# A MANUAL OF THE DENTAL LABORATORY

HUNTER

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OF THE

# DENTAL LABORATORY:

ITS CONSTRUCTION, MANAGEMENT, AND ECONOMY; THE VARIOUS IMPLEMENTS AND THEIR MANIPULATIONS; WITH LABORATORY NOTES AND SUGGESTIONS.

BY

CHARLES HUNTER,

AUTHOR OF 'A TREATISE ON MECHANICAL DENTISTRY.'

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# PREFACE.

In the following pages it will readily be perceived that the main purpose has been to present to the reader the results of a considerable experience in the methods and intricacies of Dental Laboratory practice. How far I have succeeded in producing what may be of value, the reader himself will judge. I trust, however, that I have not written altogether in vain; and that the perusal of these pages will not be without advantage to the student and young practitioner, nor wanting in interest to those who have had fuller experience.

My grateful acknowledgments are due to Mr. Macleod and Mr. Cormack of Edinburgh, also to Mr. Biggs of Glasgow, for the ready assistance they have given me in regard to matters concerning which they can speak with greater authority than I can lay claim to.

To Messrs. Ash I am indebted for the use of many of their blocks for the purposes of illustration. The Dental Manufacturing Company also have willingly afforded me every facility in their power.

CHARLES HUNTER.

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# THE DENTAL LABORATORY.

## CHAPTER I.

### ITS CONSTRUCTION.

To the dentist who is so circumstanced that he is able to build an apartment specially adapted for the accomplishment of prosthetic work, or to such as are in a position to choose one room out of several for that purpose, the *essential* points for consideration, it need hardly be stated, are — light, space, and sanitary conditions. First: light should be so supplied that no work shall be carried on in shade. Second: the internal space and *form* of the apartment should be such as not only to enable the operator to accomplish the work with facility, but also with the view to provide full breathing room for each individual working within it. And thirdly: there are the surrounding sanitary conditions, which require the most careful consideration. The reader of Faraday's work on 'Chemical Manipulation' will remember his reference to Dr. Marcet's resolve, to set apart the *best* room in the house he was having built as his laboratory, 'not knowing,' as he himself put it, 'why I should not do what I can to make that a *pleasant* place where I find so much pleasure.'

And though the dental practitioner can hardly permit himself this full measure of accommodation and comfort, still the sentiment given utterance to by Dr. Marcet must be felt by all who have an interest in laboratory work, and who therefore desire to make the scene of their labours as appropriately and as completely equipped for their purpose as circumstances may render possible.

Unfortunately, in too many instances the only available room for laboratory work is far from being a desirable one. It may be in a position in the basement, or sunk flat, which renders the light inadequate and the space confined.

But even in the most adverse circumstances much may be effected in the direction of improving upon the conditions.

*Within*, the walls should be painted of a light colour, while *outside*, if there be any wall or other structure capable of intercepting the passage of light, these should be whitewashed.* An improvement will also be secured by having, instead of the ordinary window of panelled and clear glass, one having a corrugated surface, and with as little framework as possible. The ribs of glass deflect towards the room much light that would otherwise be lost.† Further, it must be pointed out that—differing from the usual window-frame, which occupies a recess in the wall of the building—the corrugated plate of glass should be flush, or nearly so, with the outer wall, in order to obtain its full advantage. These and other means, which the circumstances of the case will suggest, may be with advantage employed to improve an originally very objectionable apartment.

There are again those who, having several available rooms, find it possible to choose that one which will best fulfil the requirements of the dental laboratory.

Lastly, there are the smaller number who are in the still more fortunate position of being able to have an

* A slightly green tinge makes it more healthful to the eyes.

† Sir David Brewster.

apartment constructed designedly for the object in view.

And this leads us to the consideration of what are the essential and desirable points to be attended to, in deciding upon the position and form of the proposed structure.

In coming to a decision upon these matters we are influenced by two considerations: namely; the desire to have a laboratory to which there is an easy access from the surgery; and second, to have an apartment so arranged, with regard to light, space, and sanitary amenities, that all requirements for a healthy and facile prosecution of the work shall be fully provided.

The second of these conditions, it will be admitted, is the more important, so that, where both cannot satisfactorily be combined, readiness of access will be less considered than sufficiency of space, light, etc.

*Dimensions of Laboratory.*—The space suggested by Faraday* as being suitable for a chemical laboratory is a room of 20 to 24 feet by 16 to 18 feet. Morfitt (an American writer on the same subject) advises still larger dimensions, viz., 40 feet frontage by 24 feet in depth, with 18 to 20 feet height of ceiling. A room of these dimensions we may assume (though the writers do not say so) is intended for the accommodation of a considerable number of workers. The chemical laboratory, too, from the character of the operations engaged in it, may, man for man, demand a larger breathing space than that required by the dentist. But however that may be, the fact remains that the dimensions of the dental, as of every other laboratory, must be proportional to the number of those who are engaged in accomplishing work within its walls. Hence it is that in connection with the principal dental schools we find that the laboratories, which are

* 'Chemical Manipulation,' Faraday.

intended to accommodate over twelve pupils, are, in dimensions, approximate to the figures just given.

In private practice such dimensions for a laboratory, even if attainable, are undesirable. An extravagant amount of space necessitates an altogether unnecessary perambulation of the room, and so wastes time. 'The laboratory,' as Dr. Haskell remarks, 'should not be a *machine*-shop, but adapted to, and arranged for, the object intended.'

Where one has a plethora of space, which can be availed of for the construction of an apartment for this special purpose, there may be a natural tendency to overdo matters in the 'machine-shop' direction.

It should not, therefore, be forgotten, that the progress of work may be retarded by having the various benches and implements at an unnecessary distance apart, as much as by having the space confined and confused.*

It is probably safe to say that an apartment of 14 by 12 feet, with from 8 to 10 feet height of ceiling, is, so far as space is concerned, perfectly adequate for all purposes in a practice of good average extent. Very few laboratories exceed these dimensions; and we know of course that a great amount of work is accomplished in apartments which are much more confined.

Lakeman† states that each worker should have a minimum cubic space of 300 feet. Now, if we take as a standard four operators in the laboratory, we ought, according to that authority, to have internal space to the extent of 1,200 cubic feet; so that in a room measuring 12 feet by

* M. Andrieu remarks : 'The laboratory ought to be spacious, well ventilated, and furnished with appliances for carrying away the gas or vapours which accompany the progress of work. It ought also to be well lighted, from the north or east rather than from the south or west, in order to avoid the too scorching rays of the sun.' ('Traité de Prothèse Buccale et de Méchanique Dentaire.')

† 'Health in the Workshop,' Lakeman.

14 feet by 10 feet height of ceiling, we have a space appreciably over what is considered to be necessary.

*Ventilation.*—Referring to this subject, a writer in an American work,* gives 2,000 cubic feet per hour as necessary for every healthy adult. Lakeman's estimate is 3,000 cubic feet. The means employed for effecting this free circulation of air are various; and the practitioner who proposes to construct a laboratory may find it of advantage to consult the works devoted to this subject, indicated below. The architect or builder, however, it is to be presumed, will possess sufficient knowledge of these matters.

*Light.*—The manner in which the rays of light are usually admitted is by means of the ordinary sashed windows, so placed around the building as to ensure that whatever work is being engaged in shall not be done in shade. It is well also, where practicable, to have the upper sash balanced, so that it may be lowered when required for ventilation.

A very common and very effective mode of lighting is that in which the window forms the entire front of the building. Or, again, circumstances may render it preferable, or even necessary, to admit light from the roof, either by a centre window, cupola fashion, or by those set in skylight hinged frames. And, lastly, it may be found best to have partly a side or front light, and partly a roof light.

*Heat.*—With the gas appliances now so much in use, it is, of course, quite practicable to conduct satisfactorily all operations requiring heat in the course of our work. But where it is possible to have a fireplace fitted with the common barred grate, or in furnace fashion, it is unquestionably an acquisition. It provides a ready means of ventilation, and by means of flues the voidance of acid

* Knight's 'Mechanical Dictionary.'

fumes and those from the vulcanizer may readily be drawn away; and of all methods of drying models, it may be safely said that the open grate, with a suitable frame stand, to hang in front, is the best; and for other purposes which will occur to the reader a fireplace with grate or furnace built in is of great utility in the laboratory. An ordinary grate should be fitted with a 'blower,' which is simply a sheet of iron large enough to close in the air space above the ribs. In order that this iron cover may fit closely and evenly around the fireplace boundaries of the air space referred to, the sheet is riveted at its free edges between narrow strips of considerably thicker iron, thus forming a frame, within which it is kept straight. Without this frame the heat would soon contort the sheet into an undesirable shape. At a convenient position in the arched wall of the fireplace—in the middle line of the arch, and within two or three inches of its free border—a strong iron pin is inserted, and a hole having been provided in the centre of the superior border of the blower, the latter is then readily placed in position so that it covers the whole of the air space above the ribs, and to a certain extent overlaps the fireplace boundaries. There is thus produced a draught from below which rapidly raises a powerful fire. A handle riveted to the middle line of the sheet near the centre is of course provided for convenience when using.

The character of furnace most suitable for the dental laboratory is fully described in the text-books, and need not, therefore, be enlarged upon here. Where it is intended to melt and roll the gold used in the construction of dentures it is desirable to have such a furnace, perhaps; but, unless in very exceptional circumstances, the gas appliances so much perfected within recent years will be found amply sufficient in an ordinary practice. They are not only capable of melting considerable quantities of gold, but provision is made for directly flowing the metal into a mould, which forms part of the apparatus. For such *com-*

*paratively* small quantities of gold the gas apparatus supplied by Mr. Fletcher is an excellent substitute (Fig. 1).

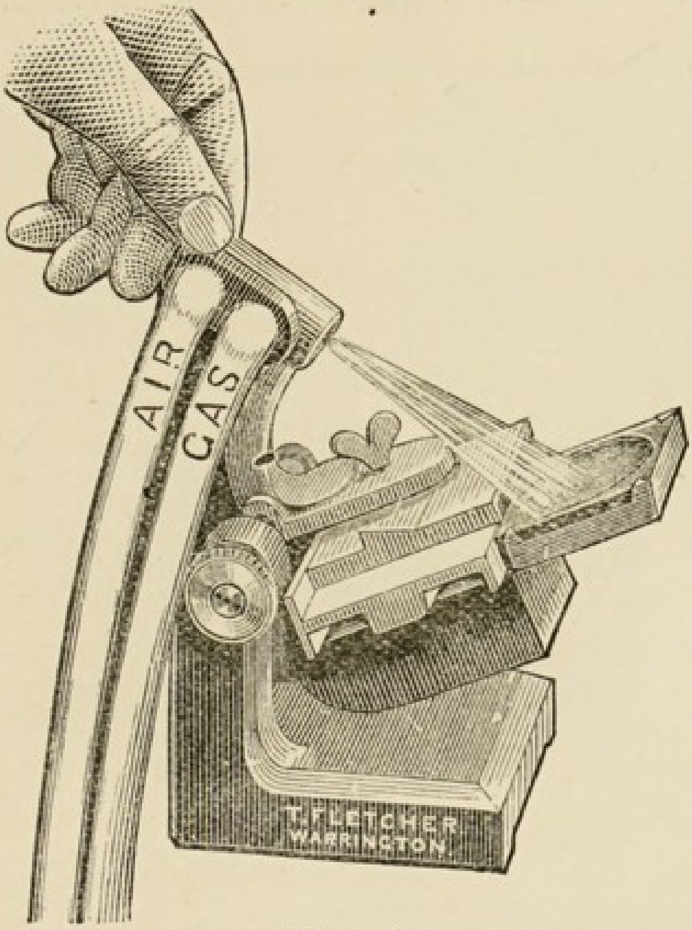



Fig. 1.

The illustration will readily inform the reader of the characteristics of this ingenious contrivance. The flame, it will be observed, is directed upon the *crucible*, so to speak, in which the gold is melted; behind the crucible is the ingot-mould into which the flowing metal is run, on tilting this part of the apparatus lightly with the fingers which command the supply of air and gas. With such an arrangement, having the mould forming part of the machine itself, and in direct communication with the crucible, we not only dispense with the ordinary skellet, but also run less risk, than while employing the latter, of losing gold by misadventure.

Among the most useful of the many gas appliances introduced by Mr. Fletcher, and particularly adapted to the requirements of the dentist, is the water-heater (Fig. 2), which, if placed in a suitable position in the laboratory, is well fitted for clearing the wax from flasks, and for the many other purposes where hot water is required. Another

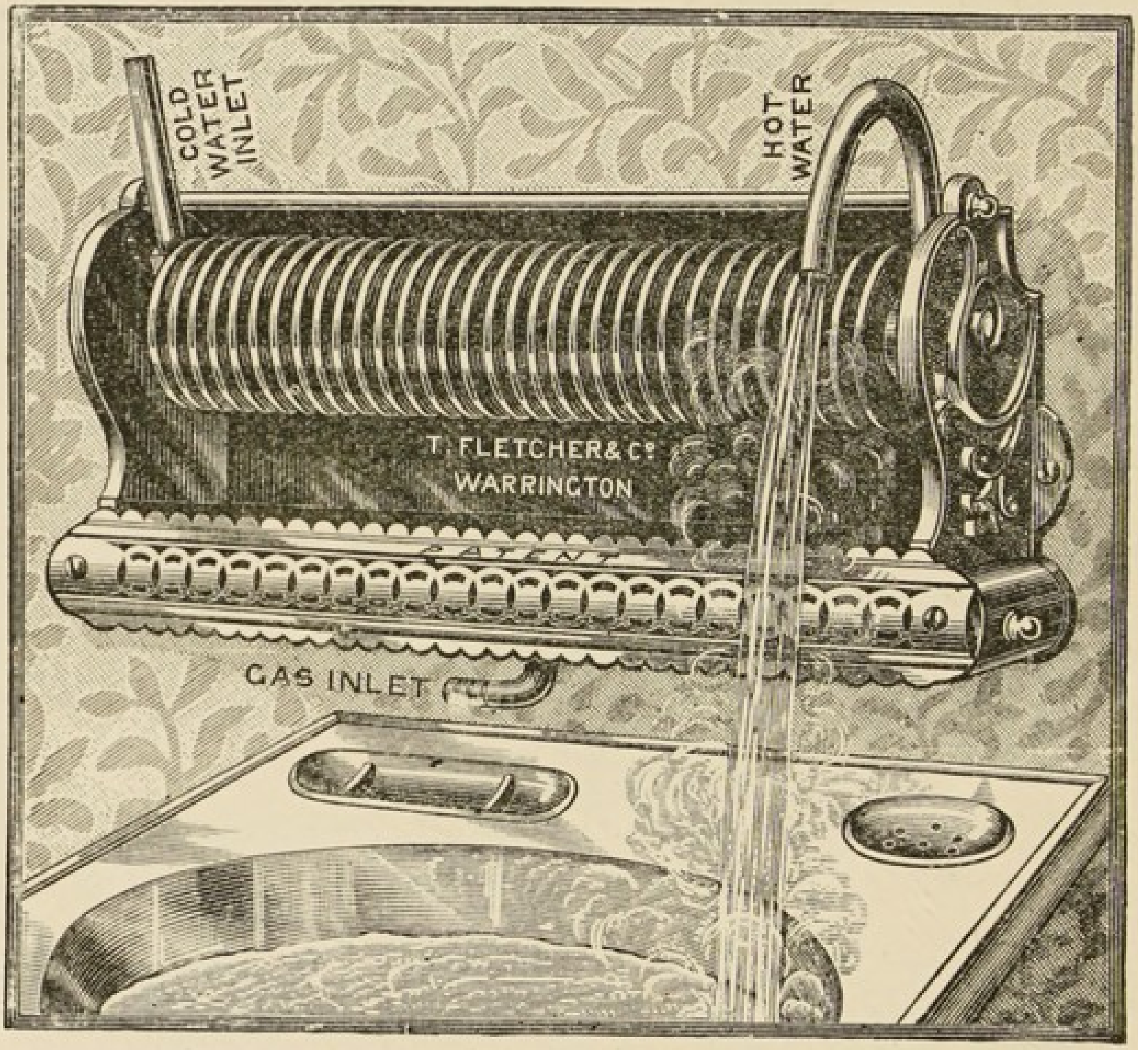



Fig. 2.

appliance of much value is that represented in the accompanying figure. (Fig. 3). It is mainly of value in heating

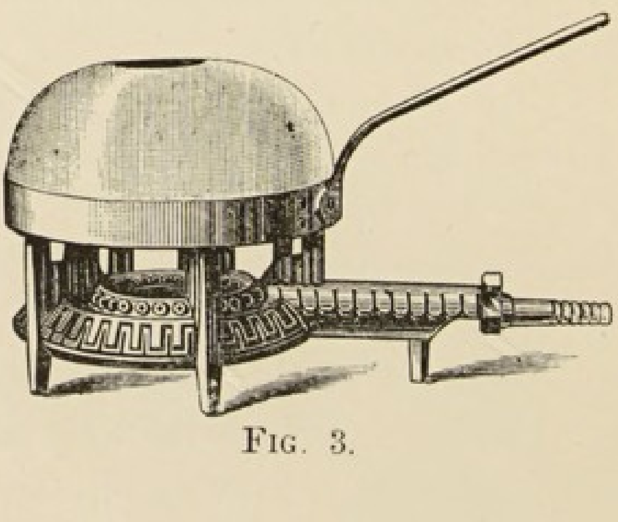


Fig. 3.

invested cases to the point fit for soldering, but it will be found of much assistance to the operator in other directions.

*Water Supply.*—That the water will be 'laid on' to the laboratory, if that is *possible*, may be taken for granted.

Faraday attaches much importance to the possession of a good sink in the chemical laboratory. Perhaps, for the dentist, however, who has not so much necessity for this as the chemist, an enamelled iron basin is most convenient. It is set in a wood frame, and having a central aperture, a connection is made leading to the general waste-pipe.*

In a small practice, or where rubber work is the rule, *one* such basin is sufficient; but where gold is used for base plates extensively, in a large practice, it is profitable to have a second, *reserving it exclusively* for the washing of plates. This, of course, is for economical reasons, which the reader will find referred to more fully in a subsequent page.

* The wood framework in which the basin rests (and which should not be too cramped in its dimensions) may, with advantage, be covered with sheet lead. We may also utilize the space underneath this arrangement by enclosing it, cabinet fashion.

## CHAPTER II.

### THE BENCH AND ITS BELONGINGS.

HARD wood should be used for what may be termed the principal, or constructing bench. M. Andrieu recommends oak as being the best class of wood for this purpose, but with us, beech is nearly universally employed.

Mr. Fletcher gives his opinion upon this subject as follows: 'The best wood for the bench is old and dry beech, free from knots and shakes. Really dry clean beech is difficult to obtain, but the trouble is well expended, as it is easily kept clean, will not splinter, and will last an unlimited time.'*

It is of advantage to a new bench to go over the surface with a cloth saturated with linseed-oil, giving three applications, and allowing a day for drying between each. The thickness of the bench is usually from 1 inch to $1\frac{1}{4}$ inches. Its height from the floor should be such that work may be effectively accomplished, and yet at a level which will not necessitate a crouching attitude of the body injurious to health. From thirty-eight to forty inches may be taken as a good level at which to work with effect and with comfort.† It is obvious, also, that there is a

* *English Mechanic.*

† The reader may have observed in a late number of the Journal of the British Dental Association, some remarks made 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.

correlation between the physique of the operator, the height of the bench, and the stool upon which he sits, so that, the bench being a fixture, the seat must be higher or lower in level, as the individual may require, for effective and healthy working.

As to the fixing of the bench, if it is to be placed against one of the walls of the room, the readiest and perhaps best method is by means of strong iron brackets. Besides these, however, there ought to be auxiliary supports of a substantial character of wood perpendicularly placed underneath the front border of the bench, in order to prevent, as far as possible, vibration when hammering.

To every space in the bench there should be fitted two drawers; the upper one to contain tools which are not in constant use, and other things which may most conveniently be kept in abeyance, and yet ready to hand. A narrow strip of wood dividing the drawer into compartments will assist in preserving order. The second drawer, being intended for filing and cutting plate into, should be much shallower than the upper one. It should be lined with zinc, and it is an improvement to have a perforated cover through which the filings may pass, while *pieces* of gold are retained on the perforated surface.

This drawer is an undoubted advantage, even where the system of using a metal tray resting on the skin is adopted; for, the latter being removed when plate construction is practically ended, it is tedious to replace it for those constantly recurring cases in which but a trifling amount of gold filing or cutting is to be done—trifling incidentally, but considerable in the aggregate—whereas the drawer is convenient and can instantly be used. It should be in size about 14 by 16 inches, and from 1½ to 2 inches deep.*

*The 'Skin,' or 'Apron.'*—Hanging from each side of the

* Where dental alloy is used to a considerable extent it is well to have a third drawer, similar in character to the gold drawer.

working space—festoon fashion—we have the 'skin,' or leather apron, which is an essential accompaniment to every bench space. It is fastened with tacks to the under surface of the bench, first on one side, then, allowing a very free sweep of the drawers, it is similarly fastened on the other, a few tacks being also used to hitch up the back border. We have then a scoop-shaped receptacle resting (or nearly resting) on our knees while working, which is of the greatest use in retaining articles falling from the bench, some of which might otherwise be lost, and others which might be injured if falling on the floor. In providing one's self with these aprons (which can be had of leather merchants), it is best to choose one of ample dimensions.

*Pin.*—The bench is not complete without the wedge-shaped piece of hard wood fixed at the centre of the working space. As got from the depots, these pins are usually too long, and require more or less modification to make them quite efficient.

If the conditions be favourable, and the bench has a sufficient expanse from front to rear, lockers should be provided for the accommodation of each worker. These, being constructed at the back of the bench, are readily and inexpensively provided by fixing a shelf about 6 inches above the bench surface, and extending as far as there are working spaces; a second shelf (or, rather, strip of wood), similar to the first, is fixed about 6 inches above the latter; then it is only necessary to close the extremities, and the dimensions of each locker being defined by appropriately placed square pieces of wood resting on the lower and supporting the upper shelf, it is a simple matter to fit a cover to each compartment, with hinges and lock and key.

A complement to the bench which is most essential, is that which contains the teeth and fittings appertaining to each case in process of construction or repair. This principle of keeping the parts that belong to each individual denture in isolation, as it were, is a most important one to carry into practice. The manner of doing so must, of course, depend upon circumstances. Whether, for instance, we should have, at the back of the bench, fixed shallow spaces for the purpose, or boxes marked by numbers to represent and contain all the belongings to each individual case, will be decided according to the appropriateness of the general surroundings. But what is most important to insist upon, is, the value of acquiring the habit of keeping all materials necessary for each case separate and confined. When teeth, for example, are left promiscuously about the bench, every-one knows how liable they are to go astray; and thus much waste of time and possible disaster may be the consequence.

*Laboratory Stool.*—The form and height of the seat used for bench operations is a matter worthy of attention. If it is a movable one—such as an ordinary office stool—it should be adjusted in height to agree with the individual operator. One of a certain height, for instance, may be too high for A, and so require him to crouch unduly over the bench while working, whereas B finds it to be his best working level.

There are some who advocate a kind of stool which may be termed fixtures, inasmuch as they are adjusted to a socket permanently fixed to the floor; but being thus arranged on a swivel pattern, a rotary motion is given which enables the worker to turn with perhaps greater ease and less friction while changing his position during the progress of work. This last is, of course, the advantage claimed for a stool of this sort; but it may be questioned whether the disadvantage of having the base *fixed* is not a still greater evil.

*Bench Lighting and Heating Appliances,*—The appropriate arrangements for the various heating and lighting purposes in the laboratory necessarily depend upon its construction.

In a room of confined dimensions—of which, unfortunately, there are too many—with but one window giving access to the light, the working bench will then, of course, be fitted to the window space ; and probably, in these circumstances, the best manner of giving a gas supply for the various requirements is to have a central tube with couplings at convenient parts of it, for bunsen, muffle heater (previous to

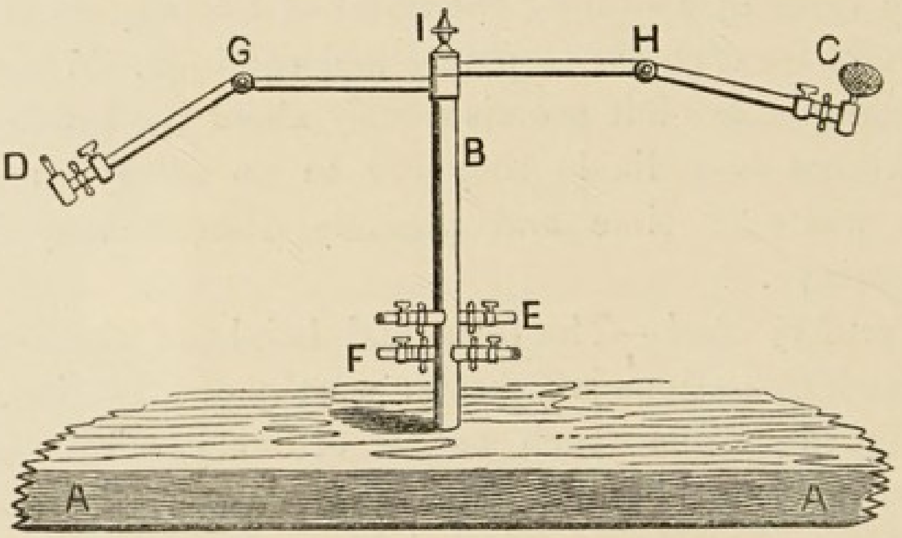



FIG. 4.—A, bench level and standard for brackets ; B, standard for gas ; D G, gas bracket for lighting purposes ; C, bracket for soldering ; E, branches for bunsen attachment ; F, branches for the heating apparatus used in preparing cases for soldering and vulcanizing, rubber tubing, of course, being used for the connecting link.

soldering) ; also for the vulcanizer, soldering bracket or appliance, and the bracket or burner for supplying light. The accompanying figure will give some idea of what is referred to.*

With such an arrangement, it will be perceived that several operations may be proceeded with simultaneously, and all under the control of the outstretched arm of the operator while he remains seated.

