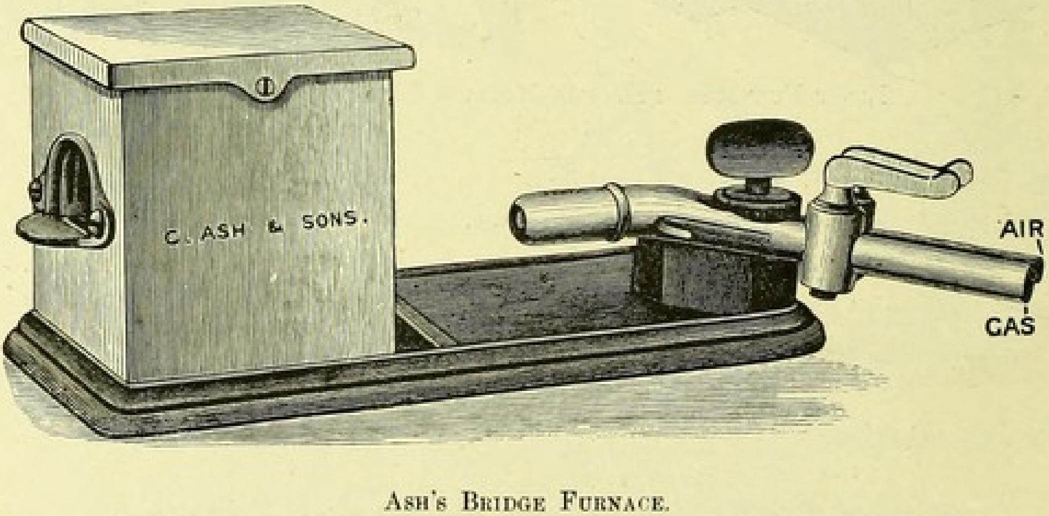
FURNACES, ETC.—*continued.*

Fig. 382.



Ash's Crown Furnace, with Crucible Attachment for melting Gold and Silver.

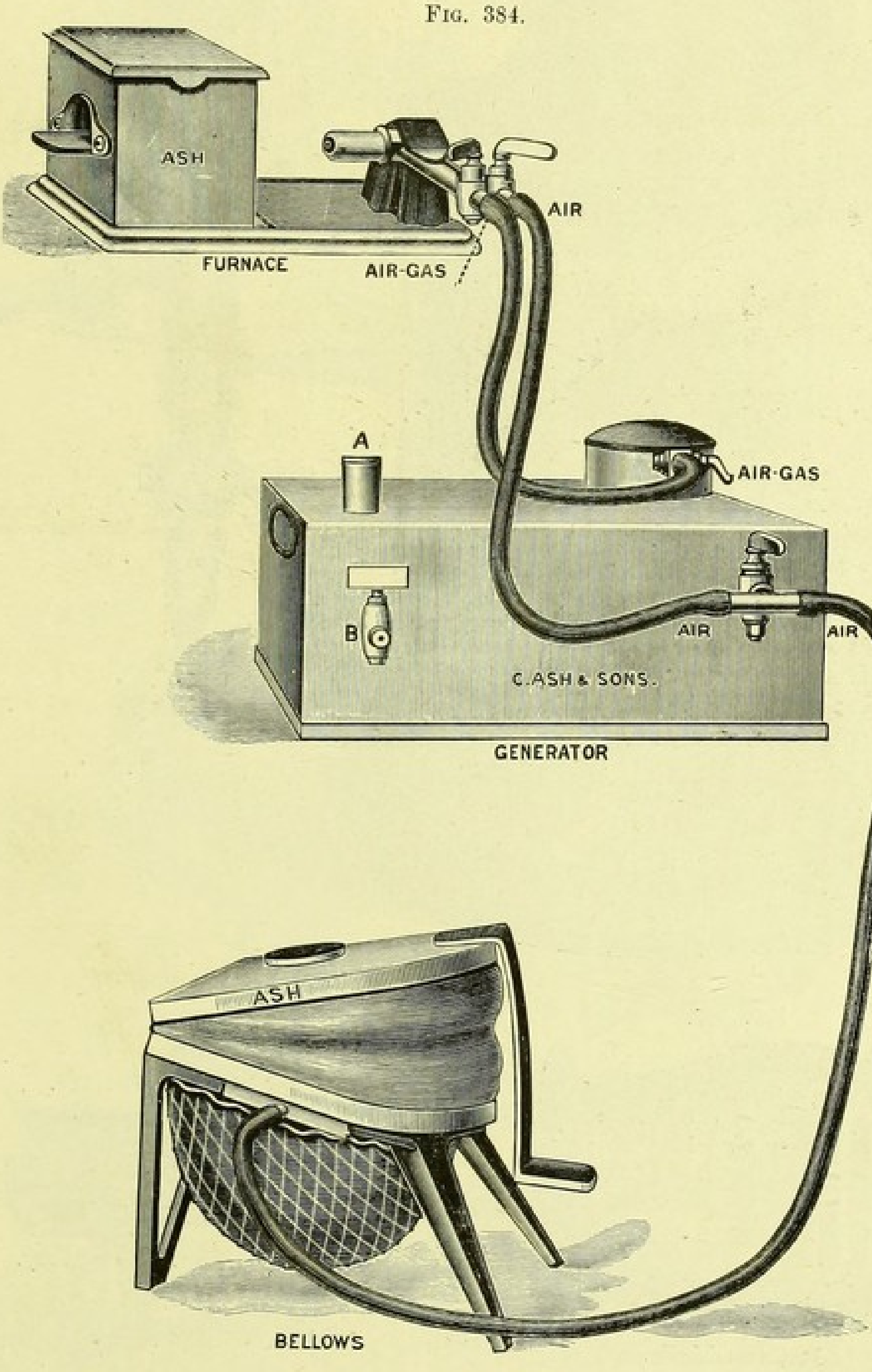
Fig. 383.



Ash's Bridge Furnace.

FURNACES, ETC.—*continued.*

Fig. 384.



Ash's Bridge Furnace with Fletcher's Air-Gas Generator and Bellows.

FURNACES, ETC.—*continued.*

Fig. 385.

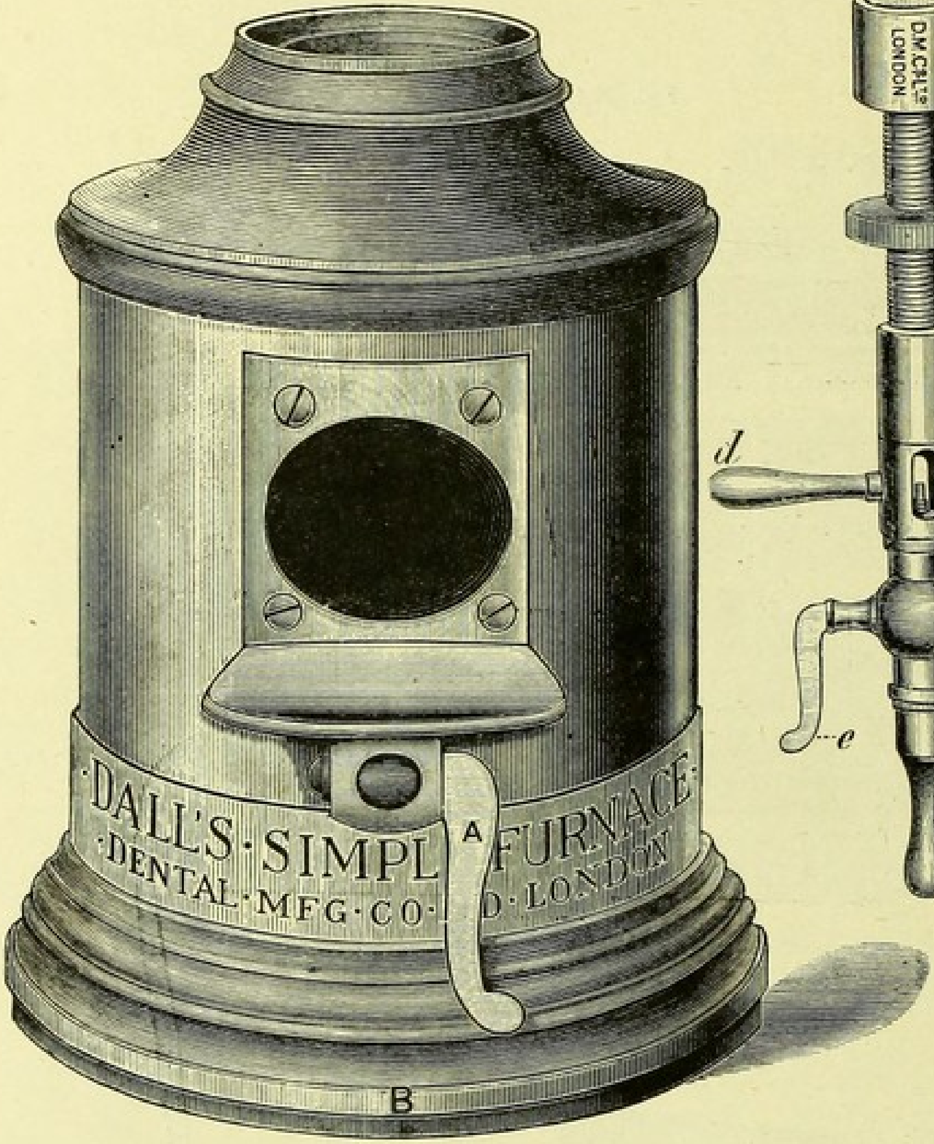
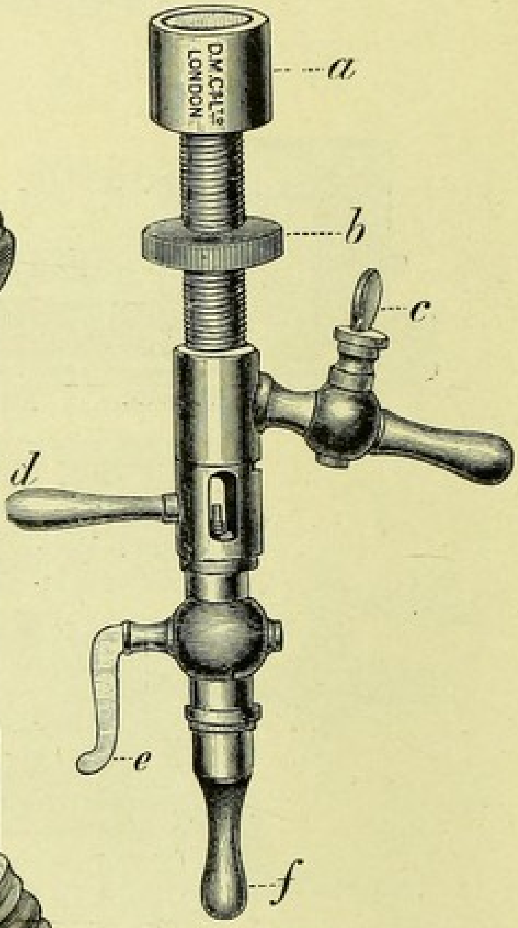
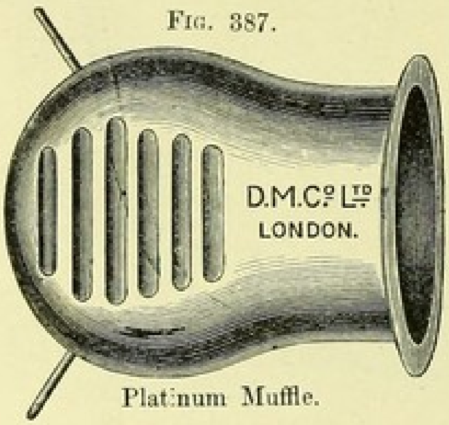


Fig. 386.



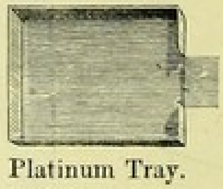
Burner.

Fig. 387.



Platinum Muffle.

Fig. 388.

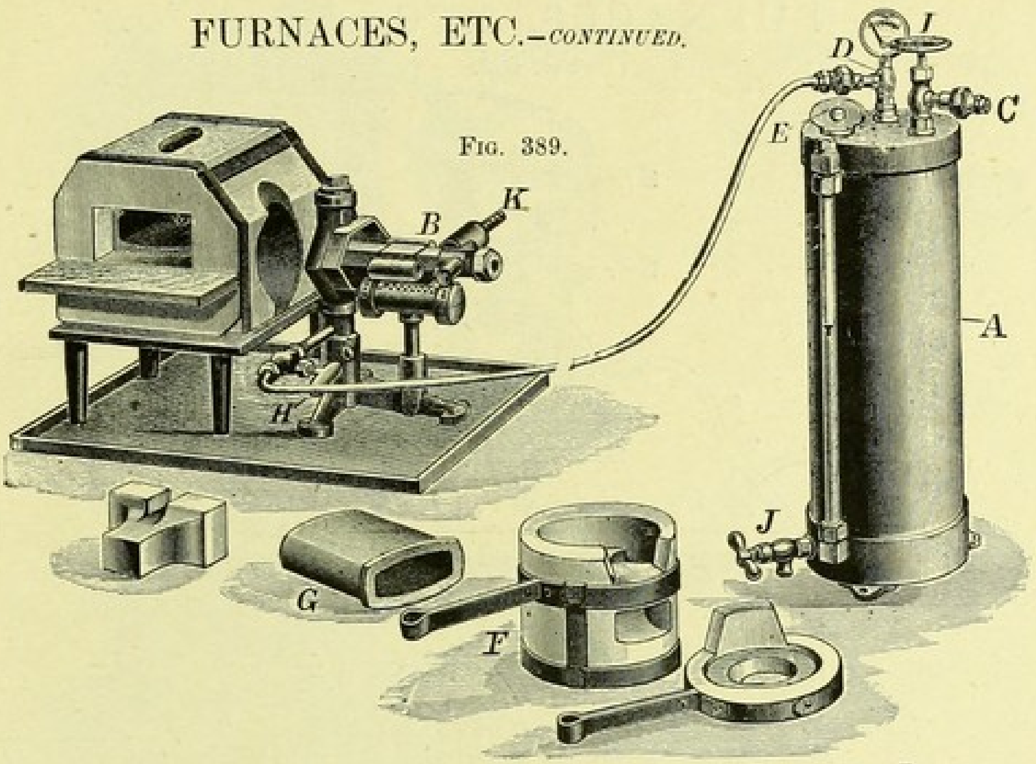


Platinum Tray.

Mr. Dall's Crown Furnace, full-size, with Burner, Muffle and Tray.

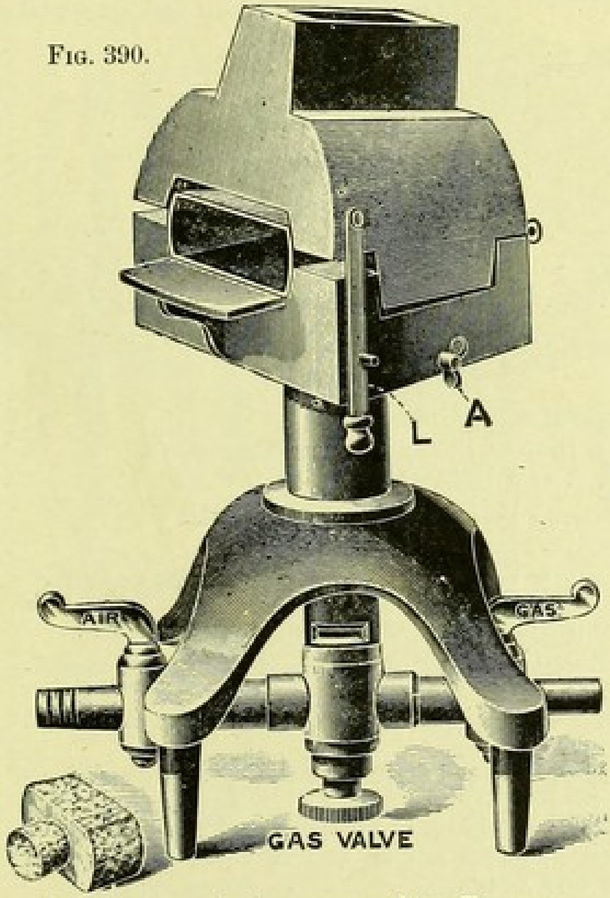
FURNACES, ETC.—*continued.*

Fig. 389.