The gas distributor here illustrated (Fig. 5) is upon the

* The above figure will serve to give the reader an idea of the *principle* referred to in the text, but there are many adaptations which may be preferable, according as the circumstances indicate.

same principle, but more elaborate in its design. It is supplied by Mr. Fletcher, of Warrington. Another design, introduced by the same gentleman, is that represented in Fig. 6. It will be observed, however, that this latter, though well adapted for bench-work under certain circumstances, is not, in the sense above referred to, a distributor.

Such arrangements for distributing the gas supply necessary for bench requirements as those illustrated by Figs. 4 and 5 are invaluable in certain circumstances—as, for instance, in a small workroom with one window, into which the bench is fitted. But where there is ample space, and the bench runs parallel to the longer wall of the building, a different plan must be adopted. In such circumstances the gas supply pipe will be continuous with the back of the bench, and branches from it will be inserted for the full accommodation of each operator.

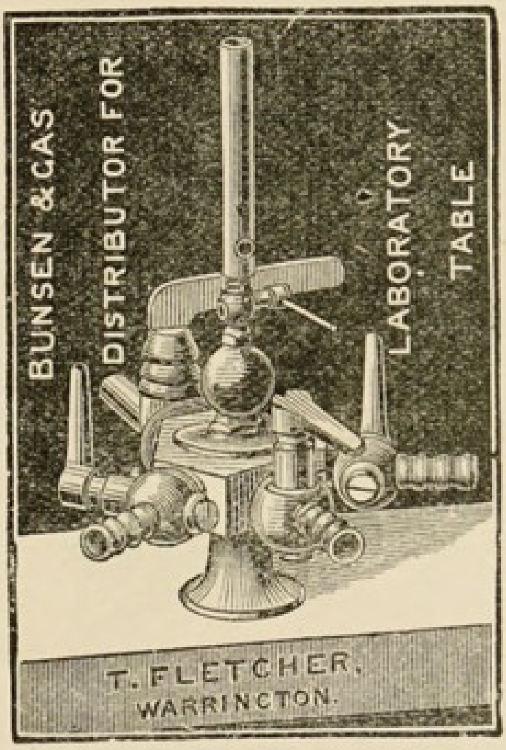



FIG. 5.

In a laboratory of this character it will probably be the case that a particular bench is set apart for soldering purposes. But even so, provision should be made within each space on the working bench for soldering. There is much light work of this kind which may most conveniently be done by the operator without moving from his seat. The bracket for soldering represented in Fig. 7 has much to recommend it in this connection. It has, first of all, an outlet or nozzle at A, well adapted for supplying a flame

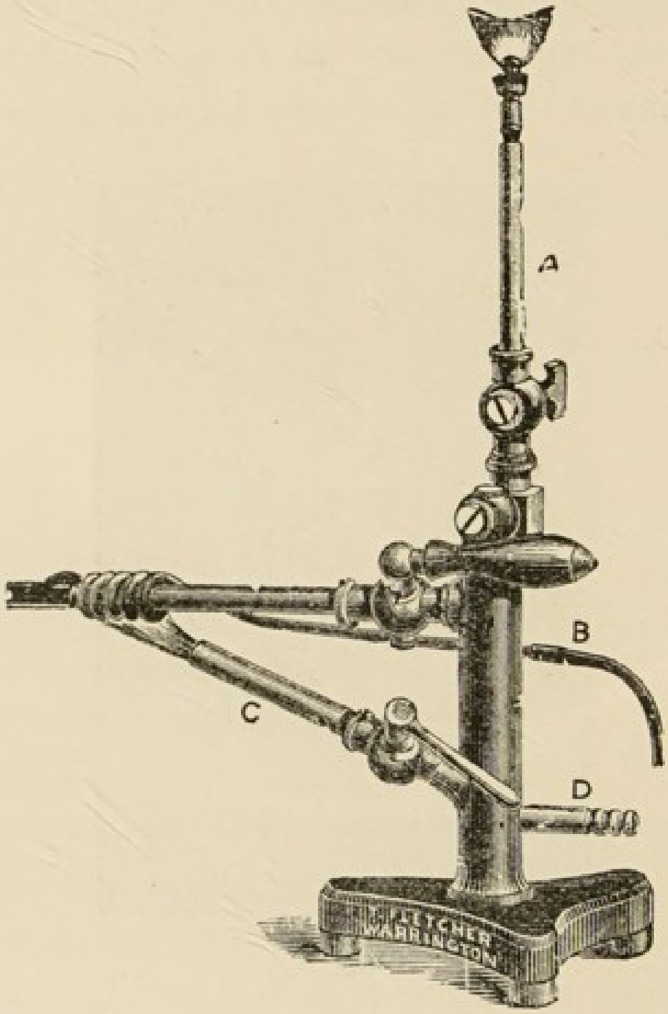



FIG. 6.

suitable for this purpose. Then there is the tiny tube B, proceeding from the gas-supply pipe C direct, and independent and uninfluenced by the stop-cock D. So that after soldering, and after the gas has been turned off at D, there is permanently remaining a small jet of gas at B, which immediately lights the burner for subsequent soldering operations.

*Bunsen Burner and Spirit-lamp.*—Just as it will probably be decided to have a distinct bench for soldering, when the laboratory space is ample, so also, if possible, a particular bench space will be assigned to the preparatory and final stages of rubber work. The character of the waxing-up

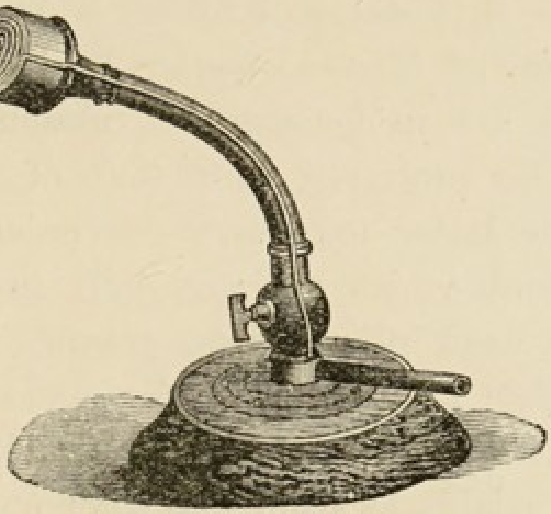


FIG. 7.

process, and the after-filing of the rubber to shape, is not congenial to the space that is used for gold work.

Whether the bunsen or the spirit-lamp is the best medium for supplying the heat necessary for softening and melting the wax used in constructing the model of the denture is a point somewhat difficult to decide upon. Formerly, when spirit of wine was a somewhat costly item, we cannot be surprised that the bunsen was universally used. Now, however, that methylated spirit has been introduced, which can be purchased for something like three shillings a gallon, the question of difference of cost reaches the vanishing-point, and we have only to consider which is best for our purpose. It is probable that most practical men will give the preference to the bunsen; nevertheless, there is much to be said in favour of the spirit-lamp. First of all, there is the ease with which it can be moved about. Then, secondly—and which is of more importance—it consistently maintains the blue flame, which is so much a desideratum for the above-mentioned class of work. Everyone is familiar with the liability of wax to drop into the bunsen tube and burner, and so produce the smoky flame unsuitable to our purpose. We must, of course, have the bunsen, but the writer is inclined to the opinion that a spirit-lamp of considerable dimensions may with much advantage be used very extensively in the first stages of rubber work.

*On the Keeping of Pliers and other Bench Tools.*—For such implements as are in general use, undoubtedly the rack system is to be preferred over that of having them in a drawer. The latter may very conveniently be used for those of the tools which are not daily in requisition; but the constantly-used pliers, files, gravers, etc., should be in a rack, within easy reach of the operator while sitting at the bench. Further, each tool should have its individual and invariable location, and when out of use it should be returned to its place, so that there may be no searching for gravers, pliers, or files—they are always ready to hand. The position of the rack is, of course, entirely dependent upon the character of the bench. That form of rack, therefore, which permits of the most facile method of reaching the tools, under the circumstances, is the best.

For such bench tools as are *not* constantly in requisition, the 6-inch deep bench drawer will be found convenient. And not only for this purpose, but for the borax slate, etc.; and if there should be no lockers, the drawer will be useful (as remarked upon in a former page) for the reception of models and materials pertaining to them in the construction of the denture. In these latter circumstances the drawer should be furnished with a lock and key.

As with the bench tools, so with all other implements or articles in the laboratory: each should have its particular place, to which it should be at once returned when it has served its immediate purpose.*

* A too rigid adherence to this rule the writer, of course, would deprecate. It would be ridiculous to push this salutary habit so far as to return a tool to its place when one knows that it will be required again in a few seconds. This subject of order in the laboratory is, however, considered more fully in a subsequent page.

# CHAPTER III.

## PLASTER AND CASTING BENCHES.

USUALLY, soft wood is assigned for this bench, but it is difficult to understand why hard wood should not be preferred, the denser grain of which gives less grip to setting plaster, and so facilitates cleansing operations.

Wood an inch thick will do well for the bench, and around its borders strips of wood should be fixed, rising at the back and sides to about 4 inches, and along the front to about 2 inches. On the back strip, which should be sufficiently strong, a shelf may be fixed which will be found convenient for many purposes. The providing of the laboratory with shelf accommodation is very important, and full shelf space should be given for the reception of everything that is not in immediate use, so that order may be secured.*

A fully-equipped plaster bench has underneath, and at the centre, a box-shaped drawer for holding the plaster, and to the side of this, near to one or other of the ends, a

* M. Andrieu gives the following description of the plaster bench as he prefers it. 'The table should be of beech, and the height from the floor 3 feet 9 or 10 inches ; length (*i.e.*, from right to left), at least 4 feet 6 inches ; depth (*i.e.*, from before backwards), about 2 feet. The back and sides should have a raised border 0·3m., while the border along the front should be only 0·05m. (that is about 2 inches, while the back and sides have a border much higher). To the border at the back a length of wood to form a shelf can be fixed, to provide a recognised place for the various articles used in plaster work.'—'Traité Buccale et de Méchanique Dentaire.'

similar drawer of sufficient capacity to hold the waste plaster of a week's work. A part of the bench immediately above this waste drawer, about 6 inches square, is cut out to form a trap for the plaster débris. If neatly done, the sawed-out part may readily be adjusted as a cover, either by means of hinging, or by screwing a small projection of brass or iron plate to the middle of the four sides of the square.

Failing the drawer system above described, a ready means of providing for waste plaster is to have a strong square box of sufficient area, with an iron handle screwed to both sides to facilitate removal; this box, resting on a shelf or other support which keeps it *nearly* up to the level of the under-surface of the bench, affords a readier, and some think a better, method than that of having a drawer. As to keeping the plaster for use, it is better in an average practice to get it *often* rather than much at a time, as it deteriorates; and should there be no drawer, a tin box is best for keeping it in. The plaster bench should be clear of all *waste* before commencing to cast models, and bites, etc.; so that should an accident occur—such as the fracture of a tooth, or essential portion of the impression, or the inadvertent dropping of an artificial tooth—there shall be no difficulty in discovering what is lost.

*Casting Bench.*—It will necessarily depend upon the amount of space at one's disposal, and the character of it, with respect to light and form, whether it is judicious to have the sand bench in connection with that for plaster work, or distinctly separated from it. Supposing, however, that the circumstances indicate a combination; we would have a bench of sufficient length to be divided into two compartments, each compartment affording comfortable working space for the respective operations in plaster and sand-modelling. The portion of the bench set apart for the latter will best fulfil its purpose if it be given the form of a shallow box; and this is easily done by surrounding the square with stout strips of wood about $4\frac{1}{2}$ inches high, and so shaped at their free edge as to receive and hold a cover in position.

Another method is to bisect the wood of that portion assigned to sand casting; cutting out the half to the right, which then forms, when supported by flanges underneath, a movable cover. To the lower surface of the bench is fitted a box about 8 inches in depth, and in extent corresponding with that of the cover. The box, of course, contains the casting sand, and the remaining *fixed half of the bench* to the left forms the table on which the casting operations proceed.

As with the other benches, so with that for casting; full shelf-accommodation should be given for casting rings, etc. The sand for casting, supplied in bags by the depots, is very suitable for our purposes, and easily kept in working condition.

As to the casting-rings, there is little to be said, except that those for the lead counters should be distinctly bevelled or cone-shaped, so that the casts will easily disengage.*

The essential implements for the plaster-bench are, a mixing knife or spoon, a cutting or paring knife—a shoemaker's knife, if a good one, does very well—and a saw, to act, when fixed in the jaws of the large vice, instead of the paring knife, when a solid bulk or thick section of hard plaster is to be cut from a model; also a hand-brush for clearing away waste.*

* See Notes, p. 148.

## CHAPTER IV.

### TOOLS AND APPLIANCES.

THAT the dental laboratory shall be thoroughly well furnished with all instruments which can possibly facilitate and perfect the work contemplated, must naturally be the desire of everyone who has an interest in his profession. The practitioner will therefore, in justice to himself, provide every appliance which can contribute to this object.

At the same time it must be admitted that many new things are introduced which are not improvements on the old. And the practitioner, especially the young practitioner, will do well to remember that 'what is new is not therefore true.'*

*The Lathe.*—If the bench is a long one, running parallel to the wall of the laboratory, it is best to have the lathe-head fixed to the bench at the right hand of each working space. And in an appropriate situation, there will be a polishing-lathe for general use.

Under other conditions, however—such as where space is contracted, or the position of the bench is unsuitable for this arrangement—it is preferable to have the lathe apart from the bench, as in the accompanying figure, and so

* This observation is ventured upon, as the reader will understand, not by way of discouraging new methods, or new means of accomplishing more effectively our work, but because it is possible that the younger and less experienced may, without sufficient guarantee of worth, seize upon new implements or novel methods of procedure which may be of a retrograde, rather than of an improving character.

removable at will. Fig. 8 represents a lathe adapted solely for tooth-fitting.

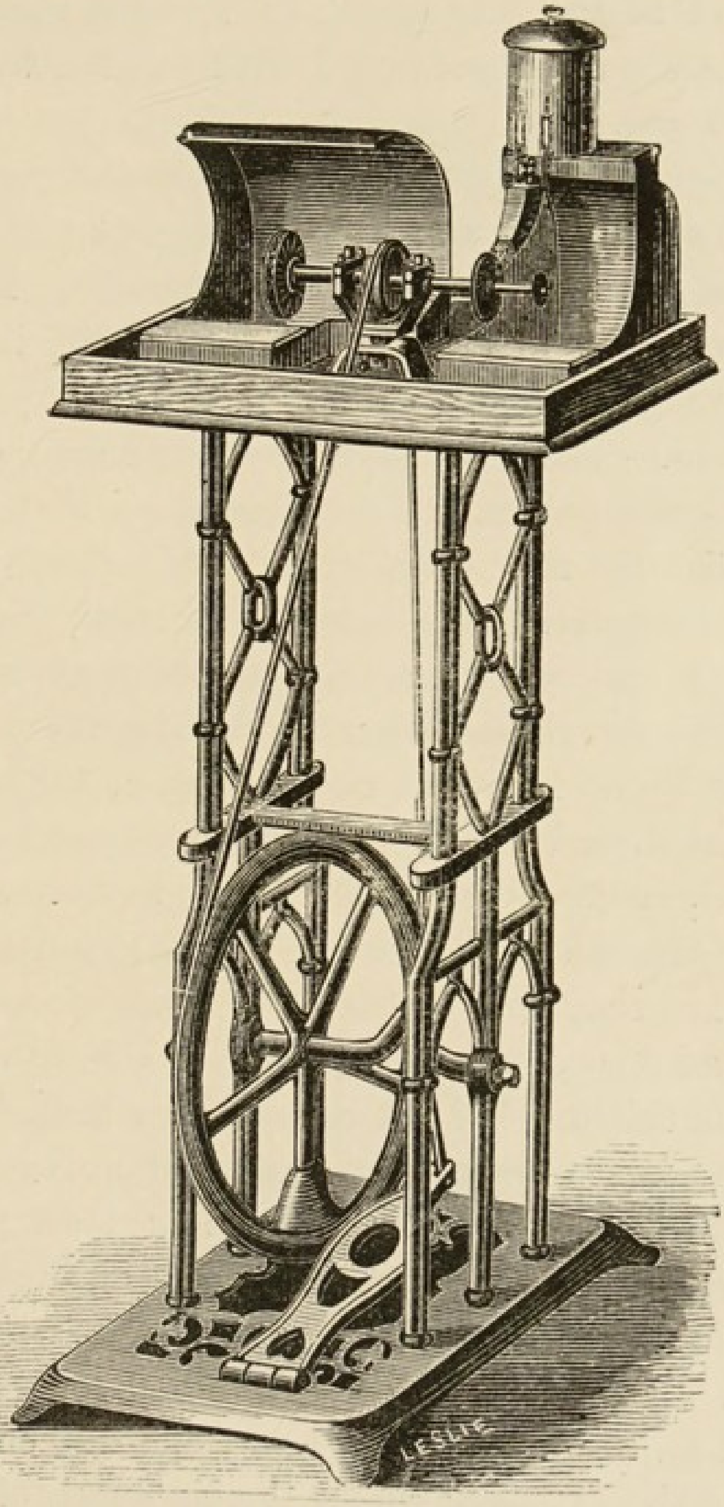



FIG. 8.

*Lubricator.*—The bearings or frictional parts of the lathe should be well attended to. Much unnecessary exertion is imposed upon one by neglecting to have the joints properly lubricated. Hence it should be made an invariable rule in the laboratory to dismantle the lathe at regular intervals, and have the joints and bearings thoroughly cleared of all used-up matter. To effect this, a knife may be required in the first place, to remove the more solid débris; then a cloth, saturated with paraffin will complete what is desired.

As to the lubricating medium best fitted for our purpose, a mixture of olive-oil and paraffin is good, in the proportion of two parts olive-oil to one part paraffin. The paraffin, as it were, keeps the oil in form; without it the latter would more quickly clog.

*Lathe-band.*—The mounting of a band for the lathe is a matter of consequence. We will assume that the one to be mounted is the usual gut cord, about one-eighth or so in diameter. We have then, first, the choosing of the hook and eye which unite the ends of the gut, and this requires discrimination; for though these connecting links may be of identical circumference, the diameter of the internal thread varies considerably, some having a proportionately wide bore, while others have a smaller and tapering bore, with thicker walls. The latter should be avoided, as they allow less substance of gut to resist tension, and hence much inconvenience is caused by slipping. The thickness of gut chosen for a lathe-band should not be too heavy—about an eighth of an inch—and the bore of the links only a shade smaller than the gut; so that when the ends of the latter are very slightly tapered with a file, they may catch the thread in the links and be wound through: it is well before entering the gut to *slightly* oil it.* When the end of the band emerges from the link to the extent of about the sixteenth of an inch, it is then necessary to form this surplus into a rivet-head; which is done by using a wire or other tool, heated sufficiently over the bunsen to soften and braze down the projecting gut. It goes without saying that the band should

* If the links are heated to a trifling extent just before screwing on the gut, the operation is facilitated.

not be adjusted to the lathe until gut and links are perfectly cold.

To obtain exactly the length of gut suitable for driving the lathe with ease requires careful measurement; for if it is cut so that it grasps the driving-wheel and spindle with severe tension, the working of the lathe is rendered excessively laborious, and the strain upon the connecting links renders an early break-down inevitable; while if the contrary mistake is made, there is not sufficient tension to carry the spindle against the force required either in polishing or fitting teeth. If error there should be, it is well that it should be on the side of having the length slightly in excess. In that case, cut the band with a sharp knife close to one of the links; heat the link over the bunsen, to clear the thread of gut, and screw the end of the band into the link, as before. If the looseness should happen only to be such as to cause a too frequent slip of the wheel, this will be sufficient to secure a perfectly working band.*

*Water Supply for Lathe.*—The reservoir in most common use for feeding the corundum wheel is that represented in connection with the lathe shown in Fig. 8. Another method of supplying water to the corundum wheel, but on a different principle, is that in which a tank for water is provided underneath the corundum wheel; and a sponge arrangement at the rear, on absorbing the water of the tank, supplies the necessary moisture for grinding purposes.

Where the bench runs parallel to one side of the room, and the lathe-heads are fixed to the bench, a different method for supplying water to the corundum wheel may be adopted; and where much work is done, it may be adopted with advantage. From the water-supply pipe, which we

* Certain lathe-heads are made to rise, so that by an adjustable movement this difficulty is overcome. But whether a lathe constructed on this principle is so steadily planted as the others, and therefore as well capable of maintaining an easy and true motion, is a matter to be considered.

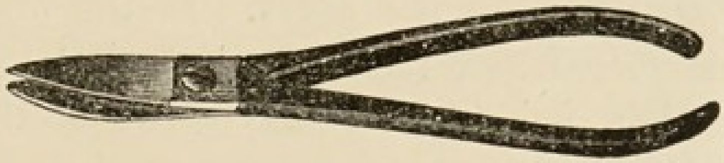
will assume runs underneath the bench, small branches may be let through the latter and attached to a suitable tube with stopcock, the tube to be arched in such manner as best to supply the water to the wheel. If this system is employed, a fairly capacious metal tank, giving a good support for the hands, should be provided; and through the bottom of this tank a lead pipe should be soldered, which, passing through the bench and connected with the waste-pipe, renders the water supply and drainage in a sense automatic.

*Files.*—It is said by those who have technical knowledge of the matter, that Warrington supplies the best files, and Sheffield the best shears and pliers. The files manufactured by Stubs, are, we believe, universally allowed to be of the premier quality. And, indeed, all other tools supplied by that firm are, according to the writer's experience, thoroughly reliable. With regard to files particularly, it may be insisted that a stock of much variety should be continually available — files of the familiar rough type used for vulcanite finishing in the first stages, and from that graduating downwards to those of the finest cut. Rifflers, too, of every useful shape, and graduating from rough to fine in the same manner, are most helpful in preparing rubber cases for the polishing lathe.* Round or rat-tailed files are frequently useful; needle files are *indispensable;* and so with dividing files, which should be of various sizes and shapes. An essential little implement in the setting of tube teeth is the tube file—cylindrical in form, and with a slightly roughened surface, so that while it effectively clears the tube of débris, it does not reduce the platinum sheath.

* The reader will, of course, understand that, with regard to the multifarious appliances designed for laboratory purposes, it is assumed here that he will consult the several catalogues which are so profusely illustrated and so readily accessible.

To speculate as to whether it is preferable to use files in which the tail-end flattened forms the handle, or those with a tang for insertion in a wooden handle, seems like splitting straws ; yet it is probable that the latter, by giving a larger grasp, are more congenial and less likely to strain the sinews.

*Shears.*—It is well to have shears of the two forms, straight and curved. And a point which should not be overlooked in choosing them is, that the blades of shears do not all close in the same way. If, for instance, one of each pattern is examined, it will be observed that in the act of



Right side.

FIG. 9.

closing, the right blade, passes in front of the left ; while in shears of the alternative pattern the right blade passes *behind* the left. We have, therefore, what is termed *right*-sided and *left*-sided shears, and it is not unimportant to recollect this when choosing them, for by selecting those of the pattern which act in a manner unfamiliar to the operator much quite unnecessary inconvenience is experienced.

## Pliers.

*Plate-cutters.*—The plate-cutters represented here may be described as complements to the shears. The latter having cut the plate roughly to shape, the cutters are employed for the greater accuracy required. These pliers are indispensable for the laboratory. Their principal use, of course, is in cutting the spaces required in a plate to accommodate the position of the natural teeth ; and after a plate is struck, if its lingual borders should require to be reduced, they will do the work with safety ; whereas the use of the shears most probably will alter the shape and fit of the plate.

Where much gold work is done, and this instrument is freely used, a considerable loss may arise from the aptness with which the cuttings escape through the arched blades. This may be prevented by a very simple contrivance

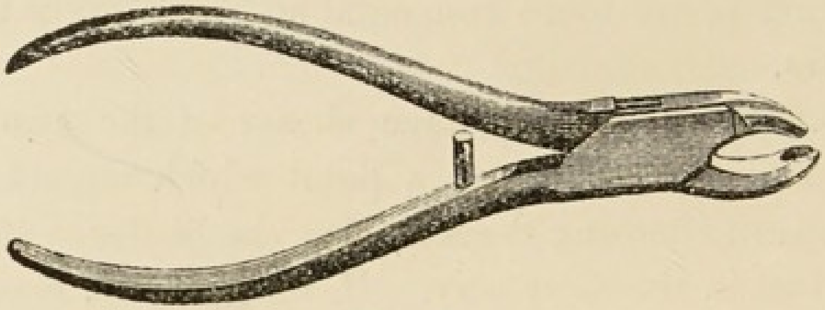


Fig. 10.

attached to that part of the pliers. In the first place it must be remembered that the 'grasp' of plate to be cut is never more than one-third of the length of the arched space shown in the form of pliers represented above. (It is, indeed, seldom that more than a fourth of that space is required.) So that by shaping a piece of thin brass or steel around the arch we make practically a box for the reception of the cuttings, which would otherwise escape. If well fitted, the contrivance will maintain its position by the spring of the wings on the jaws of the instrument. It is better, however, to have a narrow piece of clock or watch spring, long enough to reach half-way over the surface of the brass guard at the one extremity (A, Fig. 11); and at the

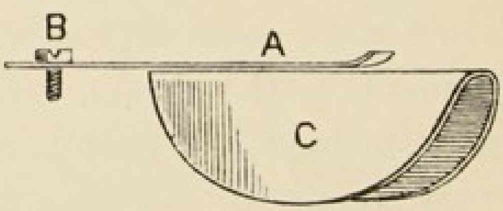



Fig. 11.

other end, B, let the spring be fastened by a small screw—a receiving thread for which has been made in the blade in such position that sufficiently free motion backwards and forwards is allowed to the guard. The accompanying sketch

(Fig. 11) will explain, perhaps more clearly, the meaning of what the writer wishes to convey. A is the spring and the direction of the beaks of the instrument. B is the small screw, and represents the direction of the handles. C represents one of the wings of the guard, which, arching over the instrument under the spring A, and reaching to an equal distance on the farther side, constitutes the three-sided box referred to.