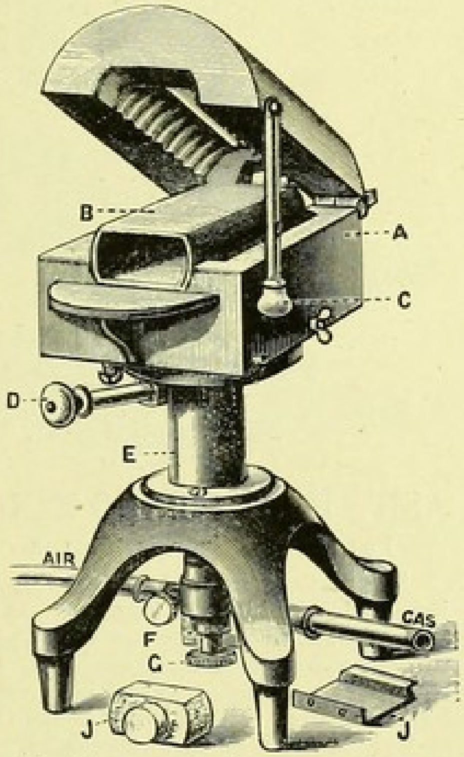
Mr. Gartrell's Continuous-Gum Furnace, etc., with Petroleum Blast.

Fig. 390.



Mr. Gartrell's Continuous-Gum Furnace, for use with coal-gas.

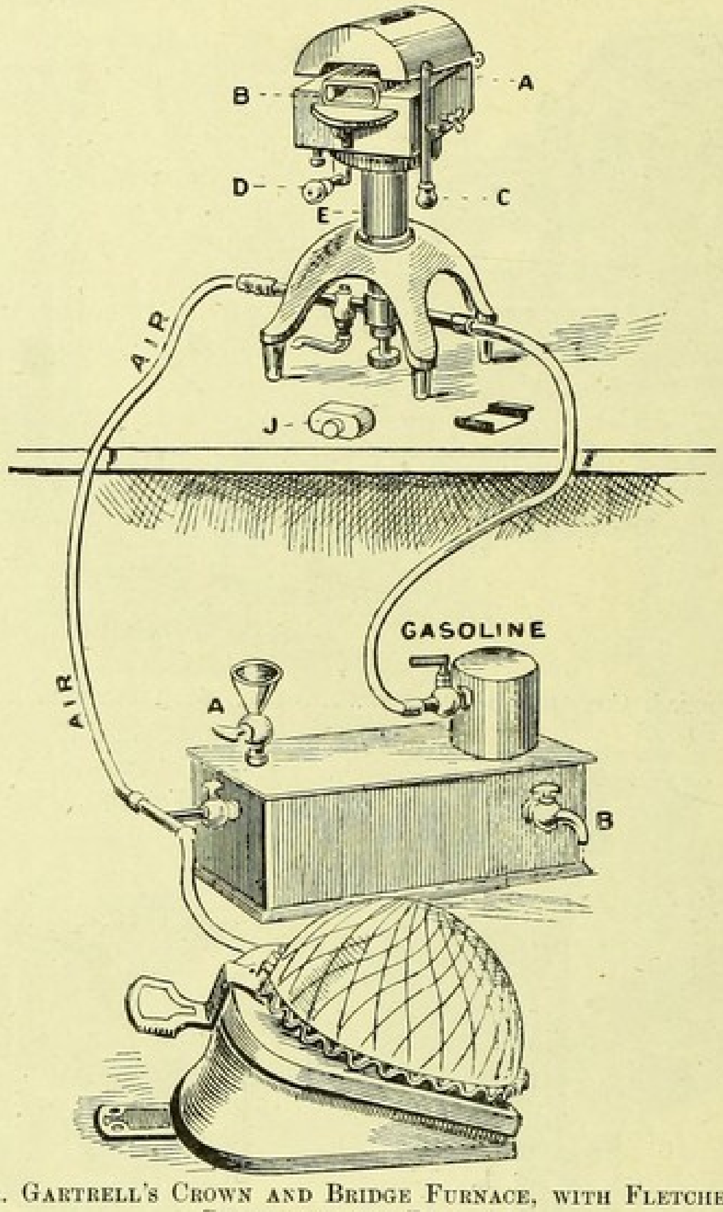
Fig. 391.



Mr. Gartrell's Crown and Bridge Furnace for use with coal-gas.

FURNACES, ETC.—*CONTINUED.*

FIG. 392.



MR. GARTRELL'S CROWN AND BRIDGE FURNACE, WITH FLETCHER'S GENERATOR AND BELLOWS.

For description of Mr. Gartrell's Furnaces, see pages 248–258.

ASH'S HIGH-FUSING MINERAL BODIES AND GUM ENAMELS,

FOR INLAYS, CROWNS, BRIDGES, AND FULL SETS OF CONTINUOUS-GUM WORK.

The manufacturers claim that these Bodies and Enamels are non-cracking and exceedingly strong and dense; that they can be ground and polished like their mineral teeth; that they are adapted for use with English or American teeth; and that they can be fired without endangering the colour of the teeth.

The Enamels are prepared in two shades, light and dark, and the Bodies in the following six shades: the light part of the teeth, B/1, B/3, C/2, E/2, F/2, and the dark part of B/4 on Ash's set of teeth shades. The two shades of Enamel and the six shades of Body are usually supplied in quarter-ounce bottles put up in a cardboard box with a nickel-plated Spatula and a camel-hair Pencil Brush.

Close's Porcelain Enamels and Bodies. Gartrell's Porcelain Enamels and Bodies. Rose's Porcelain Enamels and Bodies.

FURNACES, ETC.—*continued.*

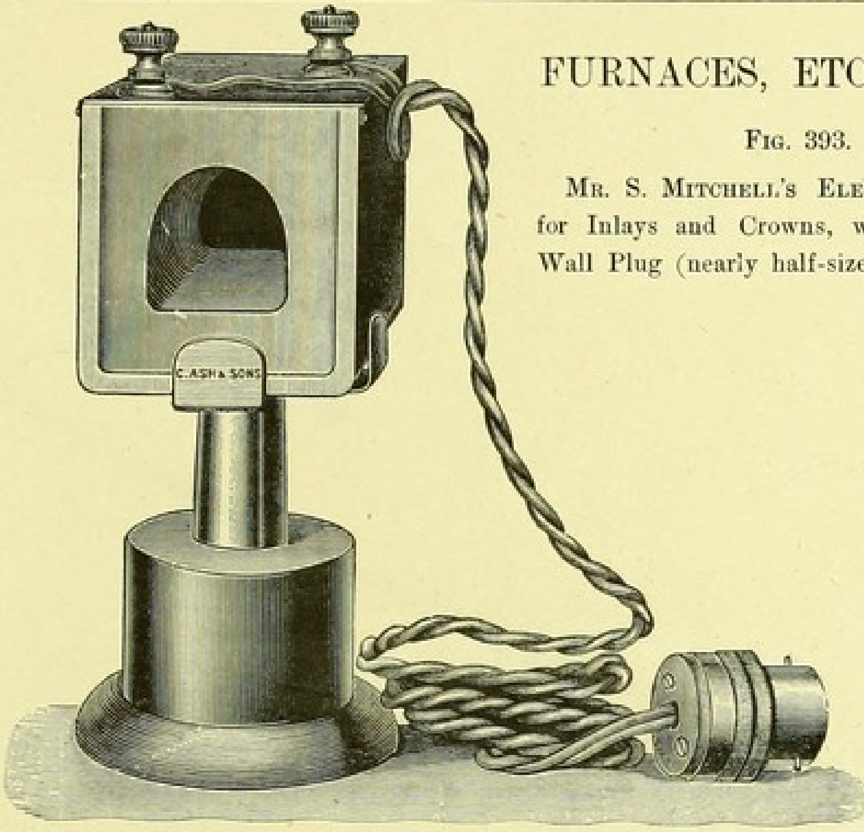


Fig. 393.

Mr. S. Mitchell's Electric Furnace for Inlays and Crowns, with Wires and Wall Plug (nearly half-size).

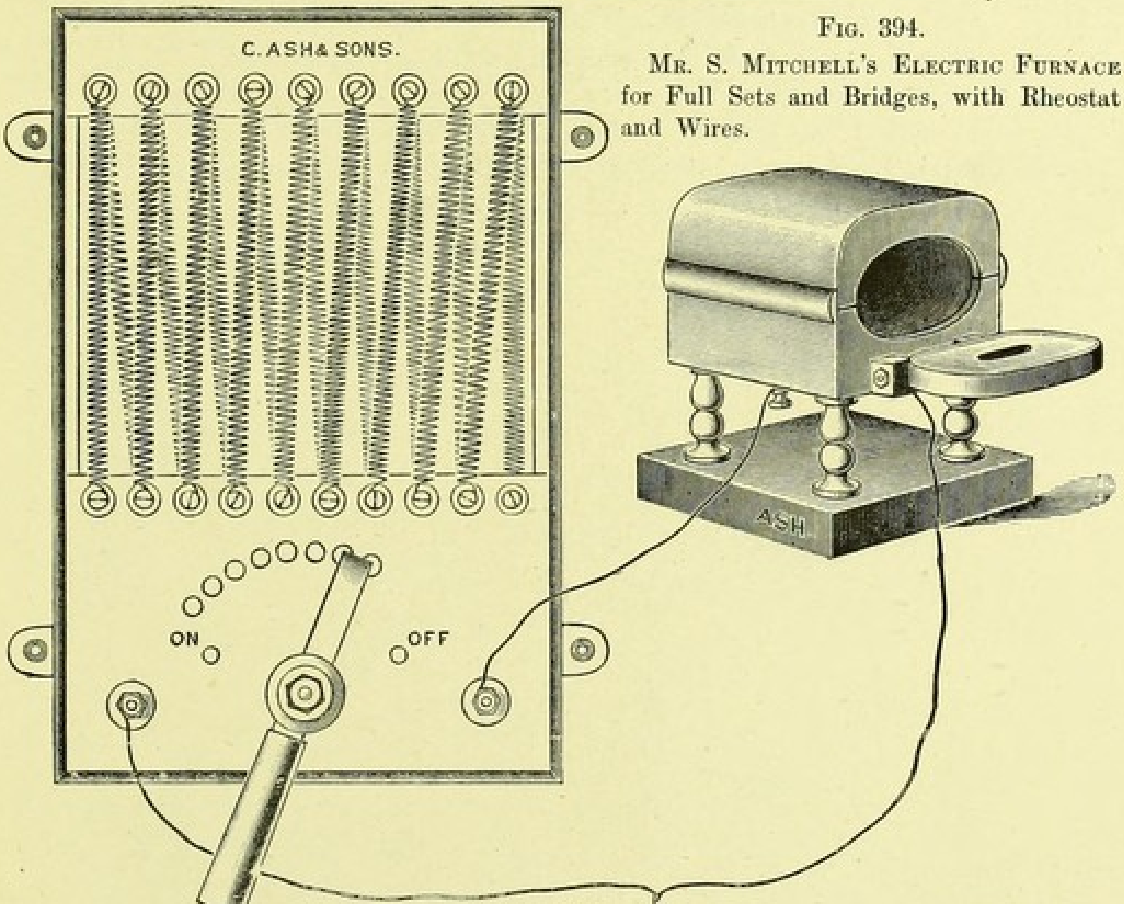


Fig. 394.

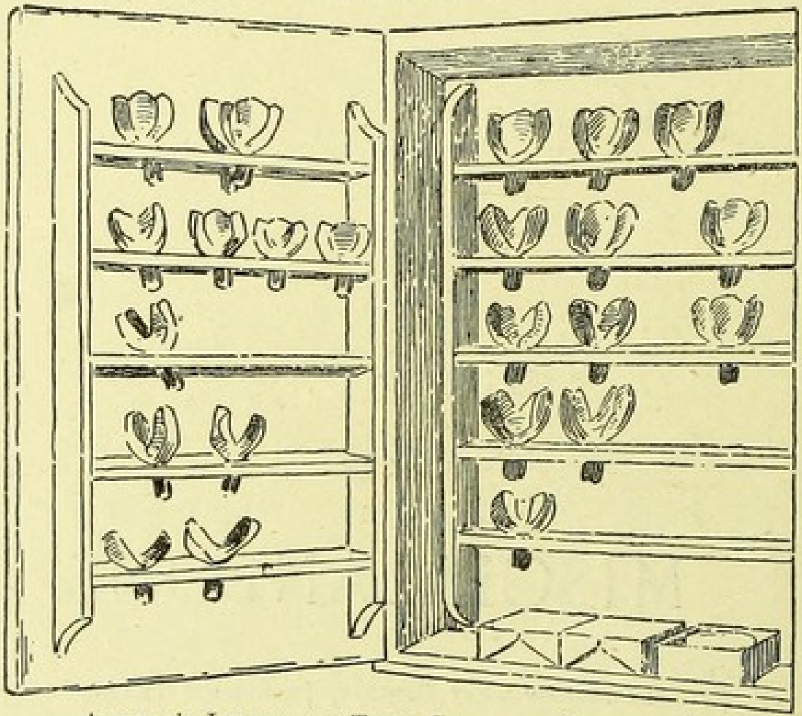
Mr. S. Mitchell's Electric Furnace for Full Sets and Bridges, with Rheostat and Wires.

MISCELLANEOUS.

Impression Tray Cabinet, Impression Trays;
Rolling Mills, Grindstone, Instantaneous Water Heater,
Fletcher's Water Motors, Ramsbottom's and Bailey's Electric Motor,
Cuttriss's Gas Engine, Crossley's Otto Gas Engine,
Gardner's Gas Engine and Dynamo, Britannia Company's Turning Lathes,
Tables of Weights and Measures.

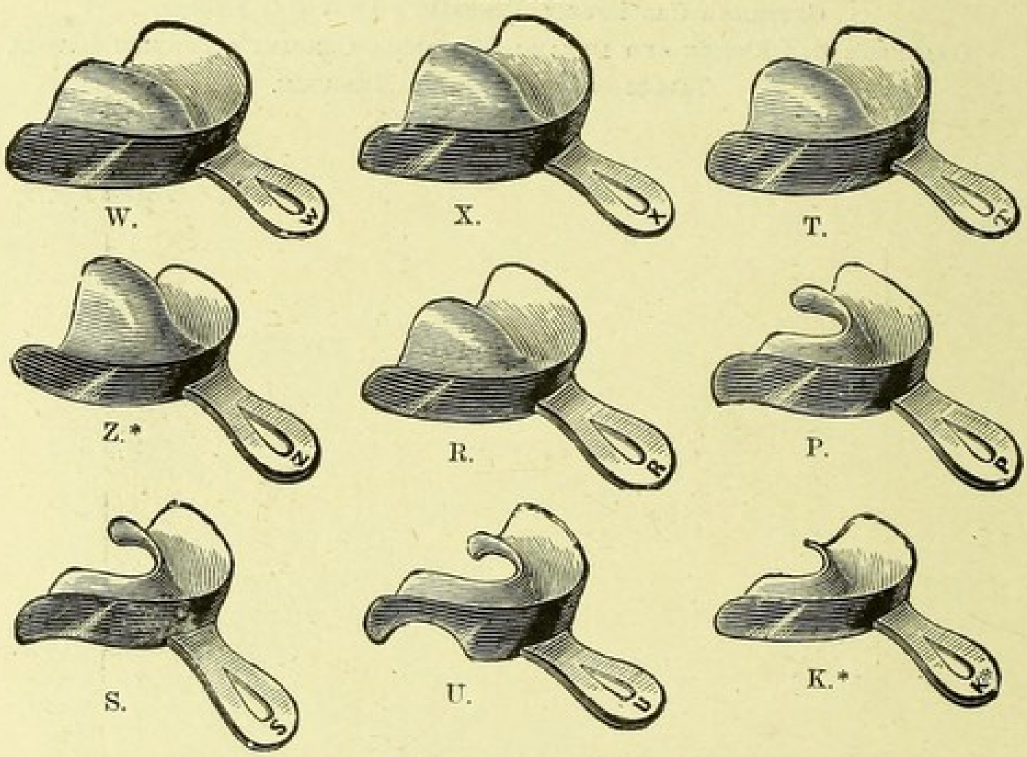
IMPRESSION TRAYS.