As a matter of fact, it may be taken that there is but a small percentage of instances in which the grasp of plate required by the beaks exceeds an eighth of an inch ; so that if the guard be placed at that distance behind the cutting discs it fully serves its purpose, and needs but seldom to be moved back. As remarked above, where but little gold work is done, it is hardly worth while to make the change ; but in a large gold practice the economy resulting from the use of the guard has been fully demonstrated.

*Cutting Pliers.* — In Fig. 12, we have represented the

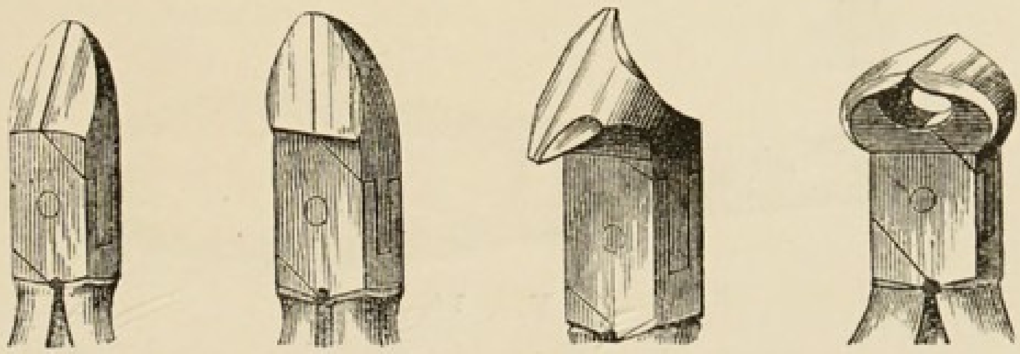


Fig. 12.

different forms of the ordinary cutting pliers for wire. For a similar reason to that which prompts the use of a sheath or guard attachment to the disc cutter just described, (Nos. 1 and 2 appear to be the best and most economical ones to choose for general work. In these we have but the single side outlet for the cut-off wire, whereas with 3 and 4 there are two outlets to be guarded, the consequence being that portions of wire are frequently lost.

A form of pliers which is essential in the laboratory is the round-nosed nippers, represented in the accompanying figure. The use of these is chiefly connected with tube

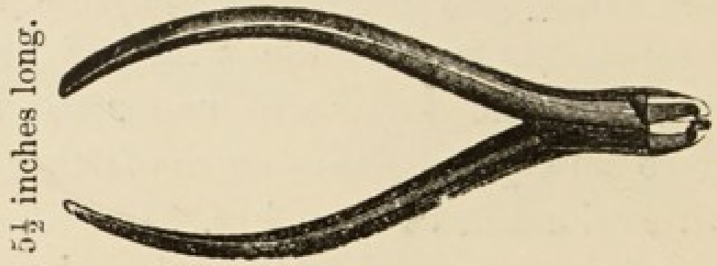



Fig. 13.

teeth work, where they are best fitted to cut the superfluous wire projecting after soldering, on the palate surface of the plate; but in many other circumstances they will be found of service.

*Pin Nippers, or Perforators.*—The simple form of perforator represented below is, in the writer's view, the best of all for the backing of flat teeth. One of the latest of new forms of perforators is fitted with a claw, the purpose being

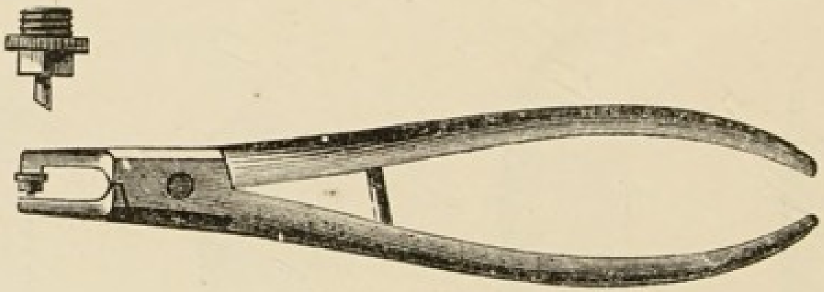


Fig. 14.

to release the gold back from the perforating pin after punching. In action, however, the contrivance is rather a complication than an improvement, and the claw arrangement will probably be dispensed with after a short trial.

Another form of perforating pliers is that according to which both holes for the pins of the teeth are punched simultaneously. Instruments of this character must be familiar by illustration to all who peruse the catalogues, if they are not so by practical experience. The latest, and in our opinion the best, appliance of this description is that represented by Fig. 15, and patented by Mr. J. C. Young. The advantages claimed for this instrument, and

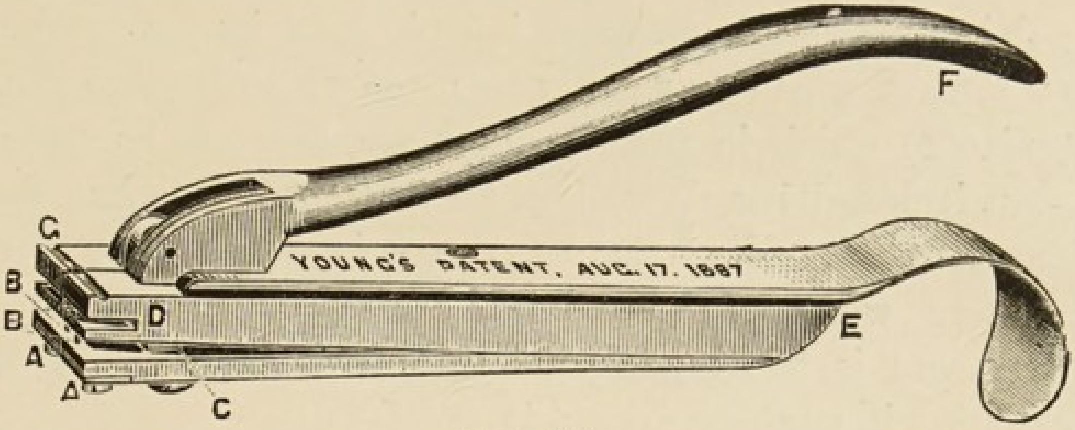



Fig. 15.

the manner of using it, are described in the following words:

'Mr. Young claims that this tool secures, rapidly and with mathematical precision, exact correspondence between the holes in the metal plate used for backing teeth and the pins of the tooth to be backed. It provides also for the quick and easy disengagement of the plate from the perforating pins after punching. The difficulty of separating without twisting or injuring the perforated plate (the greatest obstacle to punching two holes at once) is entirely removed.

'The risk of fracture in backing teeth is reduced to a minimum.

'No measuring is required. The tooth is its own gauge, virtually punching its own holes.

'METHOD OF USING.

'Holding the perforators in the right hand—like an ordinary pair of pliers—so that the end of the upper lever F rests loosely in the palm, the fingers and thumb readily grasp the lower lever E. The tooth to be backed is taken in the left hand, and one of the pins placed in the nearest punch-hole in groove G. Holding the tooth down with the thumb, the punch-holes are then slowly moved apart by pressure at E, taking special care at the time not to have the slightest pressure on the top lever F, or the jaws will not separate easily; the second pin of the tooth will slip into the second punch-hole immediately they come opposite each other, and the perforating pins are now fixed in position for punching.

'Retaining the tooth in its position, the metal backing is placed in the slotted recess D, immediately under the tooth, and the holes are punched in it by pressing down the lever F.

'Whilst perforating, the plate is easily held in position with the left hand, and the thumb placed over the tooth prevents its being jerked out. The tooth should be removed *before*, and the plate *after*, relieving the pressure at F.

'The holes in intermediate plate C support and stiffen the pins B B, and their breakage in use is almost impossible. Should it be necessary, however, to replace the pins, it can be done with the greatest ease by taking out the screws A A and removing the back.'

This appliance is not alone ingenious in its construction —a remark which may justly be made with regard to many appliances which in practice, however, prove to be useless —but it does its work well, as the present writer has seen demonstrated. 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 (Fig. 14).

*Bending Pliers.*—These pliers may no doubt be useful occasionally, and so may be included in the list of tools with which a well-equipped laboratory should be furnished. It can hardly be said, however, that they are indispensable. Though provided with them, the writer must confess that in the laboratory they are never made use of. If used too

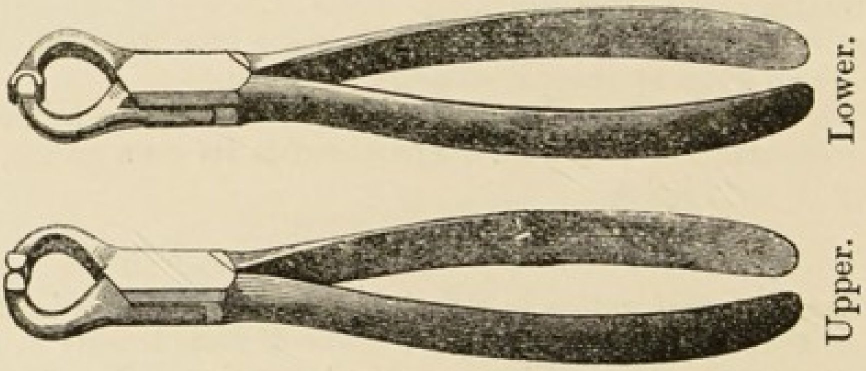



FIG. 16.

freely, it is to the detriment of the plate—as in bending into shape preparatory to swaging where the horn hammer should be employed—and in subsequent operations, bending of plates should never be resorted to if truer zincs and dies can be made to effect the purpose. At the muscular attachments, however, bending may be unavoidable. For this a pair of square-nosed pliers (a worn-out pair is best), with the angles of the beaks which come in contact with the plate well-rounded and polished, will answer well. After bending under these circumstances, the lead of the counter at these parts should be cut freely, and, with a layer of moistened paper under the plate on the zinc, a restrike should be given.

Pliers designed for removing spiral springs are considered by many as an essential item in the list of dental implements, but it may be doubted whether the muscular action of the finger and thumb is not more effective—as it is certainly less cumbrous. As in the last case, however, one of these pliers (Fig. 17) should be available for the dental laboratory, for there are conceivable circumstances, perhaps, in which

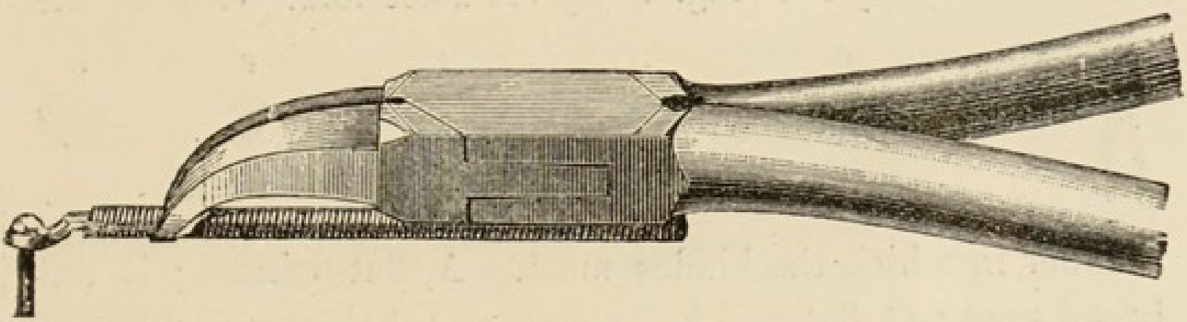


FIG. 17.

they would be an assistance. To undo spiral springs simply by the aid of finger and thumb, is really a very easy operation; nevertheless, one may have observed how difficult it is for some, who have had even a considerable amount of experience, to accomplish this. And, therefore—though to most readers of these pages the *modus operandi* must be perfectly familiar—a few words of explanation will be permitted, which may possibly assist the few.

Having ascertained the swivel from which the spring can be removed with least difficulty, allow the spring to hang in that line which permits of grasping it over the swivel shank, and between the forefinger and thumb gently turn the spring to the left, and at the same time downwards. In fact, the motion may, perhaps, be best described as a spiral movement to the left. It is a mistake to grasp the spring with excessive firmness across its diameter; that impedes the removal; the hold should be in the direction of the circumference.*

The smaller pliers which are essential, are the square-nosed, of which there should be two or three sizes; the flat and half-round, which are most useful for bending plate and wire to shape while fitting fasteners; the round pliers and rifflers. These last are pliers with their blades corrugated or cross-cut, and having a pronounced perpendicular cut, to form, as it were, a tube for the reception and fixing of wire while it is being manipulated.

The following cut (Fig. 18) gives a sectional view of the

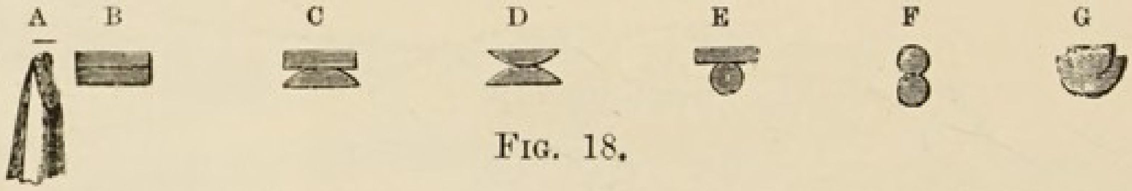



Fig. 18.

manner in which the blades meet. A, flat-pointed; B, flat broad nose; C, flat and half round; D, half round; E, flat and round; F, round noses; G, hollow. In Fig. 19 are represented, in a lateral aspect, A, F, and the rifflers above referred to, for holding wire.

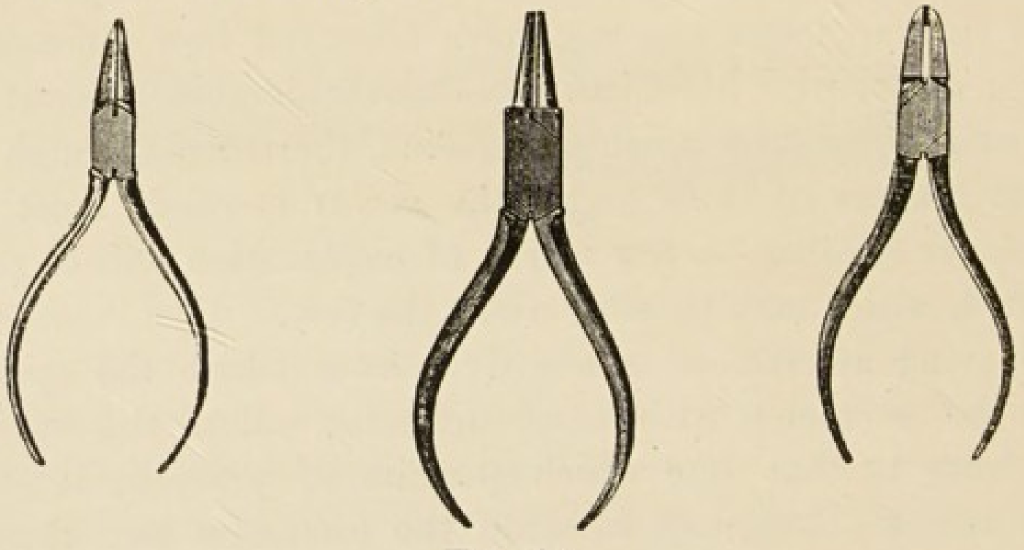


Fig. 19.

A kind of pliers of real value in bending, and at the same

* One should invariably put a file-mark when mounting springs on the swivel which is the last of the four to be inserted, it being the easiest to remove first.'—M. Andrieu.

time roughing the pins of teeth intended for vulcanite cases, is that represented by Fig. 20.

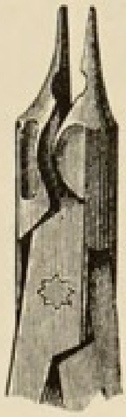


FIG. 20.

The clasp-bending pliers (Fig. 21) may be found useful,

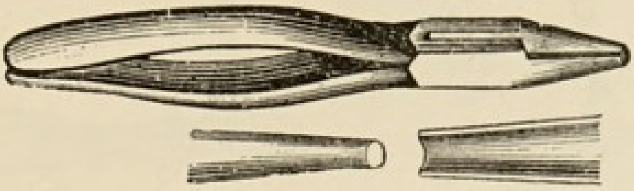


FIG. 21.

though with the complement of small pliers enumerated above they are not, perhaps, of great consequence.

Drawing-tongs are represented by Fig. 22. They are 7 inches long. It may be taken for granted that in few

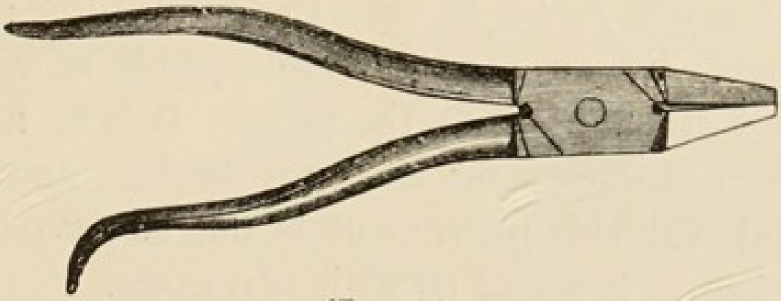


FIG. 22.

laboratories is the complete process of melting the gold

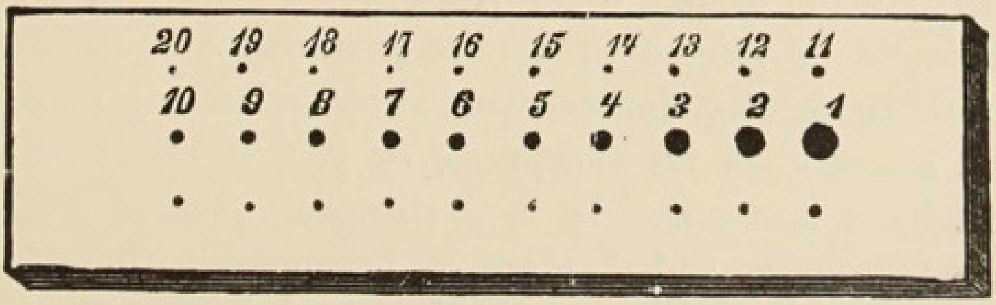



FIG. 23.

and rolling and drawing it into wire carried on. The usual practice, we take it, is to obtain wire pin size from the depot, and draw it, as occasion requires, to the desired thickness. In that case it is most convenient to fix the plate (Fig. 23) in the jaws of the large vice.

*Saw Frame and Saws.*—This is a most useful addition to our stock of tools if properly used. The saws should be inserted in the frame, so that the direction of the teeth is *towards* the handle A, not in the direction of the head B.

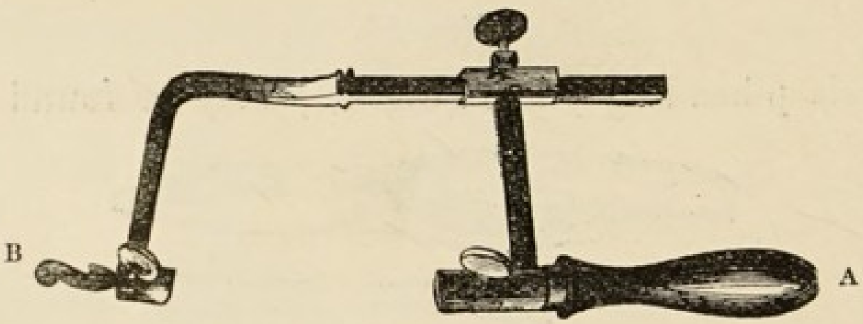
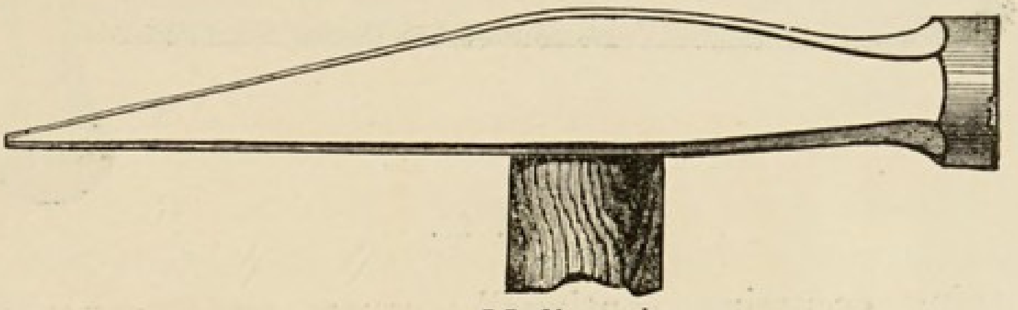



FIG. 24.

In using the saw, it is frequently necessary to veer from the straight line more or less—sometimes traversing a considerable part of a circle. When this is to be done, the saw should not be *forced* to take the desired line; but the case in hand, by an almost imperceptible movement in the required direction, gives the turns. It is by neglecting this condition that so many saws are broken, and perhaps, *therefore*, this valuable instrument is not so frequently put in requisition, as it might be with advantage.

The principal purposes for which the saw is employed are the cutting of flat teeth from plates—the same teeth, perhaps, to be refixed in a new position—and in sawing out rubber palates for repairs, as described at page 98. When a saw loses its sharpness, or *grit*, it should be replaced by a new one. It is a worrying process working with a blunt saw, and they are so inexpensive there is no valid reason for doing so.

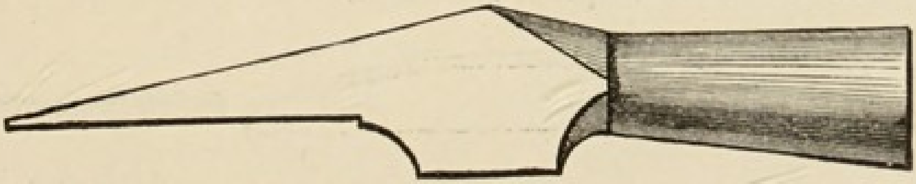
*Hammers.*—Four of these are absolutely necessary in the laboratory. First, there is the swaging hammer, which should, of course, be sufficiently heavy and suitably shaped for its purpose; one weighing about 8 lb. will do the work well. Second, the bench hammer — a medium-sized ordinary carpenter's hammer—which is useful for many purposes. Third, there is the riveting hammer. Two forms of the riveting hammer are represented here: Fig. 25 may



Medium size.

FIG. 25.

be taken as the most generally used, and deserves the preference; but Fig. 26 should also be provided. Indeed, although the three descriptions of hammer just mentioned have been represented as indispensable, the operator might with advantage add to the list some others differing in shape



Medium size.

FIG. 26.

and size. Fourth, we have the horn hammer—invaluable for preparing the plate for the swaging block, and otherwise aiding in the process of fitting it to the zinc model. These also are made in different sizes, and it is well to have a larger and heavier one than that represented by the figure for the breaking down to the zinc of the larger plates. A point to be observed is, that the handles of these hammers soon become loose in the socket if only *wedged* originally. Such

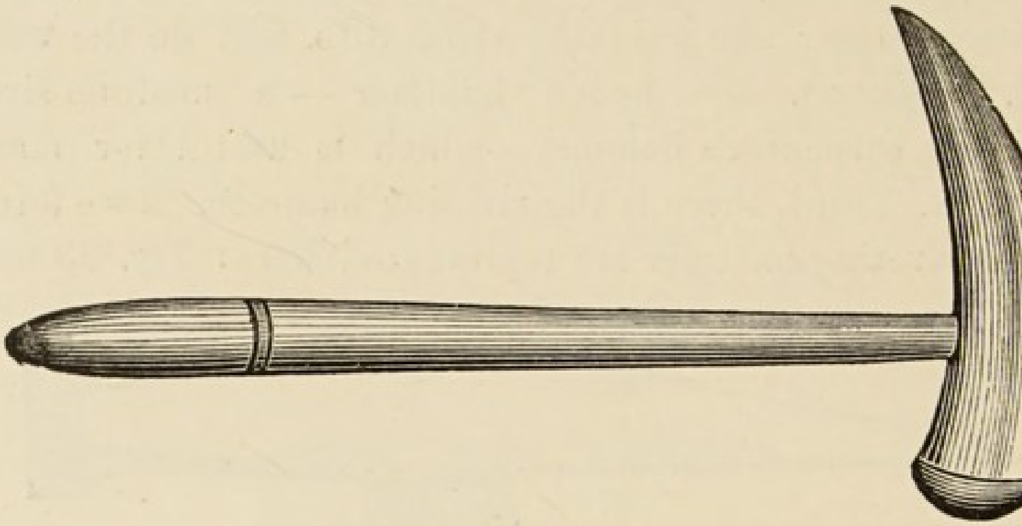


Fig. 27.

a thing occurring continually causes much annoyance, which may be avoided by drilling through horn and handle for the insertion of a piece of wire slightly thicker than pin size. The wire should go tightly through, and then be riveted.*

The place for these hammers is the side of the striking block. Two small screws being inserted at a suitable distance apart, wind copper wire round them so as to form a loop to let the handle pass through.