Fig. 395.



Author's Impression Tray Cabinet. See page 54.

Fig. 396.



Nine Useful Forms of Impression Trays.

A Cabinet or Racks for Plaster Models should also be added to the Work-room Equipment.

MILLS FOR ROLLING GOLD, ETC.

Fig. 397.

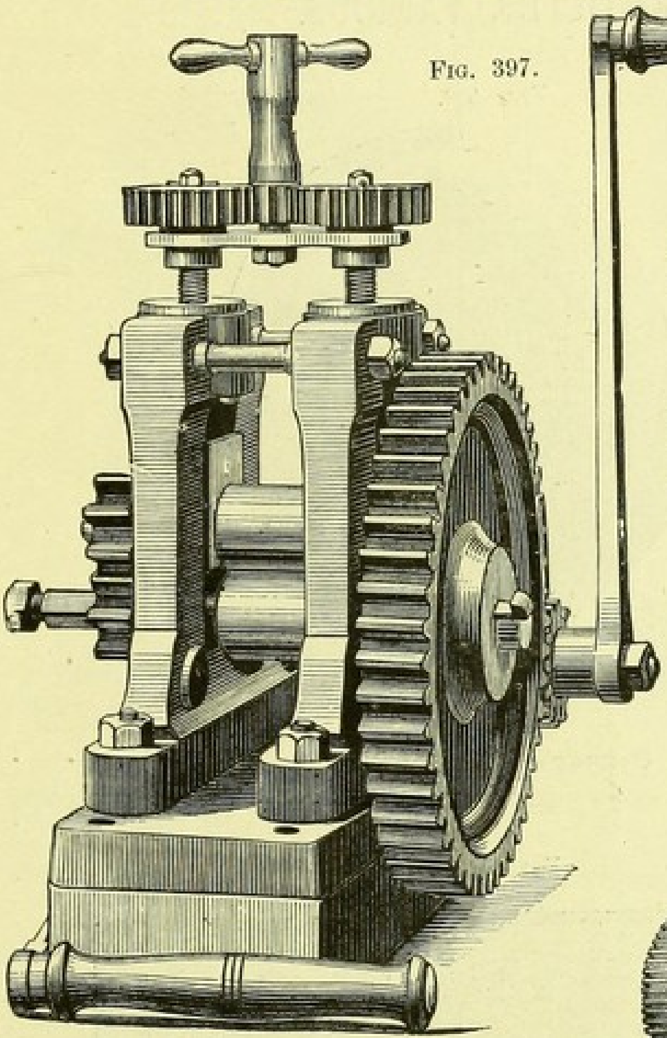


Fig. 397.
Rolling Mill with gearing on top to regulate pressure. Height about 21 inches.

Fig. 398.
Rolling Mill on Stand, with multiplying wheels, extra gearing and fly-wheel. Height 42 inches.

Fig. 399.
Rolling Mill on Stand, with multiplying wheels. Height 42 inches.

Fig. 399.

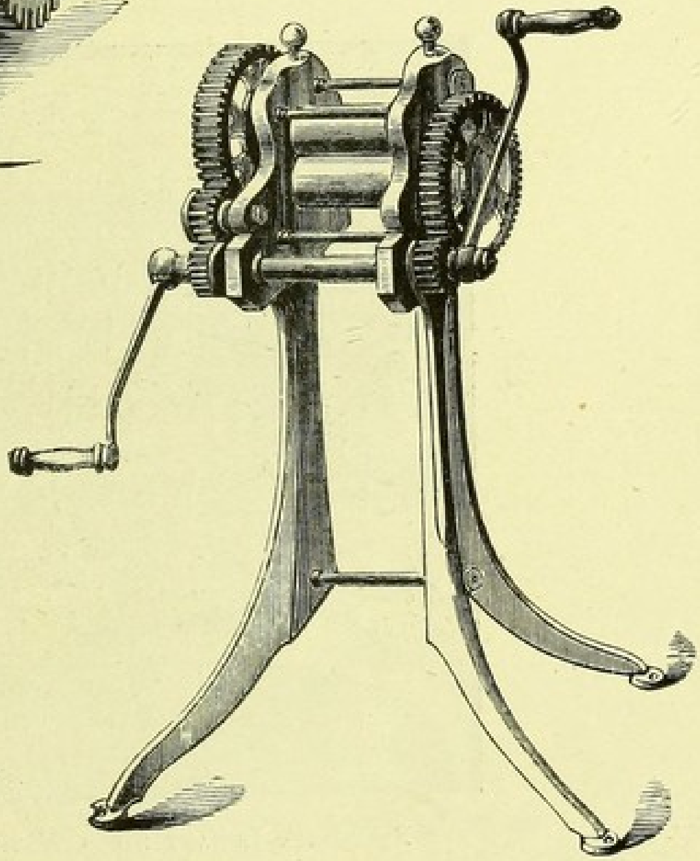
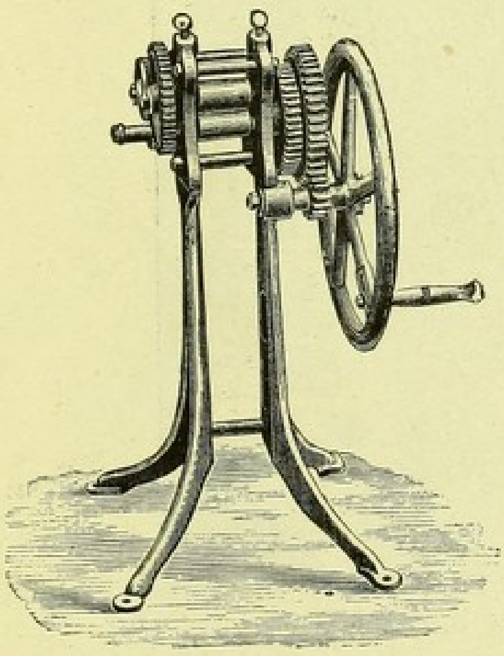
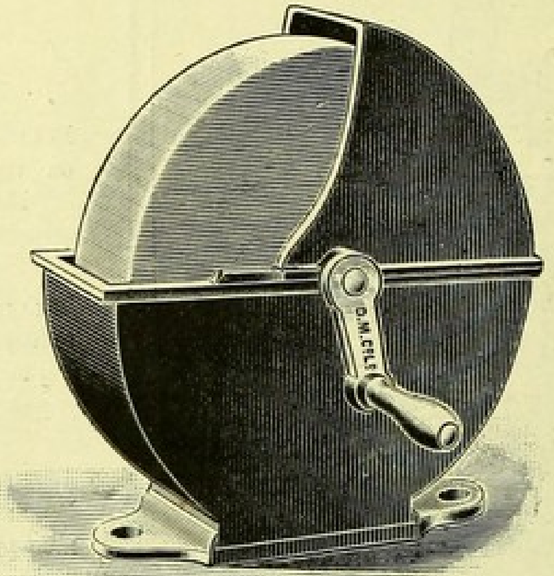


Fig. 398.



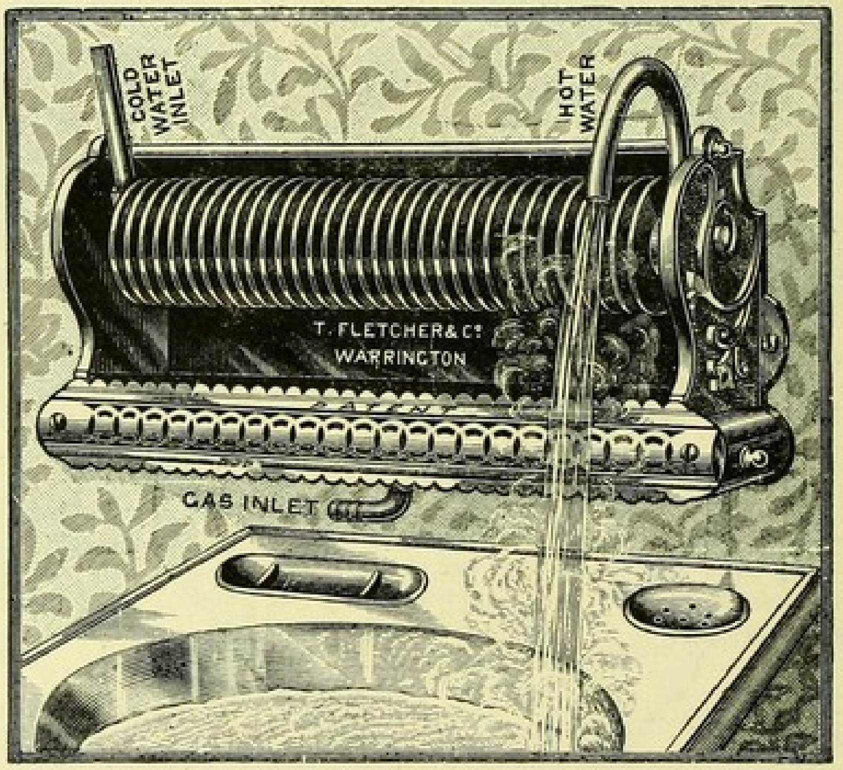
ARTICLES, VARIOUS.

Fig. 400.



Grindstone in Trough.

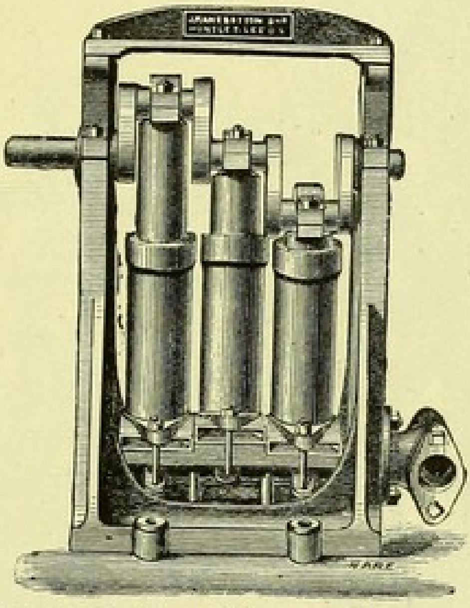
Fig. 401.



Fletcher's Instantaneous Water Heater, for Sink.

MOTORS, VARIOUS.

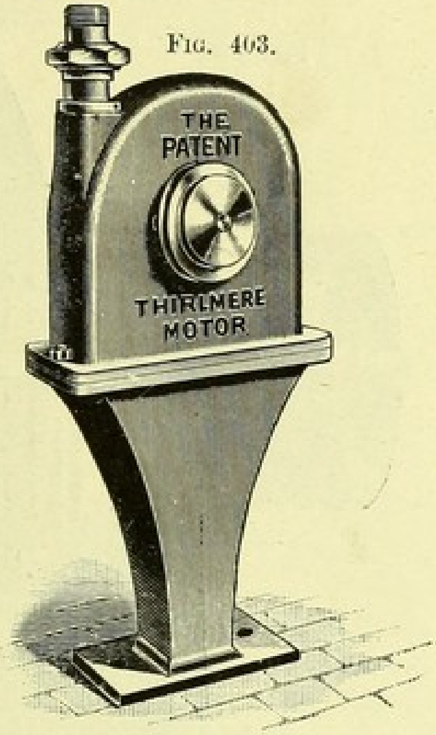
FIG. 402.



RAMSBOTTOM'S TRIPLE CYLINDER HYDRAULIC OR WATER ENGINE.

(I am indebted to Mr. M. Evers, of Saynor Road, Hunslet, Leeds—successor to John Ramsbottom—for the loan of this illustration, from whom full particulars of the Engine can be obtained.)

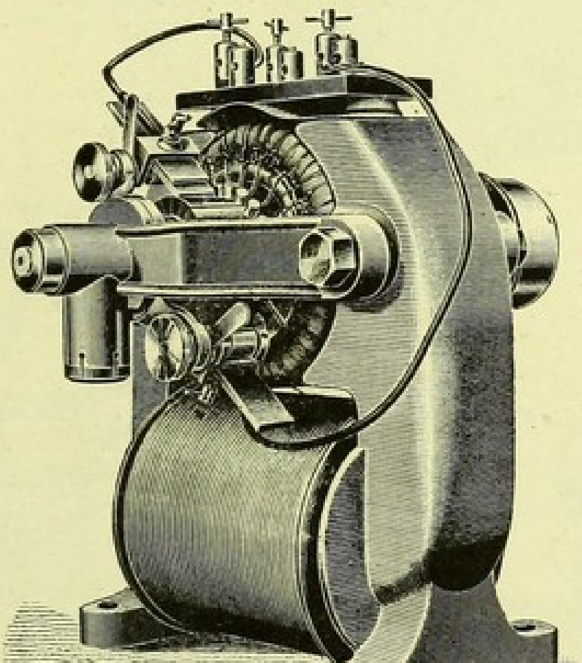
FIG. 403.



BAILEY'S THIRLMERE WATER MOTOR.

(Full particulars of this excellent Motor can be obtained from Messrs. W. H. Bailey & Co., Albion Works, Salford, Manchester.)

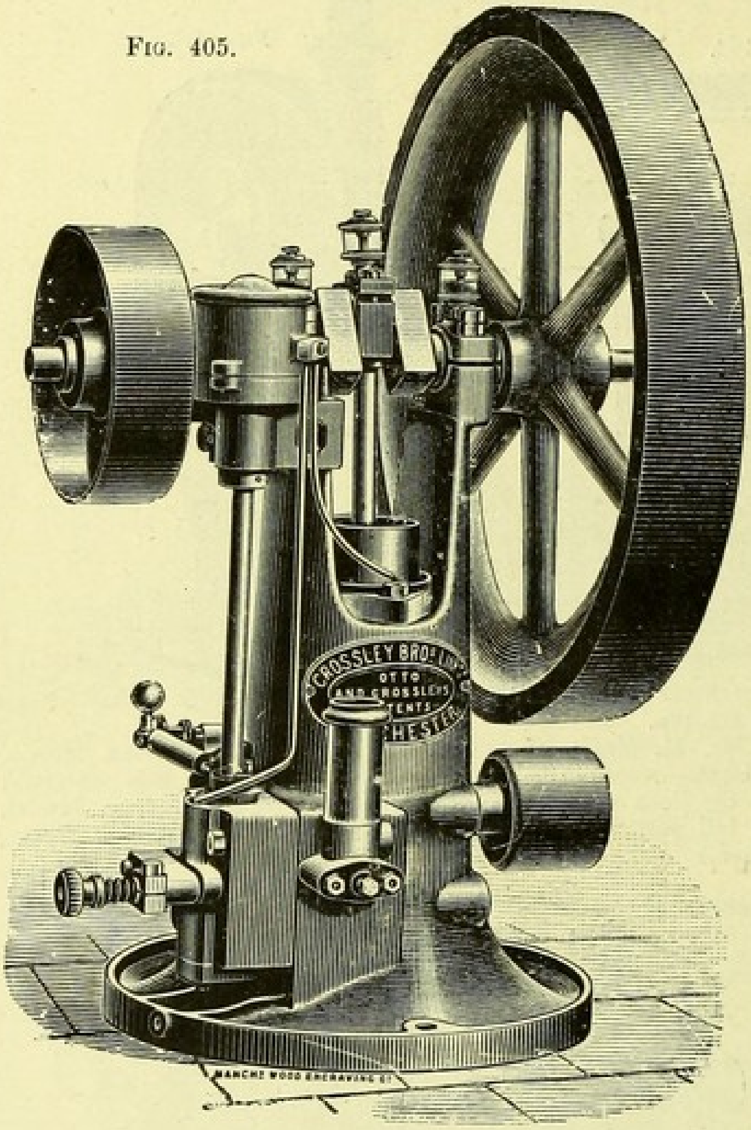
FIG. 404.