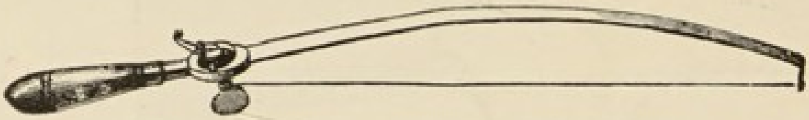


Fig. 28.

$3\frac{1}{4}$ inches long.

Fig. 29.

*Drill Bow and Stock.*—The bow represented here is a convenient one, and preferable to such as are of cane. In Fig. 29 we have the drill stock which is most commonly used; it is well, however, to have one also of the form of Fig. 30, as such a one, fixed in a small horizontal vice (Fig. 31) fastened

* Horn hammers treated in this way we observe can now be had at the depots.

to the right wing of the working space, is most convenient in exceptional circumstances.

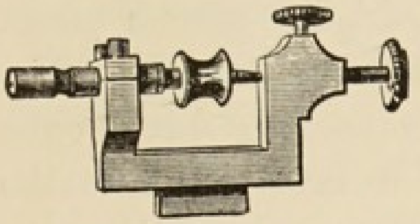


FIG. 30.

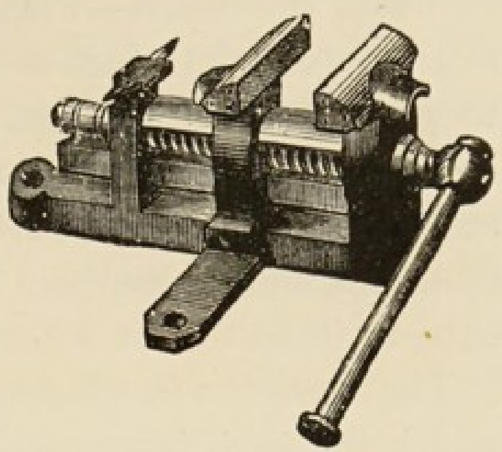


FIG. 31.

*Large Vice.*—A vice for heavy work is a necessary part of the equipment of the laboratory. It will be placed in a position apart from the working bench, if possible, and the attachments to its supports must, of course, be strong, and fully adequate to the strain which may be imposed upon it.

*Anvil.*—A good anvil, well set, at a convenient height, is of great advantage to the worker in plate. Some there are who, on account of the laboratory not being on the ground-floor, or from other causes, are obliged to swage plates on the hand or on the knee. This, no doubt, can be done, and perhaps satisfactorily, so far as the plate-fitting is concerned, especially where the silver alloy in the gold predominates; but it cannot be otherwise than injurious to the operator to continue such a practice. An iron block 6 inches square, with a 'tang,' let into a suitable block of wood, makes a good anvil for laboratory purposes.

If the laboratory is on the ground-floor the block may be let through the flooring, if there is a proper bed for it to rest on—such as asphalte; by this means the sound made in swaging is deadened. Failing this, a thick layer of rubber, or two or three thicknesses of carpet, should be interposed between the wood block and the floor, which will contribute to the same purpose.

*Movable Swaging-block.*—Mr. Haskell thus describes a block which may be pushed out of the way—as, for instance, underneath the bench—when not in use : 'It is 8 inches wide at the top, and 11 inches at the bottom, just high enough to pass under the bench. Make it of pine, with a plank bottom, to which attach heavy castors, a handle on one side, and a pocket for the hammer. Have an iron 6-inch cube cast, and, filling the box nearly full of sawdust, place the cube in it, so that it will extend 2 inches above the box.'

The reader will observe that this refers to the box in which the anvil is *set ;* and in giving the height of the box,

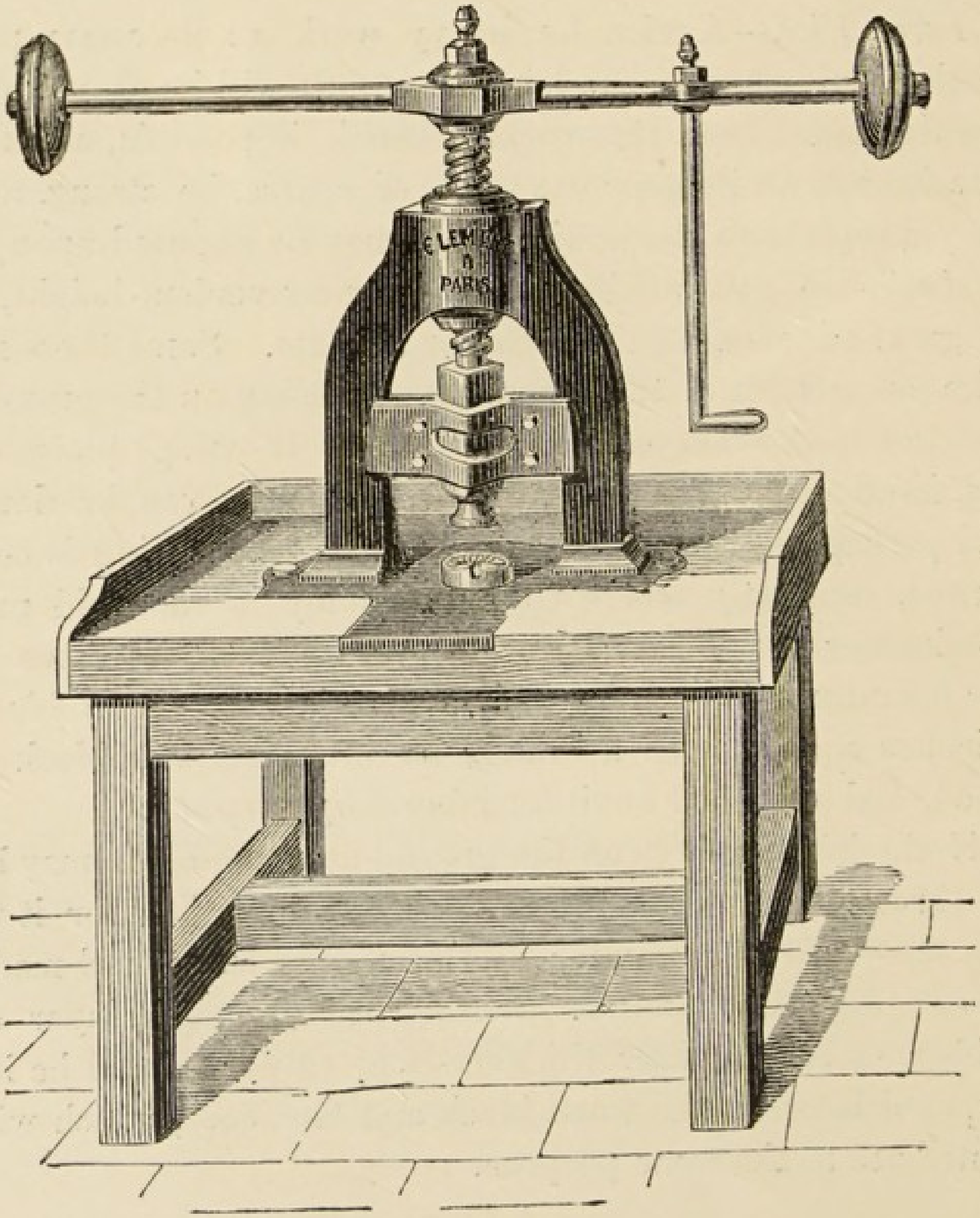



FIG. 32.

the height of anvil above it and the castors beneath must be allowed for, as the whole must pass underneath the bench.

Swaging plates on the anvil is not, however, the only method employed for fitting them to the model, though in this country it is the method generally, if not universally, practised. There is the stamping-machine, such as is used by those who raise the designs on medals. After the plate has been fairly well swaged, it receives the final touches under the stamp. Fig. 32 is an illustration taken from the work by M. Andrieu; it can hardly be considered a very desirable addition to our stock of appliances.

Machines for swaging—or rather stamping—plates by the application of hydraulic force, are also referred to by the same writer. One is by Telschow, of Berlin, and the other by Saussine, of Paris. M. Andrieu gives the preference to that introduced by M. Saussine.

Spence's Metal—a mixture or alloy of bismuth, antimony and iron—is used instead of zinc for the die, or model. This metal, which is exceedingly friable when subjected to the blows of a swaging hammer, and easily breaks, has great resisting power, according to M. Andrieu, when used under hydraulic pressure. And further, the same writer asserts that from the peculiar hardness of the metal, which he likens to steel, a much more accurate fit of the plate is obtained than that which results from using a zinc die and lead counter in the ordinary swaging process. These machines, however, are necessarily very costly, and it may reasonably be questioned whether they are practically to be preferred to the swaging process to which we are accustomed. Dr. Trueman expresses a somewhat similar opinion in regard to them; he says that in the hands of those familiar with their use they may produce good results: at the same time he doubts whether they are worthy of a place in the laboratory. It is, of course, without actual experience of this method of fitting plates that any opinion on our part is ventured upon; but when we consider how satisfactory a plate may be struck to form between hammer and anvil, if properly done, it is difficult to believe that the hydraulic presses can be more effective. But this much may be granted, that it is an advantage in such machines that we are free from all the noise consequent on the swaging process.

A miniature anvil—about $1\frac{1}{4}$ inches square, with tang to be let through the bench—is an acquisition, if placed in a convenient position and within easy reach, especially where there is not fixed on the bench the small horizontal vice (Fig. 31).

*Draw-plate.*—In choosing a draw-plate, see that it is of strong, solid make. And in this, as with all other tools that are *essential* to the laboratory, it will be found that it is the best economy to purchase the higher priced article.* In drawing wire, the plate should be fixed well down in the vice. That is to say, supposing it is a plate of three lines of holes, and we intend passing the wire along the middle row, let it be fixed so that the line is uniformly two-eighths of an inch free of the jaws of the vice; and on coming to the bottom row of holes, reverse the plate in the vice, making the bottom row the top, and letting it down to the position just described.

The wire to be drawn having been annealed and pointed, it is well to rub a film of oil over its surface before inserting in the draw-plate.† Insert at first where the wire passes through freely, then through every hole in succession, until the desired thickness is obtained.‡ When the drawing becomes stiff—as it does after passing through the first few holes—we take the full grip of the projecting point in the pliers and give a pull sufficient to draw the

* This is, of course, assuming that the two articles are exactly the same size and form. The remark would not *necessarily* apply where there are two articles designed for the same purpose, the more expensive one being an alleged improvement on the other, for the so-called improvement may be a disadvantage really.

† The annealing should be repeated if more than eight tight holes are passed through.

‡ The point filed on the wire should give about a half-inch grip to the pliers when the wire is inserted in the plate.

wire an eighth of an inch fully on its way; we then have a grip of the full strength of the wire, and a second sudden and vigorous pull will carry several inches of wire right through. A steady pull, as that used in rowing, is not suitable in wire-drawing by *hand* power, as in the vice. Having got a sufficient grip of the wire, a sudden fall back, as it were, of the body, is necessary to give the impetus that will carry it through. It is different where a draw-bench with windlass power is used.

*Sculptors, Gravers, etc.*—Of these a varied and ample supply should be provided, and full attention given to keeping them in perfect order. Accidents of very serious consequence are frequently occasioned by using a blunt graver. The illustrations appended indicate such as are used in the dental laboratory. They are all of them useful, but Figs.

Fig. 33.

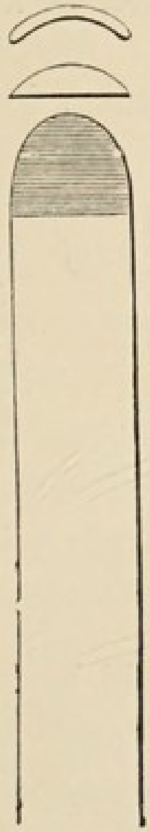


Fig. 34.

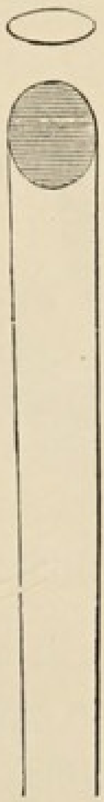


Fig. 35.

Fig. 36.

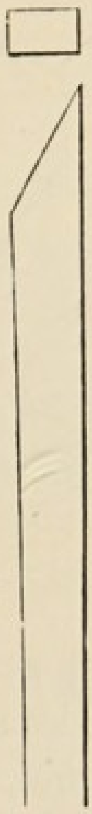


Fig. 37.

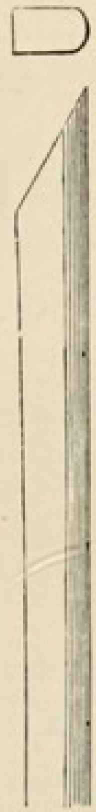


Fig. 38.

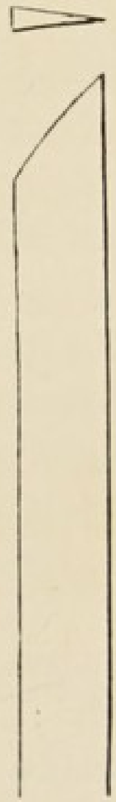


Fig. 39.

Fig. 40.

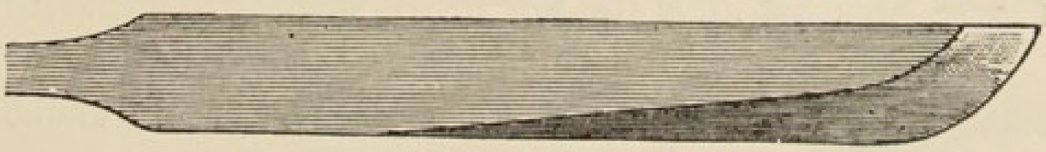


Fig. 41.

33, 34, 35, 36 and 37 are the most essential; Fig. 33 for dressing the vulcanite at the necks of teeth, etc. Fig. 34, as sculptors for many purposes, should be provided both in the gouge form and in the more solid form of a segment of a circle, or half round, as illustrated. Figs. 35, 36, are useful for finishing the insides of plates where pins have been soldered, etc. The other forms are of less consequence, with the exception of Fig. 37, which is useful as a scraper.

*Sharpening Gravers.*—In the days of bone work, when the sculptor was the most important tool in the workroom, it was considered necessary to have a grindstone of considerable circumference and thickness for sharpening the gravers; but since these tools have lost so much of their importance, through the different character of present-day work, there is not the necessity now of any such extensive provision for sharpening them. It may be that a small stone, of about

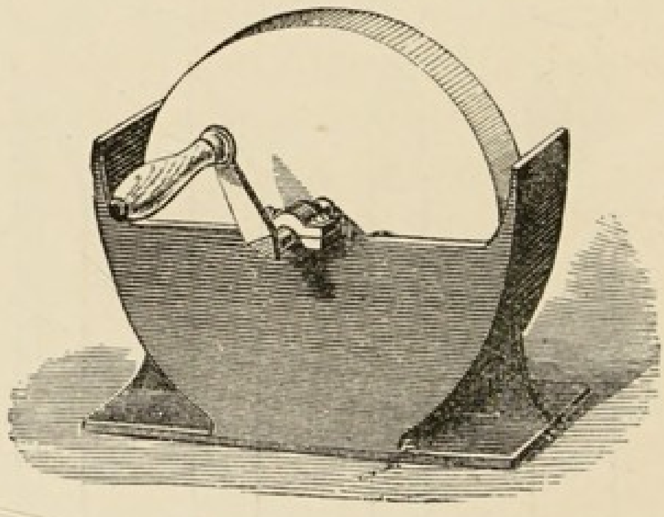


FIG. 42.

8 inches diameter, such as that illustrated, would be found useful; but a corundum wheel of fine grain and about 3 inches diameter, running on the lathe, may be accepted as a good and perhaps sufficient substitute. The graver is, of course, held flat upon the *side* of the wheel while sharpening.

*Oil-stone.*—The Arkansas stone is said to be the best for such small tools as are used in dentistry. It should be fitted in a shallow box, and have a tight-fitting cover to keep out the dust when not in use. The tools should not be rubbed along the same line of the stone successively, otherwise a groove will be formed and the efficiency of the stone impaired. And, again, after completing the sharpening, the stone should be thoroughly cleaned of oil, for if in a pasty and dirty condition of surface, it will never act to the best advantage.*

*Oils.*—Almond-oil, if exposed in a white glass bottle to the light for a few days, with shavings of lead also in the bottle, is refined to a degree which renders it most suitable for the oil-stone; and for mixing with vermilion for colouring purposes. If kept in a shallow porcelain dish, with *cover*, it will retain its viscidity for a longer time than other oils. The lubricants so plentifully supplied now for delicate machinery, however, may well be trusted to for general purposes.

The laboratory should always be provided with a supply of paraffin oil; it is most useful when the oil about bearings of lathe, etc., becomes pasty. If a lathe which becomes difficult to drive has a few drops of paraffin introduced to the bearings, it will at once resume its facility of movement. That is very well for the emergency, but it need hardly be said that the earliest opportunity should be seized to dismantle the machine, clean the joints thoroughly with a paraffin-saturated cloth, and re-oil; a point which has already been referred to in connection with the subject of the lathe.

*Calipers and Spring Dividers.*—These are among the indispensable implements for the laboratory. The calipers (Fig. 43) are required principally in the finishing of rubber cases. The eye is readily deceived, even assisted by the touch of the fingers, in ascertaining with certainty the vary-

* It is claimed for the German stone that it equals the Arkansas in hardness and efficiency, and is only half the price. The 'Washita' is a soft stone, and unfit for our purposes.

ing thickness of an irregular palate; but by the repeated use of the calipers we cannot be deceived, and may reduce the heavy parts and avoid the sufficiently thin parts with confidence.

The spring dividers (Fig. 46) are used in setting the position of swivels from the centre, and in many other instances where measurements are required they are essential. A record of such measurements may be kept on the model itself by using one of the limbs as a pivot, or centre, and

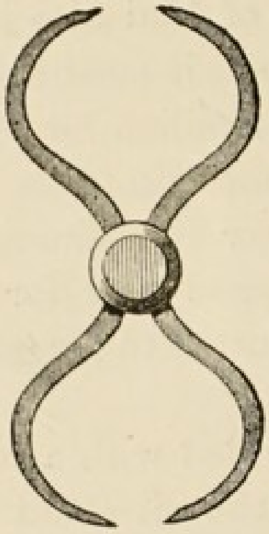


Fig. 43.

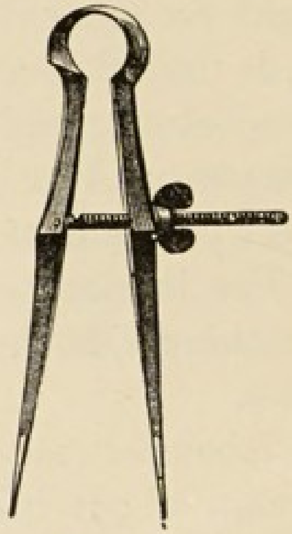
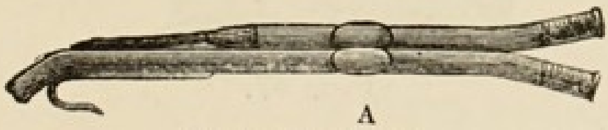


Fig. 44.

describing with the other a portion of a circle. Suppose, for example, that we wish to retain for reference a record of the length of teeth in a given denture; the dividers will be so far opened that one limb reaches to the point of each tooth, while the other limb makes a mark, or indentation, on the face of the plaster model. Thus, while the points of the calipers remain throughout at the same distance, the marked points on the front of the plaster cast will be higher or lower according to the setting of the teeth. But with these points marked for each tooth, if the dividers are then used on the base of the model in the manner above described, giving distinctly the marks of their terminals or 'reach'—then the same instrument may be used for any other work, the record remaining on the model, and to that they can be again at once accurately adjusted.

*Blowpipe.*—Whether it is better, so far as an approach to perfection in soldering operations is concerned, to use the mouth blowpipe, or that to which the necessary blast is conveyed by a foot bellows or other contrivance, is, perhaps, a doubtful matter to decide upon. Probably, however, the majority of those who have given a full trial to both systems will incline to the opinion that finer and smoother soldering is effected by the mouth-pipe, particularly in the more delicate of these operations. But on the other hand in heavy work—such as soldering large plates with flat teeth—the bellows blowpipe, after the operator has had sufficient experience with it, produces quite satisfactory results. It is, indeed, in our opinion, a necessary appliance to have in every laboratory where much plate work is done. For even to the operator with the strongest lungs, the severe exertion incident to the class of cases just referred to cannot but be injurious.

The accompanying illustrations represent two forms of this latter blowpipe. In Fig. 45 it will be observed that at




8½ inches long.

Fig. 45.

the point A on both tubes there are rubber adjustments, which, on being compressed, serve to regulate the supply of flame or air to the extent desired by the operator. Fig. 46 has the same object, but the result is obtained in a different manner; it is designed by Mr. Fletcher, of Warrington,


Fig. 46.

and is the latest improvement on his original pattern, regarding which latter he writes as follows :

'This pattern is suited for all work, from the finest up to brazing ½-inch brass tubing. The air and gas tubes are made very short, to admit of the hand being used to compress the rubber tubes, as shown in the engraving. The air tube must rest *on the knuckle* of the little finger, and the blowpipe be held precisely as shown. A slight opening or closing motion of the hand gives the most perfect and instantaneous control over the flame. With a little practice the flame adjusts itself to the wish of the user without any apparent effort or thought. Takes jets sizes 2, 4, 6; requires size 3 blower.'

The foot-bellows required for this form of blowpipe is represented in Fig. 47.

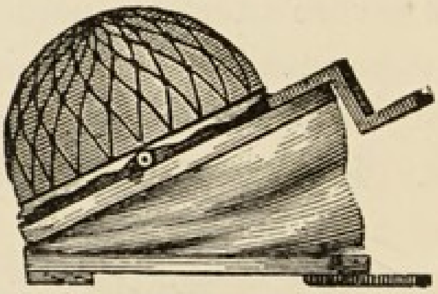


FIG. 47.

A good form of mouth blowpipe is that here indicated.* It has a chamber (A) intended to receive and retain the


FIG. 48.

moisture, which otherwise is apt to sputter out of the nozzle of the pipe, and so cause inconvenience during soldering operations. In the more prolonged cases of soldering it is not so much inability to continue the blast that gives

* As in some of the blowpipes sold as being made on this principle there is really no communication between the tube and ball, it is necessary to be careful in purchasing them.

trouble,* it is rather the exhaustion of muscular power from over-exertion; so that during exceptionally heavy or long soldering operations a point arrives when it is physically impossible to retain the blowpipe between the lips.† For this reason it has been recommended to have the mouth end encircled by a washer—of ivory or other material—so that instead of the lips *grasping* the tube, they shall press against the washer and so minimize the fatigue. There may be something of value in the suggestion; but a far more important factor in preventing fatigue and loss of time in soldering is the having the case properly placed on the charcoal, or other support, so that the heat, as it were, shall collect around the part to be soldered. A case might be placed on the support in such a manner that an hour's struggle might not succeed in accomplishing the object in view; whereas, if properly placed, a few minutes might suffice. It is for this reason that in some instances it is found of much advantage to use pieces of pumice-stone for the purpose of concentrating the force of the flame, as, for instance, in the soldering of flat teeth. It will sometimes happen that at one point or more, the flame deflects *from* the tooth back, and so loses the force necessary to flow the solder; if in that case a piece of pumice-stone of suitable size be placed so that the flame in deflecting strikes the stone, the flame is then directed *towards* the joint to be soldered. It is not often that such provision is necessary, but its adoption will be found advantageous under certain circumstances. Another avoidable cause of difficulty in soldering is invest-

* It is, of course, assumed that the operator has acquired the art of keeping up the blast—the method of doing which is fully explained in most of the text-books, and no doubt taught now in the schools.

† 'The end should not be taken between the lips, as it tires the muscles too much, but pressed against them. There must be a supply of air in the lungs constantly, so do not allow a complete collapse of the diaphragm, at the same time pressing the tongue against the palate to prevent the lips collapsing while drawing in a fresh supply through the nose.'—'Student's Manual,' Haskell.

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ment material arching over the teeth backs; the protuberance, of course, stops the direct force of the flame. The investment should be pared to the same level as the tooth back, and though the tooth material should thereby become exposed, no danger need be anticipated of cracking.

*The Stickler.*—This little instrument, which simply consists of iron wire about pin thickness, or rather less, and between 3 and 4 inches long, is very useful when soldering with the bellows blowpipe. The point of the wire is flattened and slightly pointed, and being heated sufficiently, the point is pressed into a piece of borax — the object being to give it a vitrified coating of borax. In soldering, the stickler is held in the unoccupied hand, and as the solder melts it is used to draw the solder in the directions desired.

*Borax Slate.*—A very suitable mounting for a borax slate is a shallow delf pomade dish having a 3 to 4 inch internal diameter. A good slate having been procured and cut circularly to fit into the dish, fill the latter with plaster of Paris and imbed the slate. The cover is useful in keeping out dust while soldering work is not going on.

*Pickle Dish.*—Porcelain or copper vessels are, in our opinion, the best.* When one is pushed in regard to time, it is of advantage to have the pickling acid hot, so that a momentary submerging of the plate will suffice to clean it. Where there is an open fire, if a common earthenware dish — such as an ordinary jam-pot — containing the pickle, and resting in a saucer like those used for small flower-pots, be placed at the side of the fire before commencing soldering, the pickle will be hot enough by the time the plate is freed from the investment to instantly effect the cleaning process. Where this method cannot be adopted, we should have a suitable porcelain dish set in a tripod (easily made by soldering three legs of

* Mr. Haskell approves of *lead.*—'Student's Manual.'

copper wire to a ring of the same) sufficiently high to allow for a spirit-lamp acting freely around the bottom of the dish. This contrivance should be placed in a position as far as possible remote from the working bench.

*Articulators.*—For complete sets, and for large cases upper or lower, there is no better means of fixing the bite than by the articulator. By its means we may either lengthen or shorten the bite as may be required; while the transit is in all parts a faithful representation of the natural occlusion. Second, we are able to examine the articulating border

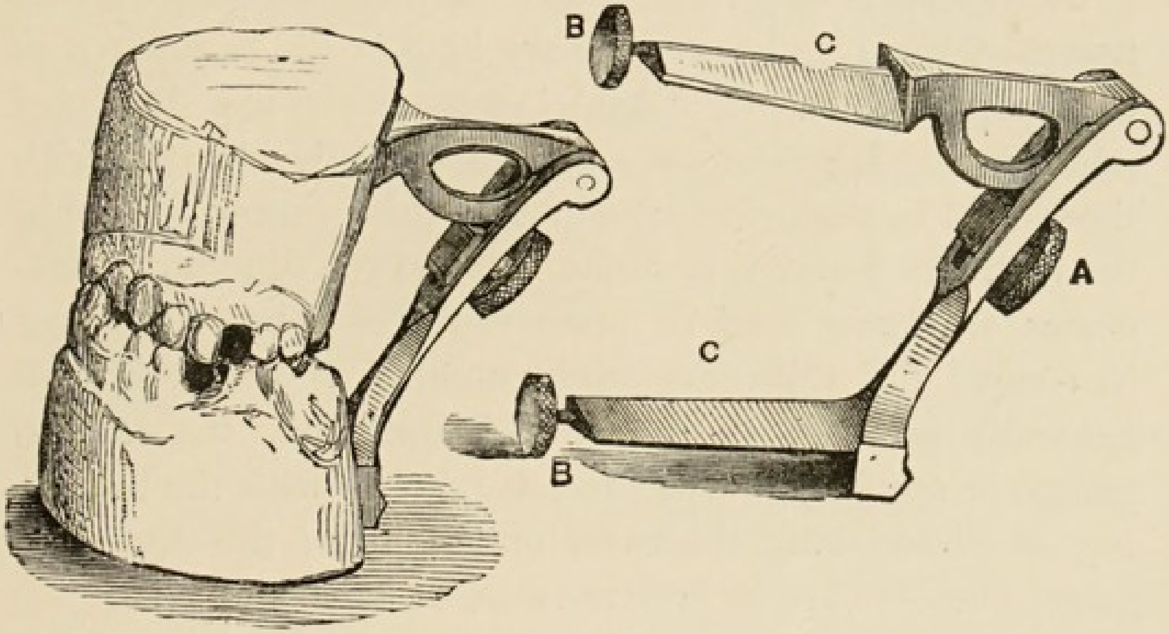


FIG. 49.

from the lingual aspect as easily as from the labial, thus securing readily a good masticating surface. Of the many forms of articulator to choose from, it may be doubted whether there is a better one attainable than Graham and Woods', represented in Fig. 49. In choosing an articulator, particular notice should be taken of the *joint*—that it fits perfectly and works steadily. If *shaky*, it should not be accepted. The bevelled parts (C) are sometimes not *sufficiently* bevelled even in the best instruments, so that it is well to make a test bite in order to ascertain whether these parts draw easily from the plaster; if not, file to a bevel that will.

The reader need hardly be reminded that the 'arms' or 'suspenders' to be inserted in the plaster ought to be well oiled, and that the thickness of plaster provided over the upper arm and under the lower should be sufficiently ample to resist any tendency to break, which might arise from a reasonable amount of freedom while in use. The circular-headed pins, when inserted, serve to indicate the amount of plaster which should be allowed.

*Gauge Plate.*—A gauge for ascertaining the relative thicknesses of plate is also a necessary item in the equipment of the dental laboratory. 'Ash's' gauge is the one depended upon by English dentists, and is apparently identical with those used in the principal depots in this country. Within the numbers 8 and 4, *inclusive*, is found the different thicknesses ordinarily used in plate work; 8 being what may be termed *full* thickness, while number 4 is slender, and generally used for strengtheners. But while the English gauge, in numbers, keeps pace, as it were, with the increasing or diminishing thickness of the plate, the American gauge numbers are in inverse ratio, as for example:

| | Thick. | Thin. |
|---|---|---|
| Ash's or English dentist's gauge - - | 8 | 4 |
| American plate - - - - - | 23 | 31 |

The French gauges are also numbered on the same *principle* as the American, though the progression of the numbers differs considerably.

*Clock.*—The laboratory can hardly be considered well furnished if it does not possess a good clock. It should be of fair size, and so placed that it may be seen from all parts of the room. In addition to the tools and appliances that have already been described as being absolutely essential, there are many others which it is very desirable to have—such as a good saw, plane, chisels, turnscrew, copper and iron wire of a variety of thicknesses, screw nails and driving nails, etc. A note-book and pencils should also have a place in the laboratory. Seldom a day passes without an intelligent operator having observed something that is new, and which may probably escape his memory if it is not recorded.

The following list of tools and appliances is given by Mr. Haskell; it is practically identical with that of Dr. Trueman, which appears in the second volume of the 'American System of Dentistry,' and represented by them as being indispensable. Dr. Haskell says: 'Dental depots are filled with appliances, many useless, others sometimes useful but not necessary. The following are indispensable:

FOR METAL WORK.

Straight shears, with openings for the fingers.
Plate-punch.
Hammer, for swaging.
Horn or wood mallet.
Files, round and half-round.
Small vice and anvil.
Slate for borax.
Sheet iron soldering pan.
Articulators.
Lathe appliances.
Felts and brushes for polishing.
Acid dish.
Sieve.
Moulding flask, 5 inches in diameter, 3 inches deep, of iron.
Plate-nippers.
Plate-benders (lower).
Pliers, round-nosed.
Pliers, flat-nosed.
Hammer, riveting.
Plate-burnisher.
Tweezers, for solder, etc.
Reamer, for countersink.
Blowpipe, mouth.
Pumice block for soldering.
Lathe, cone-bearing.
Circular saw, large and small bur, and drills.
Two ladles.
Stick for packing.
Two sizes of rings for counter-die.
Gas-pipe so arranged as to be used for soldering, 'waxing up,' vulcanizing, and melting metals.

FOR RUBBER WORK.

Vulcanizer.
Wrenches.
Scraper, round shape.
Small pointed instruments for finishing between the teeth.
Saw-frame and saws.
An instrument for waxing up, straight and pointed at one end, and slightly curved at the other.
Bowls, medium size.
Shellac bottle, wide mouth.
Flasks.

Press.
Chisel, with narrow, thin edge, for trimming around necks of teeth.
Calipers.
Files, two grades.
Plaster-knife.
Heavy tea or dessert spoons, for mixing and handling plaster.
Oil bottle.

## FOR CELLULOID.

All tools used for rubber except vulcanizing flasks and press, substituting celluloid flasks and press.

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## FOR CONTINUOUS-GUM.

Furnace.
Porcelain boxes, for mixing material.
Muffles, slides, tongs, and poker.
Camel-hair pencils.

Instruments for applying material.
Stiff brushes.

To the above can be added:

Automatic blow pipe.
Furnace or melting apparatus.
Ingot mould.
Cutting pliers.
Rolling mill.
Tongs for crucible.
Plate-gauge.
Curved shears.

'The tools should be arranged at the back of the bench, within easy reach, and never in a drawer. Have in the rack only such as are needed for dental purposes, laying duplicates aside.'*

* See Notes, p. 150.

## CHAPTER V.

### VULCANIZERS AND VULCANIZING.

CONSIDERING the many excellent machines that are now available for the vulcanizing process, it is indeed difficult to say with confidence which one is to be preferred. It is easy to indicate which are to be avoided; and first and foremost among such (in the writer's opinion) is the 'Campbell' vulcanizer, which, without giving appreciably better results than other vulcanizers, is complicated to quite a harassing degree. Placing it by the side of the centre screw vulcanizer, which in a few seconds is started on its work, and contrasting the latter with the cumbrous and—it may reasonably be said—useless complications of Campbell's vulcanizer, it is difficult to understand how anyone would willingly choose the latter in preference.*

Other vulcanizers may be placed in three classes:

*First:* those which are closed by means of several screws set around the circumference of the chamber, with corresponding holes in the lid, which latter is then fixed by nuts. This is the earliest form of vulcanizer.

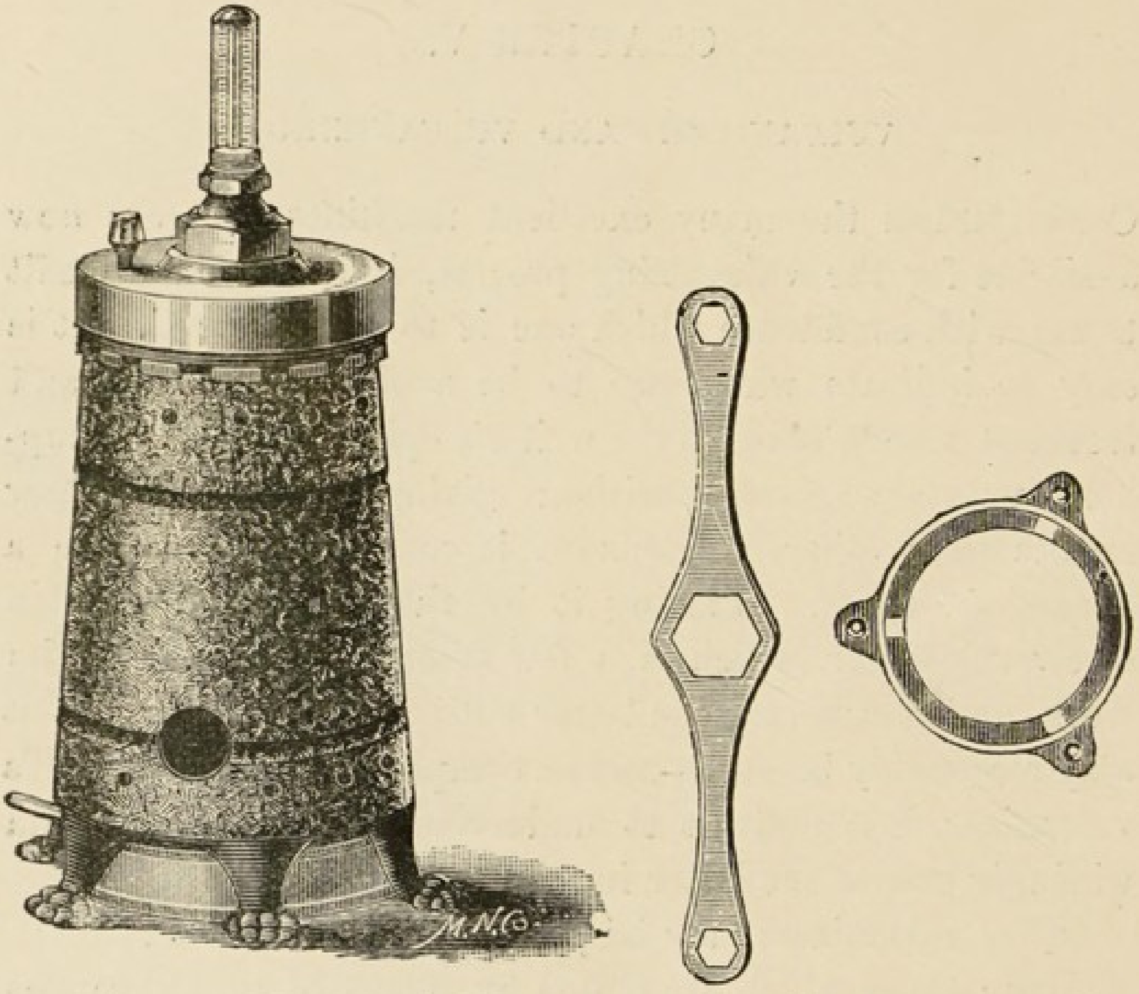
*Second:* we have those which have a thread cut around the outer superior wall of the chamber, while a corresponding thread is cut in the interior wall of what is termed the

* This machine originally was no doubt intended for the celluloid process; but the complications necessary for this process are altogether out of place in a vulcanizer. (A contrary opinion to that expressed above is maintained by eminent practitioners, whose judgment must necessarily possess much weight: see Notes, p. 150.)

'collar.' The lid having been adjusted in position, the collar is then placed over it and screwed home (Fig. 50).

*Third:* we have the principle of the centre screw, as shown in Fig. 51, which represents an Ash's vulcanizer of this type.

Of the first class of vulcanizer, it may be said that it is out of date; and, though no doubt many are still in use,




WHITNEY'S WRENCH AND BED PLATE.

FIG. 50.

the practitioner about to choose a vulcanizer *now*, will not for a moment think of selecting one of this construction—they are, in a word, 'superseded' by the improved machines of the present day.

With respect to the third type, as represented in Fig. 50, it is a fact that many skilful operators hold them in high esteem. But the manner of fixing them for the vulcanizing process, and unfixing them afterwards, is unnecessarily tedious. And—though it is somewhat foolhardy to be dogmatic on almost *any* matter connected with theory or practice in dentistry—one may with some confidence assert that there are few who have had experience of the working of the *centre screw* vulcanizer who would willingly employ one of any other design. In effectively doing its work it equals, if it does not *excel*, all others, and the facility with which it is fixed and unfixed is an obvious advantage.

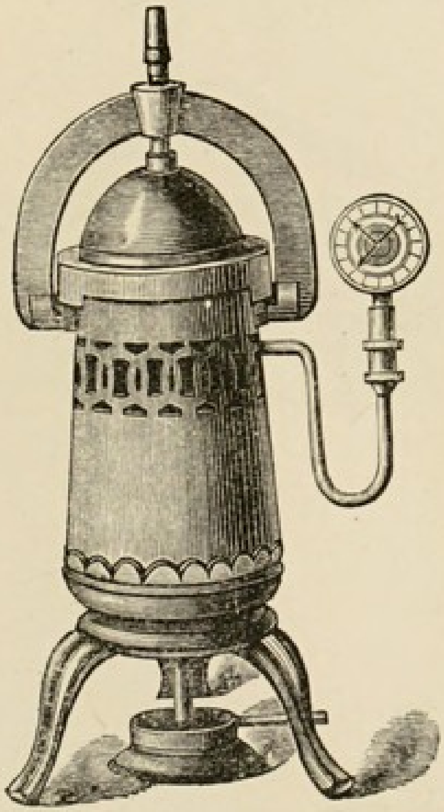


Fig. 51.

While presenting, without hesitation, the opinion and conviction that this type of vulcanizer is superior to those of any other design, the decision as to which of the various *forms* of it as supplied by the different manufacturers is to be preferred, is not to be so readily or so confidently arrived at. It may, however, not be without interest to have described the vulcanizer of this type with which the writer is most familiar, together with the manner of working it.

Without giving the preference to it over others of the same design, one may safely assert that a 'Walker's' vulcanizer—as illustrated in Figs. 52, 53—is thoroughly efficient

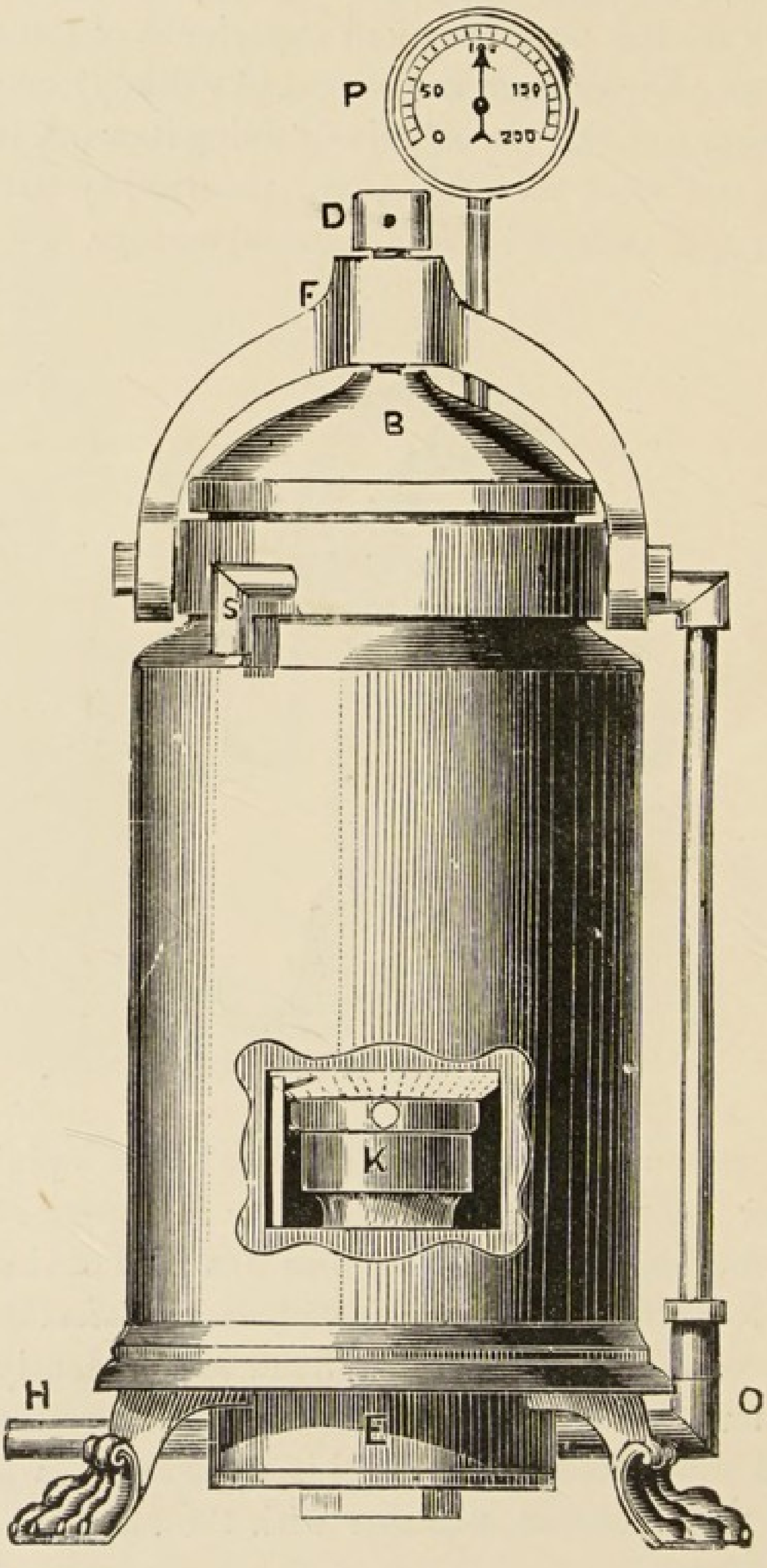



Fig. 52.

in doing its work, and it is as simple in construction as it is efficient. Taking it at first in a general view, it will be seen how readily the machine is started for its work. The

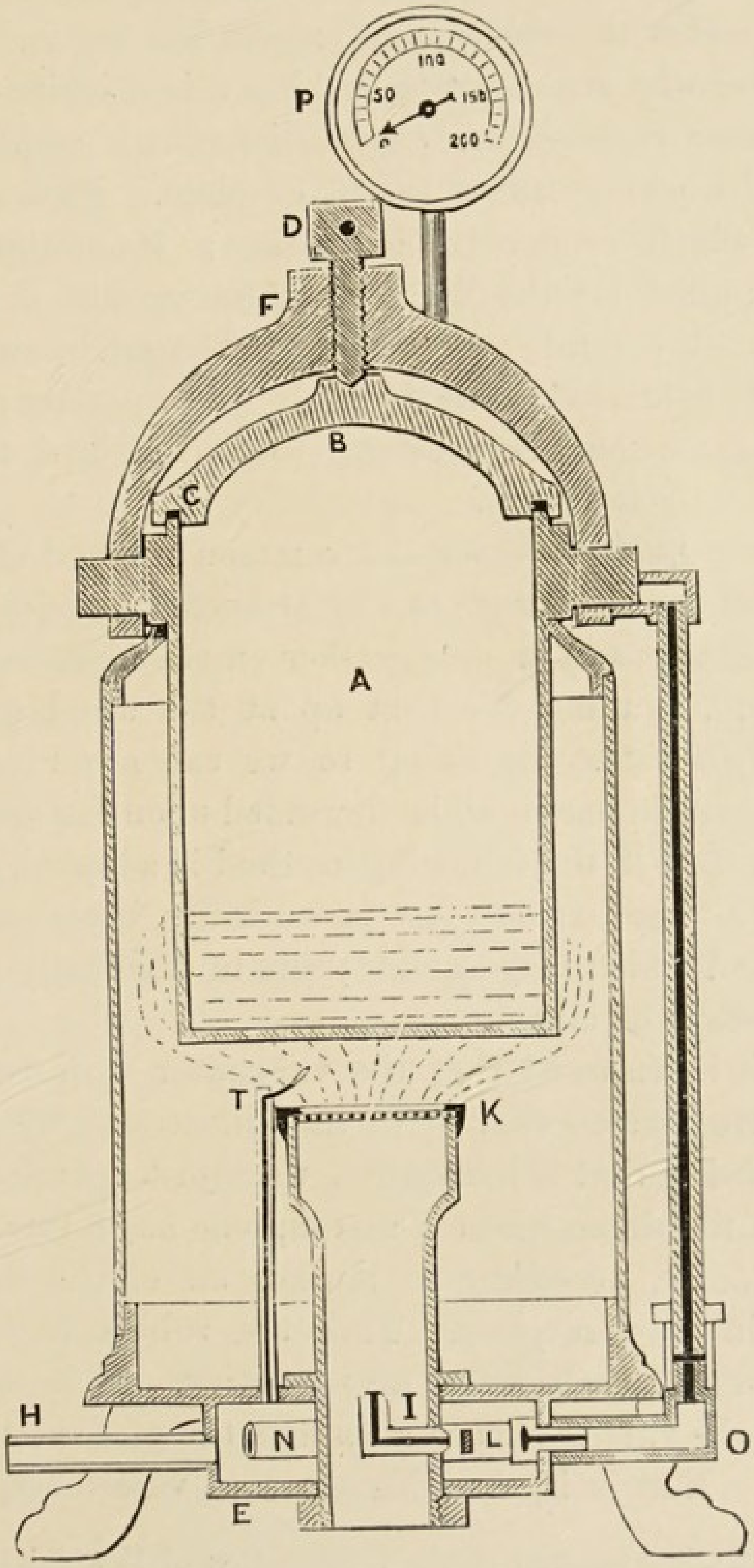



FIG. 53.

flask being placed in the vulcanizing chamber, the dome, or lid (B), is adjusted—the swivel F also—and at once the screw D being turned, the machine is secured for vulcanizing purposes; and in a few seconds from placing the flask in the chamber the vulcanizing process has begun.*

To those who are about to employ this machine—or one of the same class—some observations with respect to its successful working cannot be out of place. First as to the washer, which serves to maintain a steam-tight joint. Those supplied for the Walker vulcanizer are of rubber; and without careful adjustment such washers will be a source of continual annoyance to the operator; but if treated in the manner presently to be described, they will last effectively for years.

*Adapting Rubber Washer.*—A common method of acting, when a rubber washer gives way or becomes useless for its purpose, is to insert a new washer on the next occasion of vulcanizing, running the heat up at the usual (comparatively) rapid rate. By doing so we can never expect to secure a washer that is to be depended upon for any length of time. But if the following method is adopted, we then obtain one which, after a few vulcanizings, becomes as hard as lead, and which may last for years in effectually preventing the escape of steam.

First, it is assumed that the vulcanizer is dome-shaped, with centre screw—similar to that illustrated by Fig. 52; and supposing that it is required to adjust a washer to the groove in the dome where a used-up one has formerly been, it is, of course, necessary to remove all of the débris *remaining*, in the first place. Then the rubber to form the new washer is neatly fitted into position. It is not desirable that the rubber should *cram* into the groove; it should fit easily. Nor is it, for this class of vulcanizer, best to

* For a detailed account of the construction of this vulcanizer, see pp. 64, 65.

have a continuous ring for the washer. Strips of rubber are supplied with the 'Walker's' machine, which must be carefully cut to the proper circumference—the ends meeting edge to edge. This having been done, the surface of the washer, as it lies in its groove, is rubbed well with French chalk, the necessary water supplied, and the lid, or dome, is then placed in position on the vulcanizing chamber and screwed down, *but not with too much force.* The blow-off valve having been also secured, what is now requisite is to regulate the supply of gas so that two hours will elapse before the indicator rises from boiling-point to the vulcanizing-point, which in Walker's vulcanizer is 100 lb. pressure. During this process strict attention must be given to the circumstances. It will be necessary, from time to time, as steam escapes, to give a partial turn to the screw. But no further pressure should be employed than that necessary to prevent the steam escaping. At the end of the time prescribed, turn off the gas and allow the vulcanizer to cool *absolutely.* Then take a sharp three-sided or other suitable file and make a decided perpendicular cut crossing the lid and chamber. This is important, and its object must be apparent to the reader, viz., to have a *certain guide* in all future vulcanizings, that the articulation is, as nearly as it is possible to make it, the same as at first.