CUTTRISS, WALLIS & CO.'S "RING" MOTOR (R/3), half-horse power, suitable for driving two or three workroom lathes.

GAS ENGINES, ETC.

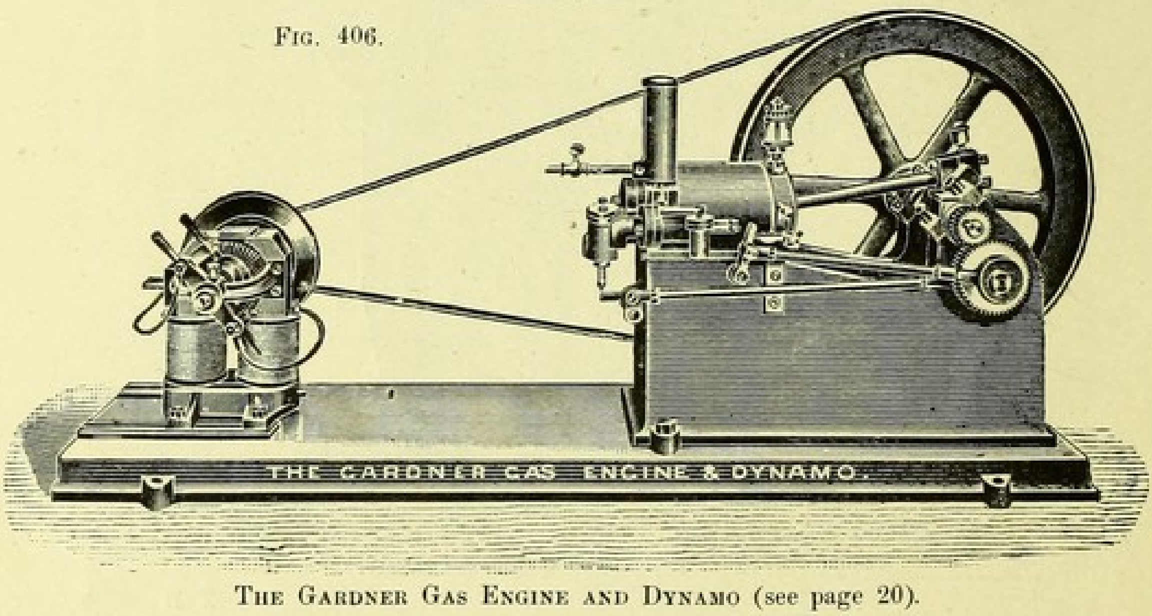
FIG. 405.



CROSSLEY'S "OTTO" GAS ENGINE.

Full particulars of this famous Engine can be obtained from Messrs. Crossley Brothers, Ltd., Openshaw, Manchester, to whom I am indebted for the loan of the block for illustrating the Engine.

FIG. 406.



THE GARDNER GAS ENGINE AND DYNAMO (see page 20).

TURNING LATHES.

Fig. 407.

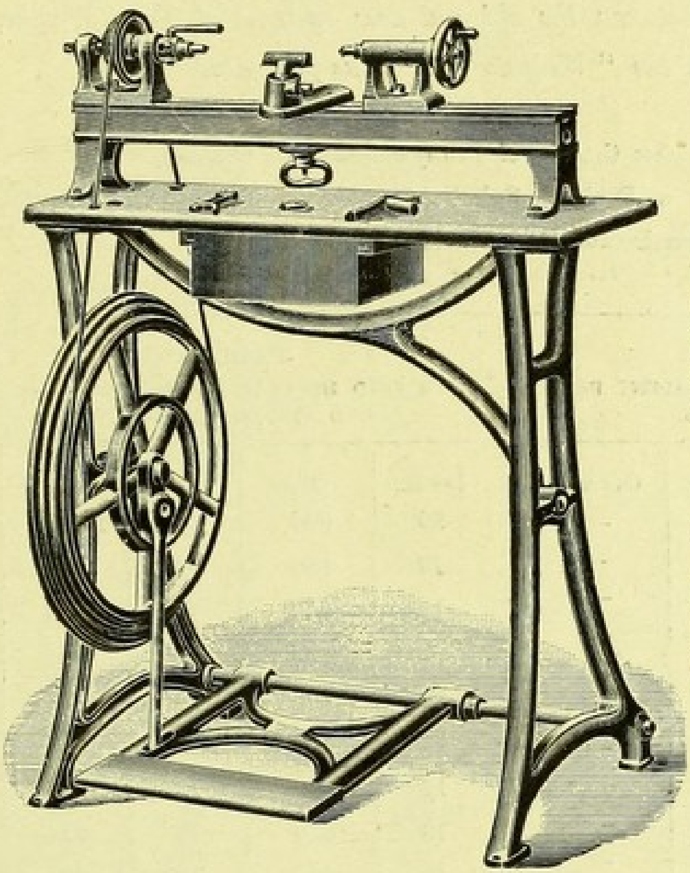


Fig. 407.

The Britannia Coy.'s Lathe, No. 2, with 24 inch bed, 2½ inch centres, turning 14 inches long by 5 inches in diameter.

The Britannia Coy.'s Lathe, No. 3, with 30 inch bed, 3 inch centres, turning 18 inches long by 6 inches in diameter.

Fig. 408.

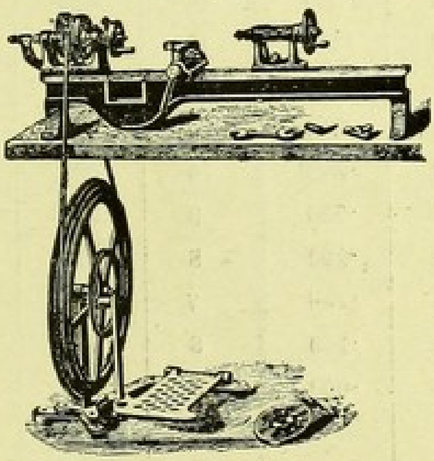


Fig. 408.

The Britannia Coy.'s Back-geared Lathe, No. 3, with bed 30 inches long, and 3 inch centres, turning 18 inches by 6 inches.

Full particulars of these Turning Lathes can be obtained of The Britannia Company, Colchester, Essex, to whom I am indebted for the loan of the blocks.

TABLES

Which show equivalents between the old and new systems of Troy Weight, in accordance with the "Weights and Measures Act," 1878.

(This Act abolishes the use of Pennyweights and Grains, and employs in their place a Decimal Sub-division of the Ounce, viz., Tenths, Hundredths, and Thousandths.)