If the lid does not *easily* part after this has been done, it is only necessary to put a light to the vulcanizer, when in a few minutes the pressure of steam will, with a slight prising, separate the parts.

The reader will perceive that this method of preparing, or, as may be said, curing, a washer is suggested by the well-known necessity of a slow process of vulcanizing for exceptionally ponderous lowers, and also for the particular rubber used for artificial velæ.

The inconvenience so often experienced from using rubber washers has stimulated the manufacturers to the supplying of those made of lead. But these, in their turn, have defects, and the rubber being so readily adjusted, and—if treated as described above—so lasting, the latter appears to be the most suitable for vulcanizing purposes.

*Fusible Metal Plug.*—This provision for the safe working of a vulcanizer is of the utmost importance. Whether the indicator be a thermometer, gauge, or regulator, all may go astray. And if this should happen, the only security from possibly serious accidents is the fusible plug, which at a certain temperature—higher than that required for vulcanizing, yet not so high as to endanger the integrity of the vulcanizer—will melt and be ejected, thus preventing the possibility of an explosion which might result in personal injury.*

*Adjusting the Plug.*—As they are supplied by the manufacturers, the plugs vary in diameter. Some enter the tube destined for their reception so freely that an altogether insufficient part of its thicker diameter remains projecting in the chamber to form a sound and substantial rivet. If such a plug is used, the pressure during the first or second vulcanizing process will probably render it powerless to prevent the escape of steam. It must be remembered that the plug serves two purposes. First, the material of which it is made must be of such a character that, when an undue temperature is reached within the vulcanizing chamber, the plug will succumb, and the steam then escapes before

* The instances of foolhardiness in the mismanagement of a vulcanizer are only too numerous. To take one example—and this is a well-authenticated case—a dentist, after finding that the thermometer tube was broken, went on with the vulcanizing process, mentally calculating the time required to reach vulcanizing-point; then, in the same way, he guessed the reduction of gas supply sufficient to maintain the heat at that point. The vulcanizer exploded, and the injuries suffered by the foolish operator were such that for some time his life was despaired of, and though he recovered health, he was permanently disfigured.

danger can be apprehended from the bursting of the machine. Secondly, it must be so closely or hermetically welded around the entrance to the tube in which it is placed that steam cannot escape, until more than the vulcanizing point is reached.

It is necessary, therefore, in order to secure the second of these objects, that a plug should be selected of such a diameter that when inserted, and driven with considerable force by the blows of a hammer into the tube, quite a quarter of an inch should remain projecting within the chamber, in order to allow a well-defined and solid rivet to be formed. But before the plug is inserted the parts around the tube upon which the rivet is to be made should be thoroughly scraped; and if the vulcanizer is heated without water the plug can be inserted and riveted most effectively. The position is a somewhat awkward one for using the hammer upon; but with some manœuvring a good and sound rivet head will be obtained.

The following account of the risks to be apprehended from the careless manipulation of vulcanizers is taken from a foreign dental journal:*

'*Another Explosion of a Vulcanizer.*

'Several days ago, leaving my vulcanizer registering 300° Fah., I went for a moment to the adjoining room, where I had hardly time to seat myself when there was an explosion, such as, by my neighbours, might have been attributed to the firing of a 10 lb. cannon. Scarcely a minute had elapsed since my quitting the vulcanizer. Upon examination, I discovered that at one point of the bottom of the machine the metal was no thicker than a visiting-card. Had I been a minute later in going out of that room, other hands would have been writing these lines.'

* Monatsschrift des Vereins Deutscher Zahnkünstler, November, 1889. (A similar, though not so dramatic, account of the accident appeared in the 'Cosmos').

Hence Dr. Adams decided upon *testing* his vulcanizer *frequently* with a heavy hammer, which would be certain to knock a hole through the weak points. But he thinks that it is still better, rather than risk one's life, to have a new vulcanizer every two years at least. This is, of course, an extravagant suggestion, which may be attributed to what appears to have been a narrow escape from serious injury. The incident, however, goes to show that care should be exercised, in the first instance, to provide one's self with a *reliable* vulcanizer, and that means should be taken, after a year or two's hard work, to have the machine tested from time to time. With a steadily working regulator-gauge, however, and the fusible plug, personal risk may be said to have disappeared.

*Gauges and Regulators.*—The thermometer as an indicator for vulcanizing purposes may almost be said to be entirely superseded by the pressure gauge; and of the latter, such as are provided with self-regulating powers are to be preferred, without doubt. The gas-regulating gauges are all of them adaptations of the Bourdon system, which is an application of the fact that steam entering a circularly-formed tube, as the pressure increases, tends to straighten the tube. So that it will be at once perceived that if the tube is fixed at the end where the steam enters, and left free at the other, it is only necessary to attach a lever to the free end, which will automatically control the supply of gas.

The accompanying illustration, which has been kindly furnished by Mr. Walker, will very clearly illustrate the action of this contrivance. It represents a horizontal section of the regulator chamber of a Walker's vulcanizer; E, in Figs. 52, 53 (pp. 58, 59). H is the gas inlet. O is where the steam from inside of boiler enters bent tube N; as pressure increases, the tube N tends to straighten itself, and thus pulls lever L —by connecting-link X—towards outlet I, by which the gas inside the larger chamber (E) passes to the burner (K).

—see Fig. 53, p. 59. When 100 lb. pressure (330° Fah.) is reached, the supply of gas is reduced and controlled, so that a uniform pressure is maintained during the process of vulcanizing.

With this regulator, the vulcanizer having been fixed and the gas turned on, the indicator goes up to vulcanizing-point (*i.e.*, 100 lb. pressure), and it *rests* there, until the gas-

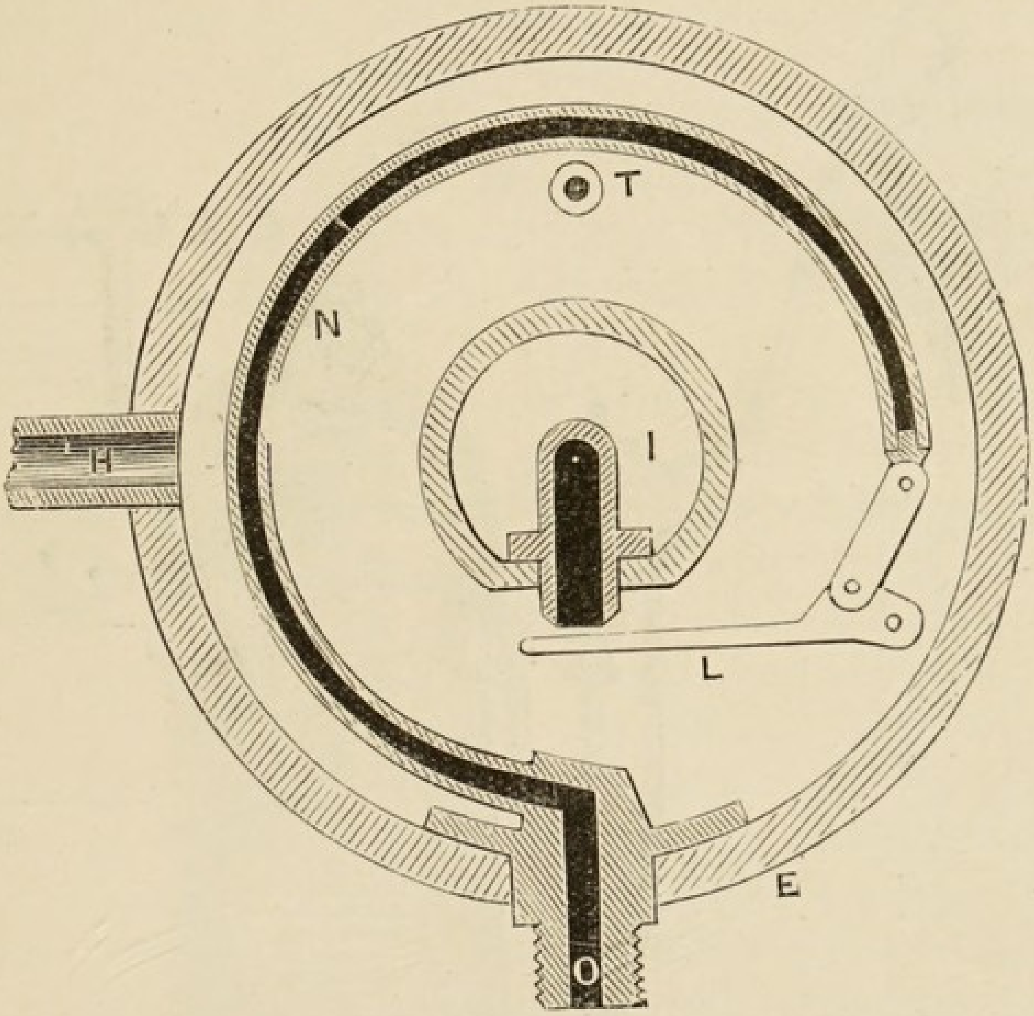



Fig. 54.

supply is stopped by the operator, when the time necessary is completed. So that with this arrangement, however anxious one may be to accelerate the vulcanizing process, that is rendered impossible—that is to say, impossible *after* vulcanizing point is reached; but if there be an excessive pressure of gas *ab initio* in raising the temperature, there is a risk with thick cases.

Then we have a form of regulator which permits the operator, by turning a joint, to set the pressure and maintain that pressure at any point he chooses, whether it be degrees below or degrees above the ordinary vulcanizing standard. Mr. Gartrell's gauge and regulator represents one of this description.

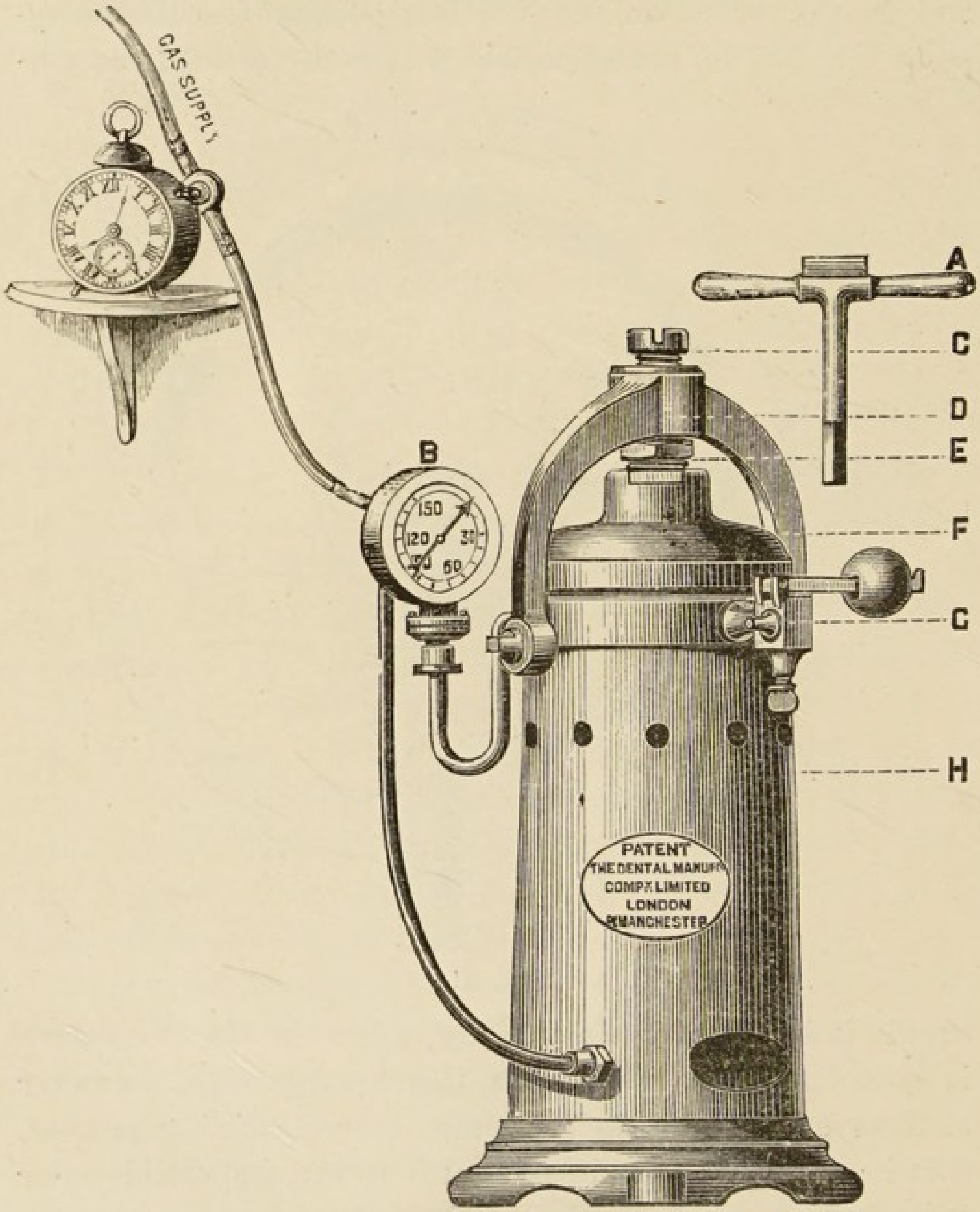



FIG. 55.

Certainly the latter kind have *one* advantage over the former. As, for instance, when vulcanizing soft rubber for obturators; in which case it is necessary to stop and maintain the temperature for a prolonged time at particular gradients. Or, in special cases, where it is permissible to accelerate the vulcanizing by raising the pressure above the regulation-point—as may be done in a certain class of repairs.* But this facility of increasing the temperature possessed by the regulators of the Gartrell type—though they may be the most recommendable to the practitioner who personally carries to a conclusion his own prosthetic work—may not be so desirable when this is done by deputy. When time is gaining upon one all too rapidly, there is a seductive influence about that joint, whose slightest turn will increase the pace of the worker.

In addition to the regulators just described, we have now further aids to exactness in the vulcanizing process. The regulator designed by Telschow of Berlin is commended by Dr. Andrieu. In this arrangement the bell or gong, when the indicator has reached its limit, is set ringing, and so attracts the attention of the person in charge. But this method has also been improved upon by Telschow and others, in providing a clock on the alarum principle, which automatically shuts off the supply of gas when the due time required for vulcanizing is completed. Dr. Andrieu, in this connection, says: 'With the Telschow regulator one can with perfect confidence leave the vulcanizer to itself, and be less apprehensive of the result, than if he had left it in the charge of the most skilful and attentive workman' ('sous la surveillance du mécanicien le plus habile').

Fig. 55 will give the reader an idea of this automatic system, connected with a vulcanizer supplied by the Dental Manufacturing Company. And for a practitioner especially,

* It is very seldom indeed that an increase of temperature is allowable—it may be so, for example, where a gold plate forms the base; but time should be saved by more legitimate means.

who undertakes his own prosthetic work, this arrangement is admirably adapted.

*The Management of Regulators.*—Where a thermometer is used as a gauge of temperature, the lowering of the supply of gas during vulcanizing does not affect it injuriously. But the machinery of the regulator being complicated, more care must necessarily be observed in working with it.

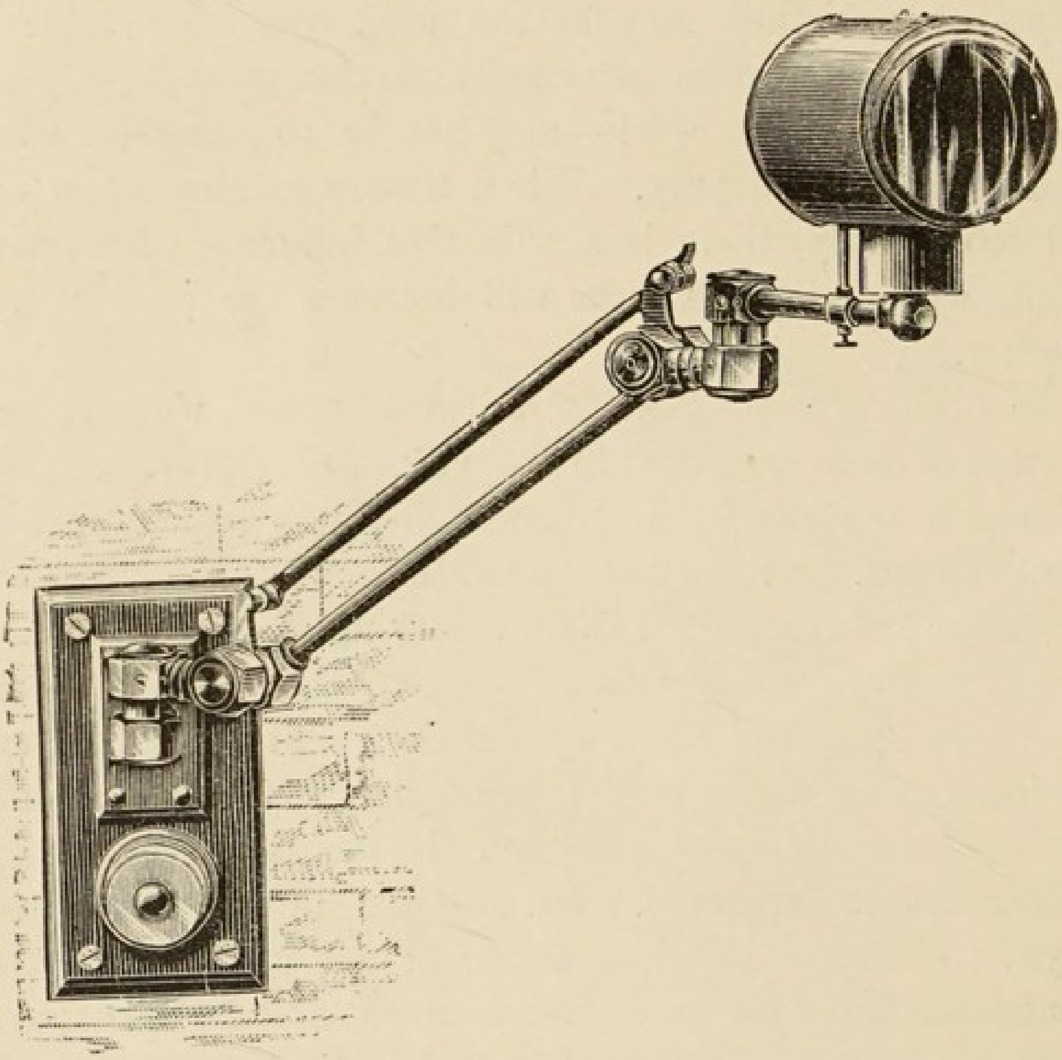


Fig. 56.

If in a given case the operator is pressed for time, there can be no possible objection to lighting the vulcanizer—with any regulator—and having it heated to boiling-point by the time the flask is packed and ready for insertion. But *before* fixing the lid and escape-valve, the supply of gas should be modulated to what is required for bringing up the temperature to vulcanizing-point. The supply of gas being thus adjusted before the vulcanizer is closed, the gas-supply should not afterwards be interfered with. It is from the violating of this rule that the regulators so often get out of order and cause so much annoyance.* In addi-

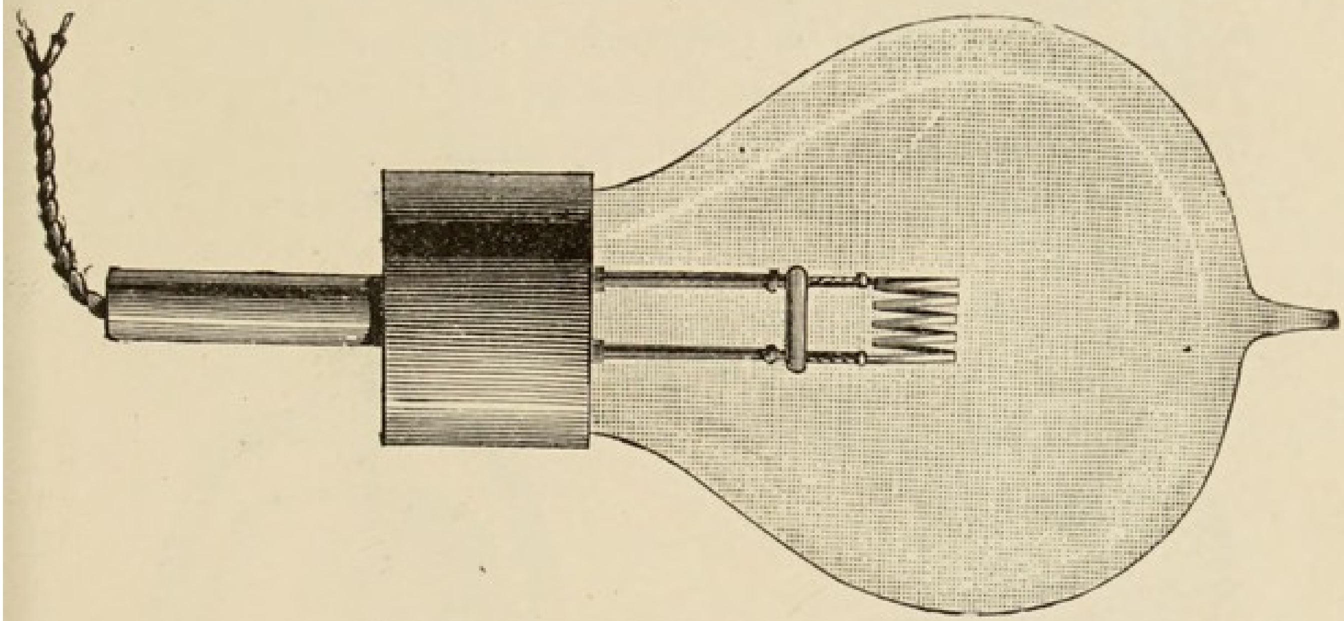


FIG. 57.

tion to this precaution, it is important to clear the flask, after it is filled with plaster, of all superfluous material that has flowed over its outer walls; this, if left on the

* The following instructions given in the catalogue of the Dental Manufacturing Company, in connection with a regulator similar to Mr. Gartrell's, corroborate what has been said above, and insist upon the necessity of careful management: 'In using a gauge for the first time with an old vulcanizer, it is desirable to set it at 80 lb., and then, whilst watching the thermometer, turn the gauge hand forward 5 lb. or less at a time, until that point is reached on the thermometer at which it has been customary to vulcanize; when once the desired steam-pressure is determined, the thermometer may be dispensed with if so desired. On no account must the gauge hand be turned back against the pressure of steam. If by accident it has been turned too far forward, and, therefore, too great heat obtained, turn out the gas, and allow the steam-pressure to subside to the extent required, *then* the gauge hand may be turned back to the point at which the dial hand stands (*but no farther*) and the gas again lighted.' It may perhaps be allowed to *increase* the supply of gas after closing a vulcanizer with regulating machinery, but for our part the method described above we would make obligatory.

flask, may in the course of vulcanizing become disengaged and projected into the tubes of the regulator, and so interfere with the precision of its acting powers.

Lastly, after the process is completed, the chamber should be freed from any water or débris remaining.*

*Flasks for Vulcanizing.*—The flasks made of gun-metal are unquestionably to be preferred to those made of iron. They last much longer than the latter, and in working with them one's hands are not so roughly soiled.

The character of flask which, according to our experience,

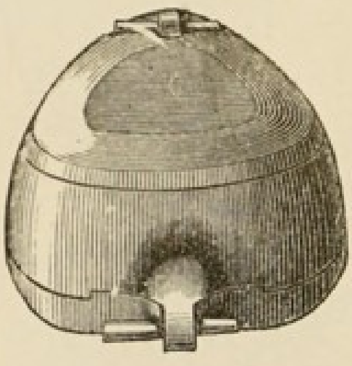


FIG. 58.

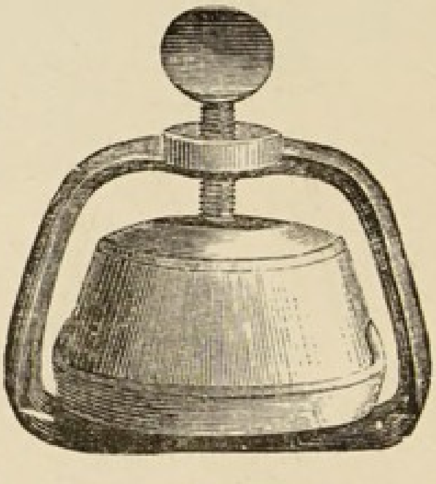


FIG. 59.

is best, is that represented in Fig. 58, or such as are fixed by a stirrup (*i.e.*, a stout metal band, between which and the flask a wedge is driven).

The old style of fastening the flask, represented in Fig. 59, should not be tolerated. The screws in a short time become inoperative ; and from the beginning they are no more effective in securing the sections of the flask than the arrangement by wedging pins, as in Fig. 58, or in the stirrup and metal wedge just referred to.

* It has been suggested to place a copper frame in the bottom of an iron vulcanizer for the flask to rest upon, as a preventive of the scaling to which they are subject. If the contrivance be in the shape of a dish, of full capacity to contain the water used for vulcanizing purposes, there may be considerable advantage derived from it.

The same objection holds good with regard to flasks fastened as those are in Figs. 60, 61.

The screws continually get out of order, and cause embarrassment and annoyance. This is a form of flask with

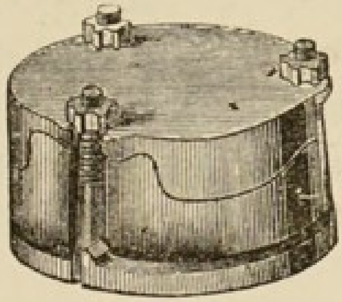


Fig. 60.

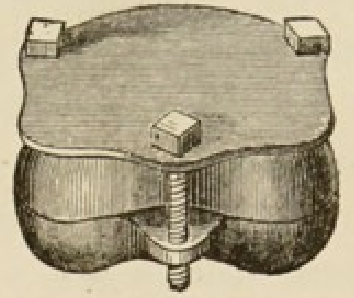


Fig. 61.

which the writer is well acquainted, and which he could not recommend.

*The Bell and Turner Flask.*—The distinguishing characteristic of this flask is that it has three chambers, instead of two, as in those which are in most common use. The original Bell and Turner flask is represented in the accompanying illustration—

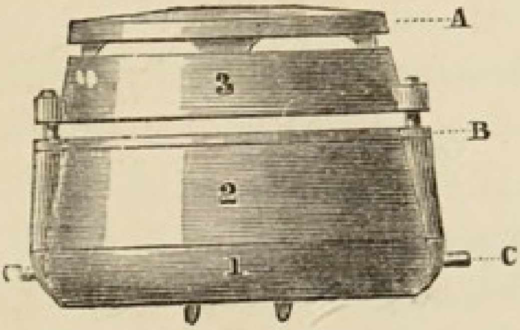



Fig. 62.

The really essential value of this form of flask is that, where the conditions are such that rubber cannot be packed from the lingual aspect of a denture to pass through and supply the contour required on the labial aspect, this three-chambered flask permits of the operation being done with complete facility.

To explain our meaning, a short account of the *modus operandi* had best be given. Suppose that we have a complete upper denture, composed of a gold base-plate with soldered teeth, and that a considerable bulk of rubber is required as a facing, while the lingual surface also, to a more or less extent, requires to be provided with a rubber coating. In such a case it is obvious that the packing can only be satisfactorily accomplished by one of two methods —either by *hand-packing*—or we must have a flask of three sections, opening in two parts, and in such manner as will give access for packing the facing rubber, and also that around the lingual surface.

Passing by, for the present, the method of hand-packing just referred to, and which, in many cases at least, can hardly be considered as quite satisfactory, a brief account may be given of the manner in which a case of the character above described is inserted in the Bell and Turner flask :

First, the palate-surface of the denture is well oiled, and the plaster being mixed, and poured carefully over this surface, the case is placed in the lowest section of the flask (C in Fig. 62), the plaster, of course, only reaching to the gum border of the denture all round, so that when the plaster is set, the denture may easily part from the model so made. It is well to part them before proceeding with the succeeding operations, and to trim off the sharp edges of plaster which form at the meeting-line. The surface having then been sufficiently lubricated, plaster is mixed and poured in ample quantity around the faces of the teeth, so that when the second section of the flask (B in same figure) is put in position, there will be a surplusage forced up to their points. Then flow the plaster over the lingual surface of the denture, leaving only the wax to be duplicated in rubber free. Having dressed and oiled these surfaces, the third section, A, is placed in position, filled in, and capped in the usual way.

It will now be seen that when the flask is in a condition for opening, a parting can be had between sections C and B, which will permit of the thorough packing of the facing rubber. And similarly a parting is given between sections B and the section marked 3, which allows of the packing of the rubber on the lingual aspect of the denture.

There are three points to be attended to in order to secure successful results with this form of flask when used with a denture of the character referred to above. First—and most important—wedge-shaped cuts should be made in the surface of the plaster of each section in whatever locality there is most space to allow of it.

To explain the reason and purpose of this as clearly as possible, we must accept the fact, so well known to all who have constructed dentures of the combination type, that in packing and closing the flask there is much risk of the soldered teeth being broken. In the opinion of some practitioners, this occurs on account of an excess of rubber having been used; and that this excess, or part of it, being forced under pressure between the teeth and their plate backs, this somehow results in the teeth being broken. But *that* can hardly be accepted as the *cause* of the misfortune. An excessive quantity of rubber may be, and probably is, an indirect cause in so far as the pressure required to close the flask under such circumstances tends to strain its articulation away from the true closure, and in a direction that will impinge upon the neighbourhood of the teeth, and *so* strain and break them. It is a fact that in most of these cases where teeth are found broken, there is a scale of rubber between the teeth and their plate backs; but it is surely certain that the bursting or breaking of the teeth has occurred first, and the inflow of rubber is *the consequence* of this, and not the *cause*.

The true cause, then, appears to be found in the closing of the flask. If the sections do not come together exactly to the respective positions in which they were cast, then, under the pressure of closing by press or vice, fracture of one or more teeth is extremely probable. Now, the joints of flasks, as is well known, become increasingly uncertain with wear; and if the usual method of leaving smooth or rounded surfaces on the plaster sections is practised, there is little resistance to the variation that the looseness of the joints allows. But if we make V-shaped cuts in the plaster of each section of the flask before filling in the succeeding section, we have then for each case a new joint and guide for the parts coming accurately together when closing.

The breadth and depth of cut is approximately represented in the sketch adjoining (Fig. 63); but the reader

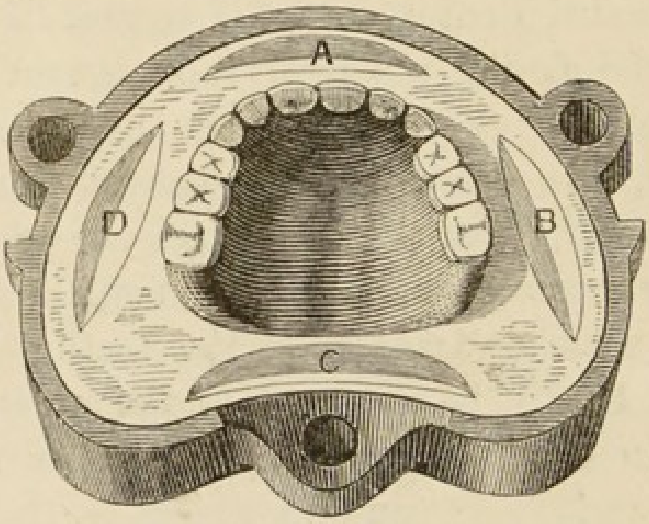



Fig. 63.

need scarcely be reminded that this, together with the length and direction of cut, depends upon the circumstances of each case. For instance, having set an upper denture with a very extensive palate-plate in the plaster of the basement section of the flask—such as is represented here—it will be seen that the cuts at A and C must be parallel to, and close to, the front and back wall of the flask, and that at D and B the cuts should be made in the direction of the parallel of the sides.

It will be at once perceived that the V- or wedge-shaped carvings in the plaster prevent a forward or backward movement of the antagonizing section of the flask; and similarly, that those at D and B serve to prevent a lateral variation.

In flaskings manipulated in this manner, and subjected to screw or vice pressure, the operator may have almost, if not *absolute* confidence that no accident in the direction of tooth fracture will take place.

Nevertheless, in cases of this kind, which are so peculiarly liable to misfortune, a further precaution where possible should be observed. In such dentures as that above referred to, there is but seldom need of the powerful force exerted by the press, for, not being *complete* rubber cases, but only a stratum or facing of rubber being required, the pressure of the hands, intensified by the weight exerted by the upper part of the body, is quite adequate to close the parts of the flask sufficiently well for this particular class of work.

The third point to observe is that, while packing in either section of the flask, the '*counter*' of that section should be affixed. While packing the facing, for instance, in C (Fig. 62), B must be adjusted as counter, and similarly, in packing from the *lingual* aspect, the part A, 3 must be placed in position. The reason is obvious. The teeth being soldered and embedded in plaster, the leverage consequent to the packing process subjects them to a strain that is dangerous to them. The counter, of course, resists the strain.

The *modus operandi* above described, though it may appear tedious to the reader, is, after a little experience, expeditious and *safe*.

The alternative method of packing dentures of this construction is by hand-pressure and contouring. This system was, we believe, first brought into notice by Mr. Williams, and further developed by Mr. Balkwill, in whose work on 'Mechanical Dentistry' a detailed account of the process will be found. There is this to be said in favour of the latter method, viz., that danger of the fracture of the teeth is entirely escaped, and, where the circumstances are suitable, the results otherwise are satisfactory.

It comes to this, that the operator should be well acquainted with both methods, and use his judgment as to which is most appropriate to the particular denture in course of construction.

The reader, bearing in mind the description given above of these wedge- or V-shaped cuts in the plaster-surface, will perceive that their value is not confined to such dentures as combine soldered teeth with rubber.

Take, for instance, a complete lower rubber case. From the conformation in many, if not in most, of these cases, it is most inconvenient to pack the rubber from *behind ;* that is to say, with the plaster of the bottom section of the flask coming over and enclosing the teeth. On the other hand, if we insert the model according to the old method, having the model fixed in the lower section, and the teeth in the upper section (in which the packing is done), there is a risk, and, we may almost say, a certainty, that the articulation and position of the teeth will be altered, on account of the 'veering' of the joints of the flask under pressure. But by making the V-shaped cuts we may then, by packing in this manner, have confidence in the result. The value of this method, as must be apparent, is, that in every case we have a new and exactly-articulating joint every time of flasking.

*Rubbers.*—Of the many varieties of rubber material supplied by the different manufacturers, it would be not only invidious, but presumptuous, to say dogmatically that this or that one is the best. Assuming that the rubber is obtained from a reputable firm, we may take it that if the instructions appropriate to it are faithfully carried out, the rubber will prove to be trustworthy. But a few observations suggested by experience may not be without some interest.

*Whalebone Rubber.*—This—as it is supplied by the American and English manufacturers—is a favourite rubber for prosthetic purposes. And, as remarked above, the American material may equal, if not excel, that of English manufacture. But there is this to be observed of the former (American whalebone), that the laminæ of cloth between the sheets of rubber are of so rough a material that much of it adheres to the rubber, and becomes incorporated in packing. The baneful results of this must be familiar to all who have used it. The cotton stuff becoming intermingled with the rubber under pressure, when the case is vulcanized, and is in the process of finishing, we find that frequently the file or graver carries away a flake of the rubber of more or less bulk, and perhaps consequence. There can be no doubt that this is occasioned by the interference of the remnants of the cloth material with the homogeneity of the mass of rubber. Even with those of English manufacture, where much finer cloth is used as a separating medium, there is a film left on the rubber on separating the sheets; but it is not nearly so pronounced as with the American.

This drawback, however, with all of these rubbers, can be guarded against by placing the sheet with its covering of cloth in hot water for a few seconds, when the cloth will part from the rubber without leaving any appreciable trace behind.

There is a rubber supplied which has this property, that when packed on a *hot mould* it can be used as it comes from the box; that is to say, it is unnecessary to heat the rubber on the hot-water plate; indeed, according to the instructions, that is to be *avoided.* It is certainly a good rubber. But the necessity of leaving the material on the hot mould until it has become sufficiently plastic for the packing process is somewhat inconvenient.

*Rubber-heater.*—The most common form of heater is represented in Fig. 64. But where a more than ordinary amount of vulcanite work is done, a plate of much larger dimensions is necessary, in order that the packing of two or more cases may be proceeded with simultaneously. A tray or plate of this description requires that a bench, or

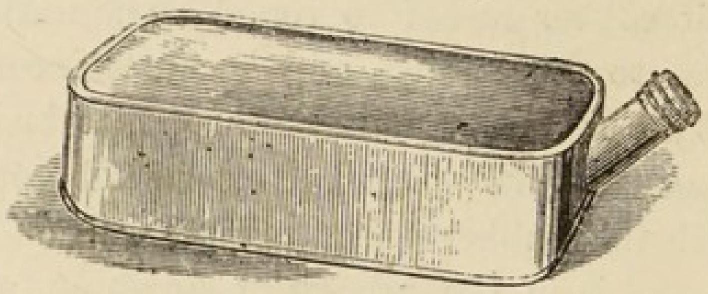


FIG. 64.

particular portion of a bench, be set apart for its permanent accommodation, the outline of the tray being cut clear through the bench. Sheet-iron ledges are fixed around the inferior borders of the space, so as to form a frame in which the tray shall rest securely. Underneath, in an appropriate position, a bracket or shelf is provided for a rose burner, which maintains the requisite heat.

Recurring to the heaters, however, which are in general use a few remarks may be submitted as suggestions for their improvement. First, the material of which they are ordinarily made is non-lasting, and is, therefore, the cause of much inconvenience when the inevitable leakage takes place during the packing process.

For this reason copper is to be recommended for the bottom and sides, and block-tin for the plate. Such a heating-pan, properly constructed, will last an indefinite length of time.

Second, if the tray does not rest on a stable support, much annoyance is occasioned while packing. A very common support for this heater is one or other of the frame bunsen burners supplied by Mr. Fletcher; but there is much unsteadiness of the plate while removing the rubber, and a constantly recurring risk of upsetting the pan and flooding the bench with water. To obviate this there are several remedies which must be apparent to the reader. The most convenient and satisfactory, perhaps, is to have, soldered to the four corners of the under surface, metal legs of sufficient length to admit easily the bunsen burner to be used. This is very simply done by using copper-tubing of about a quarter of an inch diameter, flattening both ends to the extent of about three-quarters of an inch, and bending the flattened ends in opposite directions and at right angles, so that one of the flattened ends may be securely soldered to the four corners of the bottom of the pan, while the other ends rest on the bench.

*Rubber Packing.*—The operator should make it an absolute rule and habit, never to have a greater quantity of rubber on the heater than what is required for the case immediately in hand. Where the plan of measuring the quantity of rubber by displacement in water of the waxed-up case is adopted, the amount required will be very closely approached.* This system, on account of its seeming tediousness, is, however, not perhaps in very general use. If such is the case, then the full estimated quantity of rubber should not be placed on the hot plate *ab initio*, but, having cut the rubber to appropriate dimensions, reserve a third part of it on the interspacing cloth of the box, to be supplied to the heater as the packing proceeds. By crowding the hot plate with rubber in the beginning, there is not alone a waste of material, but when half through with the packing the rubber has become inconveniently

* In complete sets especially, the above is unquestionably, we think, a system that should be practised. It consists simply of placing the case (when fully prepared for the flask) in a suitable glass, with a sufficiency of water to freely cover the denture when it is inserted. We have then only to mark, with colour for instance, the level of the water with the case submerged. On carefully removing the latter, it is then only necessary to submerge rubber until the marked level is reached.

adherent to the plate, and probably lost condition; added to this is the difficulty of clearing the surface of this unused and unusable material.

*Press for Flask-closing.*—Though a strong and well-fixed bench vice—commonly used for filing zinc casts and other heavy work—may be also employed with success for the purpose of closing flasks after being packed with rubber, the more suitable appliance for the purpose is certainly the press represented in the accompanying figure.

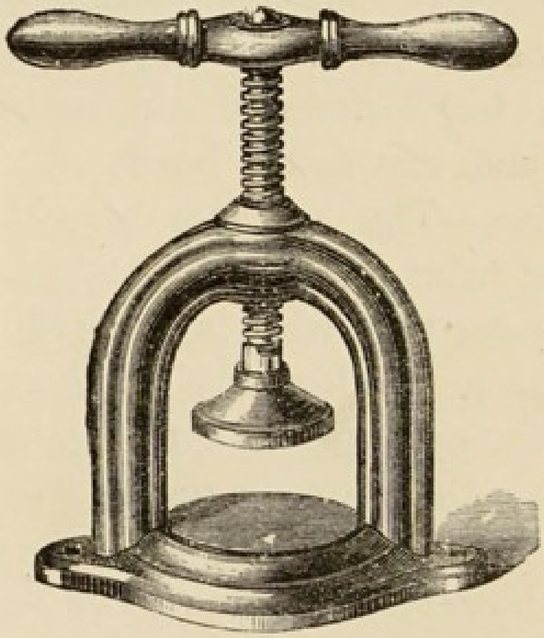


Fig. 65.

It is not *absolutely essential* where there is a vice of the kind just referred to, but it is undoubtedly a desirable addition to the appointments of the laboratory. The locality in which the press is fixed will, as a matter of course, be well considered with respect to convenience and surroundings.

## CHAPTER VI.

### LABORATORY ECONOMY.

TAKING it in a general sense, the economy of laboratory practice may be said to consist in the judicious expenditure of time, energy, and money. There should be no more time expended upon a case than what is necessary to produce the best results, and no more demands be made on the physical or mental powers than what is the natural share of the individual operator. The third condition, the money consideration, is, of course, involved in the two preceding; but more directly it may be referred to unnecessary waste, both upon materials in use and upon novelties which are worthless.

*Apportioning Time.*—The importance in every dental practice of giving acute attention to exactness in keeping appointments will be at once admitted; but unfortunately this rule is too often more honoured in the breach than in the observance.

It is true, that from the character of our work accidental circumstances are peculiarly liable to arise, and so disturb the arrangements of the most punctual. But there is also much confusion caused by a careless or too sanguine estimate of the time which is required for the accomplishment of the work. The familiar illustration that four omnibuses could not be expected to go abreast through

Temple Bar is one that is peculiarly applicable to the routine of dental laboratory operations. And whether it be the fault of the practitioner himself who overcrowds his appointments, or the assistant who over-estimates his capacity, the inevitable result must be confusion and disappointment. In attempting to accomplish too much, we have failure all along the line.

Three essential points are to be considered in order to determine when a specific case may reasonably be expected to be completed. First, there is to be taken into account the actual capacity and speed of the operator. Second, we have to well consider the *character* of the work to be done. No matter whether plate or rubber be used as base, there are varying conditions in each case which must necessarily control the length of time required for its accomplishment. In the third place, there must be a full appreciation of the length of time required to complete the work on hand, before deciding upon an hour for the return of the patient whose impression has just been taken. And, further, there is to be taken into account the contingency of repair cases intervening.

The true principle to go upon is—grasping all the existing and probable conditions—to give a margin of time *beyond* what may be really required, so that the case shall wait for the patient, and not the patient for the case.

It should be remembered that mis-timing work is not alone a cause of loss and worry to the dentist; but may occasion a considerable mishap, and must always be a source of annoyance to his client. These observations indicate in a general sense a sound basis for the punctual meeting of appointments, and the consequent result of a smooth and unfretful course of laboratory operations.

Coming to particulars, however, we have to consider what is a fair time for the accomplishment of specific cases. This necessarily is a question which can only be answered with an *approach* to accuracy. In a subsequent chapter an opinion will be given from individual experience of what may perhaps be regarded as a reasonable time for certain classes of work. Here, it is enough to state generally, as already has been done more especially, the conditions which must regulate appointments. To put these conditions succinctly, we may state them thus in order. First—the speed of the operator. Second—the number of cases on hand, and their comparative urgency. Third—the possibility of accidents.

But while the necessity of giving a full measure of time for all cases on hand, in view of the surrounding circumstances, must be insisted upon, it is necessary to guard against *dalliance* over work. *Waste* of time, it should be the ambition of everyone, as it is also a duty, to avoid. And no matter how long may be the period allowed for any given case, or cases, the trifler will usually fail to keep his appointments.

*Orderliness in the Laboratory.*—A very considerable, if not the chief cause, of this frittering away of time, is to be found in the want of the habit of orderliness in the arrangements of the laboratory appliances and materials. It is a trite saying in connection with this point, 'There should be a place for everything, and everything should be in its place.' But like many other maxims and rules of conduct which are so obviously just and true, this one also is not always sufficiently put in *practice*. Yet if one only reflected for a moment upon the importance, the *particular* importance, of order and system in the dental laboratory, it must compel attention. Pliers, or other tools, are left promiscuously about, and time is wasted in discovering their whereabouts. Again, an essential tooth, or teeth, may similarly be misplaced, and perhaps not recovered at all, or only found when it is too late for them to be made available. Further, with regard to materials in general use, how much inconvenience is caused by finding, just when most urgently required, that the supply is exhausted; and that at a time, possibly, when the depot is closed!

Hence the necessity that order and method should from the first be inculcated by the instructor, and the importance of it fully realized, and determinedly practised by the pupil. It is the *first* step which costs trouble; after that it is as easy to be orderly as not; and the profit arising from the outlay is great—not alone in money—but in the saving of the individual from unnecessary mental worry, and even bodily fatigue.

As previously stated, the system of having pliers, shears, files, etc., placed in a rack rather than in a drawer is, where practicable, the one to be preferred. Each implement should have its individual and invariable place in the rack, and thus, instinctively, the operator is enabled to at once lay hold of that which he desires.

While work is being proceeded with which requires the repeated use of certain tools, these will of course remain on the bench during the progress of that part of the case; for it would be carrying an excellent principle to the verge of absurdity to replace tools which we well know will be required a moment afterwards. But when this particular phase of the work is completed, all the tools pertaining to it, and now not required, should be at once restored to their locations on the rack. Much confusion, and consequent loss of time, is occasioned by having the bench strewed with what is not in actual or immediate demand.

*Keeping Gravers, Drills, etc., in Condition.*—All instruments (it goes without saying) should be kept in an efficient working condition. To have a generous supply of all implements in common use is a *sine quâ non* in a well-regulated practice. And especially is this to be insisted upon with regard to gravers, drills and files. But the fullest provision in this respect is of little or no advantage if they are not kept in good working condition. One graver or drill, maintained consistently in fit form and sharpness, is more welcome in an emergency than a dozen that are in a state of neglect. This the reader of course knows well; but the method and habit of having these tools in fit condition must be taught to the pupil, and its fulfilment insisted upon.

If the sculptor or graver is intended for vulcanite work, the angle of the facet should be considerable; if for cutting gold, the angle should be less acute.

On a previous page (p. 45) the necessity for cleansing thoroughly the oil-stone from remaining oil after using has been explained, and also the manner of sharpening these edge tools. But as this latter process is more difficult to accomplish efficiently than at first sight appears, the practitioner who has pupils under his care should well instruct them in this direction; and assuming that in the earlier stages of training the pupil is made responsible for this and other kinds of work of a drudgery nature (as he ought to be, and that for his own interest), the instructor should permit no implement to be placed in the rack which is not in a fit condition for work.

*Duplicating Implements and Materials.*—The value of the system of having duplicates, or reserves, of all appliances and materials essential to laboratory work must at once be appreciated, being, as it is, a very considerable factor in the saving of time and the prevention of unnecessary worry and annoyance. If a lathe-band gives way, it is not *then* the time to send to the depot for a new one. The reserve band, accurately adjusted, should be on hand for immediate application. If a vulcanizer gets out of order, it is surely a great advantage to have a second one capable of being brought at once into action. And so with many other appliances used in the laboratory, as, for instance, the iron pots or ladles employed for zinc and lead melting. When these break down, as they often do unexpectedly, it may cause extreme inconvenience if a new one is not held in reserve.

And a hundred and one other causes of obstruction in the progress of work can be avoided by the system of duplicating, as it may be termed. To take plaster-of-Paris, for instance, which is the material in most common use in the laboratory. It is usually supplied in bags or boxes of a half-stone or a stone weight (that is, where the dentist is in the neighbourhood of a depot). Now, at the commencement, let *two* of these be on hand. Then when the first is exhausted, an additional one must at once be obtained to form the reserve. So also with the supply of rubber, of plate, of *everything* that is essential, in order that when one is used up there is another ready to hand, the place of the last being promptly filled by the further reserve.

*Lemel and Laboratory Dust.*—With regard to lemel, *i.e.*, the scraps and filings from gold, the most economical system is (if the laboratory is not fully provided for smelting purposes) to collect the material and send it to a trustworthy refiner, who will return its value in the form desired.

The bench and floor sweep of the laboratory—where there is much gold work done—should be kept separately in boxes, that for the bench-dust being, of course, proportionately smaller than the other. It is well, however, to remind the reader that the cheque returned by the smelter only represents a fraction of the inherent value, and necessarily so on account of the labour connected with its recovery. Hence a haphazard method of cutting gold, by which pieces are sent flying about the laboratory, is to be guarded against; for a scrap in the tray is of much more value than a scrap in the sweep.

It has already been stated that it is of advantage, where there is a large amount of gold work, to have a hand-basin particularly reserved for the washing of such cases.

The discharge-pipe from the basin may lead directly to a large jar underneath, or to a much more capacious reservoir or barrel placed outside the laboratory walls. In the former case one will naturally be extremely economical in supplying water to the basin, so that the jar shall not too rapidly become filled. When it is filled, the gold having gravitated to the bottom, the greater part of the water can be poured off, and the jar used as before, and so on, until it is desired to recover the gold. The other system, viz., that of having a reservoir outside of the laboratory walls, is surely carrying the principle of economy, as it concerns dental practice, too far—in fact, to the other extreme, which practically results in waste going by a different way.

# CHAPTER VII.

## LABORATORY PRACTICE AND MANIPULATION.

To become acquainted with the theory and practical accomplishment of the various types of dentures, so far as book-learning can assist, the student will, of course, consult the standard works on prosthetic dentistry. But, outside what is treated of in the text-books, there are some matters which may fittingly be considered here.

First, in regard to the teeth used in laboratory work, they are of American or English manufacture. No serious attempt appears to have been made in any other countries to produce artificial teeth which could rival the English and American standard of the present day. It is probable, however, that in the manufacture of porcelain teeth originally the French showed the way.