TABLE TO FIND OLD SYSTEM EQUIVALENT FOR DECIMAL WEIGHTS.				TABLE TO FIND DECIMAL EQUIVALENT FOR OLD SYSTEM WEIGHTS.			
Oz.	Oz.	Dwts.	Grains.	Dwts.	Oz.	Grains.	Oz.
1·000	1	–	–	20	1·000	24	0·050
·900	–	18	–	19	·950	23	·048
·800	–	16	–	18	·900	22	·046
·700	–	14	–	17	·850	21	·044
·600	–	12	–	16	·800	20	·042
·500	–	10	–	15	·750	19	·040
·400	–	8	–	14	·700	18	·038
·300	–	6	–	13	·650	17	·035
·200	–	4	–	12	·600	16	·033
·100	–	2	–	11	·550	15	·031
·090	–	1	19¼	10	·500	14	·029
·080	–	1	14½	9	·450	13	·027
·070	–	1	9½	8	·400	12	·025
·060	–	1	4¾	7	·350	11	·023
·050	–	1	–	6	·300	10	·021
·040	–	–	19¼	5	·250	9	·019
·030	–	–	14½	4	·200	8	·017
·020	–	–	9½	3	·150	7	·015
·010	–	–	4¾	2	·100	6	·013
·009	–	–	4¼	1	·050	5	·010
·008	–	–	3¾			4	·008
·007	–	–	3¼			3	·006
·006	–	–	3			2	·004
·005	–	–	2½			1	·002
·004	–	–	2				
·003	–	–	1½				
·002	–	–	1				
·001	–	–	½				

TABLE

Showing Troy Weight, old style, and equivalents in Decimals and Grammes.

Grains.	Decimals. Troy.	Grammes.	Penny-weights.	Decimals. Troy.	Grammes.
1	·002	·065	1	·050	1·560
2	·004	·130	2	·100	3·110
3	·006	·195	3	·150	4·670
4	·008	·260	4	·200	6·220
5	·010	·325	5	·250	7·780
6	·013	·390	6	·300	9·330
7	·015	·450	7	·350	10·89
8	·017	·515	8	·400	12·44
9	·019	·580	9	·450	14·00
10	·021	·645	10	·500	15·55
11	·023	·710	11	·550	17·11
12	·025	·775	12	·600	18·66
13	·027	·840	13	·650	20·22
14	·029	·905	14	·700	21·77
15	·031	·970	15	·750	23·33
16	·033	1·035	16	·800	24·88
17	·035	1·100	17	·850	26·44
18	·038	1·165	18	·900	27·99
19	·040	1·225	19	·950	29·55
20	·042	1·290	20	1·000	31·10
21	·044	1·355			
22	·046	1·420			
23	·048	1·490			
24	·050	1·555			

1 ounce . . . . 31·1 grammes.

1 gramme . . . . . . $15\frac{1}{2}$ grains.

1 carat (diamond) $3\frac{1}{6}$ grains . . . 0·205 grammes.

1 ounce . . . . $151\frac{1}{2}$ diamond carats.

TROY WEIGHT.

1 lb.	12 Ounces.
1 Ounce	20 Pennyweights.
1 Pennyweight	24 Grains.

AVOIRDUPOIS WEIGHT.

1 Ton	20 Cwt.
1 Cwt.	4 Quarters.
„	112 Pounds.
1 Quarter	28 Pounds.
1 Stone	14 Pounds.
1 Pound	16 Ounces.
1 Ounce	16 Drams.

1 lb.	454·5 Grammes.
1 Kilogramme (1,000 Grammes) .	2 lb. 3 oz. 4·38 Drams.
5 „	11 lb.

TABLE

Showing English and French inches and their fractions with their equivalents in millimetres and centimetres.

ENGLISH INCHES.						FRENCH INCHES.					
in.		mm.	in		cm.	line.		mm.	in.		cm.
1/64	—	0·4	1	—	2·5	½	—	1·1	¼	—	0·7
1/32	—	0·8	1¼	—	3·2	1	—	2·3	½	—	1·35
3/64	—	1·2	1½	—	3·8	1½	—	3·4	¾	—	2·0
1/16	—	1·6	1¾	—	4·4	2	—	4·5	1	—	2·7
5/64	—	2·0	2	—	5·1	2½	—	5·6	1¼	—	3·4
3/32	—	2·4	2¼	—	5·7	3	—	6·8	1½	—	4·0
7/64	—	2·8	2½	—	6 3	3½	—	7·9	1¾	—	4·7
⅛	—	3·2	2¾	—	6·9	4	—	9·0	2	—	5·4
9/64	—	3·6	3	—	7·6	4½	—	10·1	2½	—	6·7
5/32	—	4·0	3¼	—	8·2	5	—	11·3	3	—	8·1
11/64	—	4·4	3½	—	8·8	5½	—	12·4	3½	—	9·4
3/16	—	4·8	3¾	—	9·4	6	—	13·5	4	—	10·8
13/64	—	5·2	4	—	10·2	6½	—	14·6	4½	—	12·2
7/32	—	5·6	4¼	—	10·8	7	—	15·8	5	—	13·5
15/64	—	6·0	4½	—	11·4	7½	—	16·9	5½	—	14·9
¼	—	6·4	4¾	—	12·0	8	—	18·0	6	—	16·2
9/32	—	6·8	5	—	12·7	8½	—	19·1	6½	—	17·6
5/16	—	8·0	5¼	—	13·3	9	—	20·3	7	—	18·9
11/32	—	8 8	5½	—	13·9	9½	—	21·4	7½	—	20·3
⅜	—	9·5	5¾	—	14·5	10	—	22·5	8	—	21·6
13/32	—	10·3	6	—	15·2	10½	—	23·7	8½	—	22·0
7/16	—	11·1	6½	—	16·4	11	—	24·8	9	—	24 3
15/32	—	11·9	7	—	17·8	11½	—	25·9	9½	—	25·7
½	—	12·7	7½	—	19·1	12	—	27·0	10	—	27·0
9/16	—	14·3	8	—	20·3				10½	—	28·4
⅝	—	15·9	8½	—	21·6				11	—	29·7
11/16	—	17·5	9	—	22·9				11½	—	31·1
¾	—	19·1	9½	—	24·2				12	—	32·4
13/16	—	20·7	10	—	25·4						
⅞	—	22·2	10½	—	26·7						
15/16	—	23 8	11	—	27·9						
1	—	25·4	11½	—	29·2						
			12	—	30·5						

TABLE

Showing sizes of Stubs' Steel and Pinion Wire Gauge and their equivalents in Millimetres.

NO.	Z	Y	X	W	V	U	T	S	R	Q
MM.	10·50	10·25	10·08	9·80	9·60	9·35	9·09	8·84	8·61	8·43

NO.	P	O	N	M	L	K	J	I	H	G
MM.	8·20	8·03	7·67	7·50	7·37	7·15	7·04	6·91	6·76	6·63

NO.	F	E	D	C	B	A	1	2	3	4	5
MM.	6·53	6·35	6·25	6·15	6·05	5·94	5·75	5·55	5·28	5·18	5·13

NO.	6	7	8	9	10	11	12	13	14	15
MM.	5·08	5·03	4·98	4·90	4·85	4·75	4·65	4·60	4·52	4·47

NO.	16	17	18	19	20	21	22	23	24	25
MM.	4·45	4·35	4·32	4·17	4·07	4·—	3·90	3·87	3·82	3·80

NO.	26	27	28	29	30	31	32	33	34	35
MM.	3·72	3·65	3·45	3·35	3·12	2·97	2·90	2·85	2·80	2·72

NO.	36	37	38	39	40	41	42	43	44	45
MM.	2·57	2·54	2·52	2·49	2·46	2·34	2·26	2·16	2·10	2·08

NO.	46	47	48	49	50	51	52	53	54	55
MM.	2·—	1·90	1·85	1·77	1·65	1·60	1·55	1·45	1·27	1·22

NO.	56	57	58	59	60	61	62	63	64	65
MM.	1·09	1·07	1·04	0·99	0·97	0·95	0·93	0·92	0·90	0·87

NO.	66	67	68	69	70	71	72	73	74	75
MM.	0·85	0·82	0·76	0·71	0·68	0·63	0·60	0·57	0·55	0·53

TABLE

Of sizes of Birmingham Wire Gauge as compared with $\frac{1}{10}$ Millimetre Wire Gauge.

Birmingham Wire Gauge	25	24	23	22	21	20	19	18	17	16	15	14	13
$\frac{1}{10}$ Millimetre Gauge	6	7	8	9	10	11	12	14	16	18	20	22	25

Birmingham Wire Gauge	12	11	10	9	8	7	6	5	4	3	2	1
$\frac{1}{10}$ Millimetre Gauge	28	31	35	39	43	47	51	56	61	65	69	77

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