*American Teeth.*—There can be no question about these being *generally* the nearest approach to the natural teeth in shade and life-like appearance, and the practitioner will therefore be well advised, we venture to say, who keeps a liberal stock of them. On the other hand, the superficial glaze which gives these teeth their very natural appearance forbids any touch of the corundum-wheel upon their surface; so that shaping a tooth to particular conditions, as is frequently required, becomes an impossibility, without removing all that makes it valuable.

*English Teeth.*—Those of English manufacture have this advantage: they may be shaped by the corundum-wheel, and polished again up to their original appearance.* And though, as already remarked, the American teeth are, generally speaking, the nearest approach to the natural ones in aspect, especially in partial cases, the English teeth, even in this respect, will frequently be found the most suitable.

Hence, one should be provided with an ample stock from the manufacturers of repute of both countries, particularly if one is not in the immediate neighbourhood of a well-furnished depot.†

*Flat Teeth.*—Of the three classes of teeth — flats, vulcanites, and tubes — the first named greatly preponderate in general practice. And that is so from the fact that they are adapted for both plate and vulcanite work. The teeth especially made for rubber dentures—that is, those with the buttress on the lingual aspect, representing the natural contour of the incisors—are becoming less used than formerly, and that not without reason. The mineral shelf of the *vulcanite* incisor tooth is apt to get battered in use, and so leaves a rugged surface for the tongue. This is a matter of common experience, and must be a cause of annoyance to the patient when it occurs. With flat teeth, on the other hand, the natural contour is given in rubber, which wears better.

But a further advantage consists in the fact stated above, viz., that the flat teeth are immediately available for either

* To do this satisfactorily, after being shaped at the lathe (finally with a very smooth corundum-wheel), a fine corundum-file should be used over the ground surface, followed by water of Ayr stone; then a wood wheel running on the lathe supplied with pumice, and lastly with whiting, will complete the process.

† The system of having teeth from the manufacturers on approbation is a convenient one, for at each term—three months or six months, as may be agreed to—only such as have been used are charged for, and that number again replenished. The price is necessarily a little more than for teeth purchased right off.

plate or rubber work. On the other hand, if the stock is largely made up of vulcanite teeth, it may happen that a set of these is the nearest in shade to the natural ones, in which case the cutting of the shelf to form a flat back to the tooth is usually necessary, and this can only be done with difficulty and at the risk of weakening the pins; while with the greatest care the resulting surface is more or less unsatisfactory. These remarks apply but little, if at all, to lower dentures, which are, in the great majority of cases, made in rubber; and even when not made entirely in rubber, the teeth are nearly always vulcanized to the plate. Besides this, from the manner of articulation, the lingual shelf of these teeth (the vulcanites), is not subjected to the force which is exerted upon the upper ones in the act of closing the jaws. So that, except in practices where a particular class of work is the almost invariable rule, it is best that the stock, as regards upper teeth, should be composed chiefly of flats; but in the supply of lowers the vulcanites should preponderate.

*On fitting Teeth, Flat or Vulcanite.*—Care must be taken not to grind the base of the tooth—the part resting upon the plate or gum—so freely that the platina pins shall become exposed, or even nearly exposed. In many mineral teeth the pins are inserted too near the base; so that, in order to reduce the length of the tooth to what is required, so much is taken from this part that the necessary material for strength is removed, and the tooth is certain to give way under the slightest strain. Such teeth, therefore, should not be chosen for a 'short' case, unless no others can be found to harmonize so well with the natural ones in shade and form. But if on this account they must be used, the operator should proceed with the fitting only so far as is consistent with the strength of the tooth. When that point has been reached, any required shortening of the length ought to be effected at the cutting edge.

Again, we will suppose that a narrow space is to be fitted with an artificial tooth ; it is then advisable, and in very narrow spaces absolutely necessary, to select teeth which have the platina pins placed perpendicularly, not laterally ; that is to say, not in line with the cutting edge, but in a line centrally perpendicular from the cutting edge to the base. Otherwise, so much of the mineral body is ground from the sides of such teeth that they are deprived of requisite strength by the more or less denuding of the pins.*

*Backing Flat Teeth.*—It should be the rule in doing this work to leave the plate the full width of the tooth, and reaching to about one-eighth of an inch of the cutting edge. The advantage of a backing of this liberal extent is apparent when an accident occurs. For instance, if the original tooth had pins a short distance apart, and the plate was reduced at the sides to conform to them, the chances are *against* finding another with pins so placed as to give sufficient strength in the plate-back for riveting. There is therefore the necessity of putting the case through the soldering process, with all its risks and extra expenditure of time. Whereas, if there had been a gold back the full width of the tooth, a new one could have been riveted in a few minutes with no risk whatever, and that so securely (if properly done) as to equal in stability and staying power a soldered tooth.†

*Tube Teeth.*—These are now but seldom used, and it is perhaps to be regretted that such is the case, and that the exigencies of modern practice have crushed this class of work so far out of the field, for there is much to be said in its favour. In certain partial cases, for instance, tube teeth most fittingly supply the places of those that have

* Such narrow teeth—if carefully fitted, so as to make them overlap the contiguous natural ones—often serve as most efficient fasteners, thus dispensing with plate or wire clasps.

† See page 104 on Riveting.

been lost, and give greater comfort to the wearer. The dentures of former days, which, in a complete set, consisted of a gold plate with tube teeth right around the arch, may probably be considered in the present time as in practice extinct. A form of denture which is still in favour, however, is that in which the incisor teeth are soldered flat-backs, accompanied by tube bicuspids and molars. But the most common principle now adopted in complete cases where there is a gold base plate, is to solder attachments to the plate and vulcanize the teeth to it in the usual manner, having made up the contour with wax to suit the conditions. And this, in the majority of cases, is not only an expeditious, but also a most satisfactory, class of work, *if the attachments to the plate are judiciously fixed.* There are, however, cases which require exceptional strength, and for such the following method undoubtedly has much to recommend it.

Supposing that we have to supply a complete set of teeth, upper and lower, and that spiral springs are necessary, also that the upper denture has a gold plate for the base. Then the six front teeth are soldered to the plate; while the bicuspids and molars are tube teeth with pins soldered in position. In such a case rubber is necessarily required, if only to provide a protection to the cheek against the action of the springs (plumpers, as these rubber buttresses are termed). These rubber additions being therefore necessary, we can at the same time surround the tube teeth, and, if advisable, the lingual surface of the incisor teeth, with rubber. In this class of work it will be seen that fine fitting of the tube teeth is unnecessary. What is required is this: to shape the lingual semicircle of the tube teeth to the form represented in the skeleton jaw, even intensifying the smaller circumference between the crown and the roots; then, with a very thin corundum-wheel, make a cut around the lingual aspect as shaped. Wax is then moulded around to produce a natural and comfortable contour.

Dentures made on this principle secure excellent results, both with respect to strength and comfort. The drawbacks are the extra expenditure of time required, and, further, the possibility of the soldered teeth giving way in the process of packing and closing the flask. With respect to the latter of these objections, however, viz., the breaking of the soldered teeth, this may be avoided almost with certainty by adopting the method which is described in another page.

*Duplicating Dentures.*—There is a natural disinclination on the part of the practitioner to urge upon his patient the desirability of having a *second* case, on the ground that the suggestion may appear to be dictated by self-interest rather than benevolence. Yet it cannot be doubted that, to persons possessed of fair means and reasonably susceptible to the effects of appearance and comfort, a duplicate denture is a most desirable acquisition.

There are two methods by which a duplicate may be produced. Supposing that the case is a complete upper and lower set in vulcanite. The first set is arranged in the usual manner, and adjusted, if necessary, when trying in. Being satisfied with the expression, articulation and fit, the lower set is then placed upon its model, and a wax (or other) plate is made for the upper, exactly reaching the dimensions of that first set up. Teeth are then mounted on it to articulate with lower *number one ;* the shade, shape and length of the teeth being as far as possible a faithful copy of upper set number one. The first lower is then removed from its model, and a new one mounted to upper number two, in the same manner making *it* a copy of its predecessor. Having accomplished this, we then interchange the sets on the models; that is to say, we fraternize the first upper with the second lower, and the second upper with the first lower. By this means we obtain cases that are readily transposed, instead of *complete sets* that must be worn separately. It is well known that even in those duplicated in the most exact manner possible, the patient adopts one as the favourite, so that if an accident should occur to the upper or the lower, it is of advantage that the antagonizing one, uninjured and comfortable, may be used conveniently with the duplicate of the one injured, while the repairing process upon the latter is being accomplished. That is one method of duplicating cases. The other is on an altogether different principle, and, where the circumstances permit of it, is surely the one to be preferred.

In the process just described it is evident that the one set cannot leave the laboratory until the other is completed. This in itself is an objection which must be at once perceived, especially by those employing few assistants, and in practices subject very much to a flowing and ebbing tide of work. But, besides this, it is at the best far from perfect.

In the process of duplicating now about to be described, the circumstances, as already stated, are different. The first set is finished, and we will assume that it has been worn for a sufficient time to satisfy both patient and dentist of its efficiency. Then we proceed as follows: First, the patient must surrender the completed set for a certain time (about an hour) for use in the laboratory. If the case has spiral springs, let them be detached entirely; then make a perpendicular, wedge-shaped cut on the outer wall of the model, about the position of the first molar, and a similar one at the first bicuspid; join these by a cross-cut of a like kind, and we have something like an H figure carved on the face of the model. The other side of the model is, of course, treated in the same manner, and, in addition, we have to make similar cuts between lateral and canine on each side. Now place the case on the model, and oil the entire front, both teeth and model (the latter thoroughly), then mix plaster, flow it around the faces and spaces of the teeth, and into the cuts on the model, and, as it thickens, build up over all a sufficiently strong wall of plaster; and immediately upon having shaped this, pass a knife-blade or spatula in a perpendicular line through the still unset plaster, between the canines and first bicuspids. The facing-plaster being set, and its superior border and the teeth smeared with oil or other substance, it is then necessary to take an overcast mould, which will give an exact representation of the cutting and abrading surfaces of the teeth. Thus we have, in so far as the length, position and articulation of the teeth is concerned, as nearly as possible an infallible guide for the reproduction of a set that will be a duplicate. The facing-blocks of plaster give the true position of the teeth, and the overlapping cast gives their length, and superficies of the bicuspids and molars.

What has just been described, however, concerns only the duplicating of the *teeth.* The duplicating of the palate *base* is, in rubber at least, a more difficult matter; fortunately, it is a consideration of minor importance, and in rubber cases, with ordinary care, and free use of the calipers (Fig. 43), we are able to go sufficiently near the original.

This method of duplicating is not alone applicable to original dentures, as the reader will readily perceive; for in the event of certain classes of repairs being required to be done, the same principle, put into practice, will give the most satisfactory results.†

* In duplicating rubber cases, the method which will produce the most perfect results is that in which the trying-in plates are made of rolled pewter the thickness of modelling wax.

† See also p. 152.

# CHAPTER VIII.

## ALTERING AND REPAIRING DENTURES.

To this subject there is but little space given in the text-books. Yet the manner of effecting alterations and repairs in dentures must necessarily be of interest to the pupil and young practitioner, and so may profitably occupy a few pages. For it will be conceded, we think, that—though after a three or four years' training in the laboratory under a competent instructor, a young man may then be able to construct dentures *ab initio*, and complete them with fair celerity and success—a more considerable experience is necessary, and not a little originality of mind, to effect many cases of repair in a proper manner.

*Vulcanite Repairs.*—A very common occurrence, as we all know, is the fracture of a vulcanite upper or lower denture. Now, this may be pure accident, such as letting the case fall to the ground, or the fracture may, though indirectly, yet chiefly, be caused by a badly-fitting denture. The latter may have been an excellent fit when first inserted, but subsequently, when absorption had taken place and so left the outer ridge without support, the centre line of the palate then became a fulcrum, and the opposing teeth the force which effected the fracture.*

We will consider first those cases which are the result of

* It is assumed above, of course, that the denture is suitable for a rubber base, and that the material has been carefully fired.

pure accident. Suppose that we have an upper suction case broken in two, and having a clean break. The parts within some distance of the line of fracture should have spirits of wine applied to them, with the object of removing the film which is found on the vulcanite surface. When rubbed dry, carefully scrape with a graver the lingual surface of the vulcanite in parallel lines to the line of fracture, but on no account let the immediate edges of the fractured parts be touched. We then, with the greatest possible accuracy, hold the denture in position with the fingers of the left hand, while we drop hard wax well over the joint, and in sufficient bulk to *hold*, with our right. Retain the case steadily in position until the wax is perfectly set. Then lightly oil the palatal surface of the vulcanite, and make a plaster model, exercising every care to have the plaster run solidly over the surface and into every crevice. To effect this it is well to use a camel's-hair pencil.* The next operation, after having disengaged the denture from the model, is—as generally practised—to make dovetailed cuts well into the vulcanite on each side of the fracture, filing also the parallel walls of the fracture to an extent sufficient to permit a line of new rubber along its course. The denture being then placed in position on the model, and the spaces filled with wax, the subsequent proceedings are too familiar to require description.

Such, then, is the usual method of repairing a fractured case where there is no original model to fall back upon, and where it is impossible or undesirable to obtain a new impression of the jaw. But it is well known that repeated vulcanizings render the rubber exceedingly brittle; hence this method, which leaves the larger portion of the palate subject to a second firing, is not to be commended in a large number of instances. Where, for example, the vul-

* A point to be especially insisted upon in flasking without a model.

canite plate is thin, or has been through the vulcanizer more than once, the following procedure is decidedly preferable :

Having obtained the model as above described, with the fretsaw cut out the whole of the palate ; that is to say, commence with the saw at one heel of the plate ; work it round semicircularly behind the molars, bicuspids and incisors to the heel opposite. In doing this it is not necessary or advisable to take a line in very close proximity to the pins of the teeth. The line to be chosen is that in which the *palate* portion of the plate blends with the pronounced thickness behind the teeth. This having been done, it will be seen that we have now the teeth in a saddle-shaped block or blocks of vulcanite, according to the character of the accident. We have also the palate portion of the denture, which will be utilized presently. The blocks containing the teeth are filed dovetail-wise, so as to give a sufficient hold for the new rubber ; and if appearance is of consequence, slope the vulcanite up towards the mineral in such manner that when the case is finished no mark of joining will be observable. Having got so far, then place the block (or blocks) accurately in position on the model, and fasten with wax run around the labial border. Now place the palate, previously removed by the saw, in position also on the model. The reader at once observes that all that is now required is to fill in the interspaces with wax, and flask in the ordinary way. The flask having been opened, and the usual boiling-out process gone through, the old palate has then of course served its purpose, and is cast aside. We are now able to supply an entirely new palate of exactly the dimensions of that to which the patient has been accustomed. It will be observed that this method may be adapted with advantage also to partial cases. These are usually thin plates, and if once broken, the palate-rubber should not be subjected to a second vulcanizing.

Either the case should be completely reset, or, in the manner just described, a new palate-plate should be grafted. When casting the plaster model for many of those repairs which have teeth fitting the gum, it is well to allow the plaster to rise around their face to the extent of a third of the length of the teeth. We then have a sure socket to return them to, whichever method of repairing is adopted.

The guiding principle for the operator should be to secure every possible aid to accurate reproduction, and, therefore, he will frequently find that in what we may term radical repairs more elaborate provisions must be made, the character of which will probably be in the direction already indicated. For many simple cases the packing may be done directly on the model. For example, suppose we have a denture in which one tooth is broken. Another having been chosen, and the space suitably prepared for its reception, let the tooth be well heated, then pack vulcanite thoroughly around the pins, and add vulcanite until there is fully sufficient to fill the dovetailed space; the tooth and vulcanite around it having then been again heated on the hot-water plate, press all home to position, and dress off at the joint with a hot knife.*

Mention has already been made at the commencement of this chapter of those dentures which from after absorption of the jaw become unsteady in the mouth. If the articulation of the teeth (and their arrangement, etc.) is satisfactory, the following method of procedure may be the best. A new impression of the jaw having been obtained, and the plaster-cast formed, place the denture upon the model, and run or mould wax around its borders, filling out those parts which have suffered most absorption

* This principle of doing rubber work is practised not only with repairs, but with original cases. This system, which is understood to have been introduced by Mr. Williams, and further developed by Mr. Balkwill, will be found fully described in the latter gentleman's work on 'Mechanical Dentistry.'

(if there should be doubt as to whether the case sits in its true position, let it be tried in the mouth). Then place model and denture in the lower part of an ordinary flask, bringing the plaster up to the gum margin. When the plaster is set, cut wedge-shaped grooves on its surface as described at page 74, and fill in the upper section in the usual way. After separating the flask and clearing away all wax with boiling water, with a sharp graver roughen the entire surface of the vulcanite. It is then only necessary to heat the flask and pack with small pieces of rubber, putting in rather less than the estimated quantity, and adding what may further be required on opening the flask after pressure.* The pieces of rubber should of course be proportioned in packing to the requirements of the parts. By this means we obtain a perfectly fitting case with a comparatively trifling amount of trouble.

*Gold Plate Repairs.*—What has been already said of impression-taking and modelling in the case of vulcanite alterations applies of course equally, in the initial stage, to gold.

Beginning with the commonest form of a gold repair, we may take that in which a natural tooth (incisor) having been lost, an artificial one is to be added to the existing plate. Having chosen a suitable tooth, fitted it to the mouth, and backed it, heat a small portion of hard wax and make it cubiform by rolling it lightly between finger and thumb; then heat the backed tooth and attach the small roll of wax to it. The plate is now scraped (or filed if necessary) at the margin of attachment, and (plate and wax being heated) the tooth is placed in a position as nearly correct as can be judged. Try then to the mouth, and set the tooth absolutely as required. The subsequent stages of investing, heating up, and soldering are, of course,

* In closing and opening flasks during the packing process, the cloth which separates the sheets of rubber, if moistened, is in our opinion the best medium.

familiar to the reader. Yet there are some points with regard to which a few observations may not be superfluous. First, with respect to waxing teeth to plate. It is, as everyone knows, most annoying to find the tooth becoming detached from the plate while trying to the mouth. This may be avoided almost invariably by a *particular* cementing of the wax to the toothback, and at the other extremity the wax to the plate. Having, as above described, heated the backed tooth and attached the wax, place the blade of a spatula or knife in the flame of a bunsen, and when sufficiently heated apply it to the tooth-back where the latter meets the wax; maintain a pressure upon the gold for a moment or two in order, as it were, to heat the gold to the temperature of the melted wax; act in a like manner entirely around the joint, and this part, at least, may be said to be securely fastened. Exactly the same method at the other extremity is to be adopted after attaching the tooth to plate, the joint with the latter of course requiring the same particular treatment.

The second point to refer to is the act of sinking the plate in the muffle. The denture having been just removed from the mouth of the patient, there remains a certain amount of moisture lurking about the teeth; a slight shower of unmixed casting sand will take up the moisture, and so remove a possible cause of tooth-cracking. Now, having mixed the plaster and sand* (or ground pumice-stone), and poured a sufficiency on a piece of paper placed on the bench, use what remains in the basin to fill in the palate of the plate.† This we can do quickly, and yet with sufficient care to ensure that the plaster occupies every depression and portion of that surface. Then, having sunk the case in the investing mixture, take a piece of wire

* If sand, let it be unworked, as it comes from the depot.

† The writer is strongly of opinion that this provision for having the investing material solidly and completely in contact with the plate is a factor in the prevention of warping.

—*less* than pin size, and of length appropriate to the case in hand—bend this semicircularly, and imbed it in the investient in such manner that it will occupy a middle position between the teeth and the outer wall of the mixture; lastly, cover over wire and teeth. By adopting this method, that cracking of the outer wall of the investing material is prevented, which so often spaces certain of the teeth to an undesirable extent.

A point deserving particular attention while preparing to solder added discs of plate to dentures is, to make certain that the part of the muffle representing the gum or remaining root does not become blunted or abraded. Especially necessary is it to guard against this in the case of roots remaining; for if the piece of plate filling the gap be soldered, resting on such abraded surface, it is obvious than when placed in the mouth the denture will not resume its former seat, but will rock more or less upon the part abraded.* To avoid such accidents, the following method of proceeding will be found simple and effective. A piece of pattern lead—in size sufficient to fully cover the part to be made up—is pressed smoothly over that portion of the model, and fastened with the slightest flow of wax around its joint. Oil the lead surface slightly, and proceed in the usual manner. The denture, of course, is invested minus the lead; and so we obtain a surface for the added plate which is in a safe degree free of the natural gum or root, and permits the main plate to resume its usual seat in the jaw.

Where an addition of considerable proportions is to be made to a plate, it is necessary, after having secured the plaster model, to obtain also a zinc model and lead counter, which is done as follows: That part of the plate to which the addition is to be attached is filed sufficiently close to the

* This condition is sometimes attributed to warping of the plate, and so recourse is had to bending, which simply aggravates the trouble.

gum, and bevelled in such manner that subsequently—when the added part is also bevelled—there will be an overlap. Placing the plate on the model thus prepared, and fastening it with wax, we then proceed with the sand-casting.

With regard to soldering the parts in repair cases, particular care is necessary, especially when all is to be done in the one operation. The first point is to fix the parts, and this is best done by applying one, or it may be two, small pieces of solder to the joint *with the tooth*, and the same to the joint *with the plate;* and in heating up do not apply the blowpipe so as to *flow* the solder at either joint, but only *sweat* it to the parts; when both joints are thus treated, we then add a sufficiency of solder and finish the operation. By acting in this manner we avoid the liability of the added plate 'tilting,' which it is apt to do when the solder is made to flow at one joint before the other.

As in most cases of repairing the operator is inconveniently pressed for time, a few minutes gained here and there are of importance in the aggregate. What has already been described indicates some of the means by which the work may be expedited.

After soldering, a further economy of time is secured by having the pickle acid hot when the case is parted from the investient.

With regard to cooling a case after soldering, the safest rule is to allow it to cool naturally. But if one is pressed for time, another method may be adopted with—according to the writer's experience—no risk of accident. Let the muffle at once after soldering be transferred to the anvil, or other cold surface, and after pouring a teaspoonful or more of water upon a part remote from the case, draw the latter to the water so that the latter shall be gradually absorbed by the investing material. If this be carefully done the moisture will not reach the teeth until the temperature of the investing material and teeth is practically identical, and so occasions no risk of injury. In practice the writer has not found any bad results from this method of cooling soldered cases—the time required being at most three minutes—but, as already remarked, slow cooling should be the rule, the other the exception.

*Riveting.*—The advantage of providing ample backs for plate-teeth is at once perceived when a tooth gets broken. Then, having chosen a substitute of suitable shape and colour, we are able to securely fix it to the plate by riveting, thus saving much time and avoiding much risk in putting the case through the fire. In choosing teeth for this purpose, one will naturally avoid such as have pins of very small diameter, as these have not sufficient bulk to produce a satisfactory rivet. It is possible—and with a large stock of teeth probable—that we may secure a tooth of the proper shade and size, which also has the pins in exactly the same position as the broken one. In that case the riveting is very simple. When, however, the pins of the chosen tooth occupy a position different to those of the former one, some care is necessary in order to be quite successful.

First see that the pins are in perfectly parallel lines, then take the compasses and measure from the pin—where it enters the mineral—to the cutting edge of the tooth. The compasses are then applied to the tooth-back, and the one point being kept on a level with the neighbouring tooth, the other point will indicate the line on which the holes are to be pierced ; the distance, centre to centre, of the pins being then taken by the compasses and applied to the line already marked, we have the correct position indicated for piercing the holes. These having been drilled, use a graver to remove the rugged edges on both sides, and on the lingual side—on which the rivet is to be made—make a slight counter-sink ; scrape the back around the holes, also the pins of the tooth ; insert the latter, and cut as much from the pins as will leave them projecting about a sixteenth of an inch beyond the lingual surface of the back.*

In riveting, it is the practice with many to do so with the tooth resting on the bench ; but the alternative practice of riveting upon a lead block—such as a counter—is preferable in the writer's opinion. The surface of the lead should be so shaped that, while riveting, only that individual tooth being acted upon shall rest upon it. Having passed a piece of fine sandpaper over the point of the hammer to ensure cleanliness, we then proceed with the riveting. To accomplish this properly, our first care must be to have the tooth in the direct line of force. This is easily found by slightly moving the position of the tooth upon the lead, until there is a *sensible solidity* in the strokes of the hammer. The stroke must be perpendicular ; if at an angle the pin is bent, not truly riveted. When this operation is effected in a careful manner, giving a dome-shaped surface to them, and having the platina welded, as it were, to the gold, then we may with confidence trust to teeth so fixed lasting with as much persistence as those that are soldered.

*Combination Work.*—Of all the varieties of dentures which require alteration or repair, those which are a combination of gold plate and rubber are, in certain circumstances, the most troublesome. To take one or two of these cases as examples : We will suppose that a gold plate was originally made carrying bicuspids and molars vulcanized on ; subsequently an incisor tooth gives way or is removed ; what is the best method of supplying its place with an artificial one ? It is true that the conditions may be such that by drilling a few holes around the adjacent parts, or roughing the plate, a tooth may be vulcanized without much trouble. But, on

* The cutting pliers leave an angular surface on the terminals of the pins, so that it is well to draw a fine file across them, in order to give a flat and level contact for the action of the riveting-hammer.

the other hand, on account of the closeness of the bite or other circumstances, there may be no choice between stripping the plate of the rubber, soldering the tooth, and revulcanizing, or that of riveting. In the former case the best part of a day (or more) is required; in the latter two hours is sufficient, and if properly done is no less satisfactory, even with regard to appearance; while the advantage of leaving all the other parts in their original form and position is evident. The manner in which a tooth is riveted in such circumstances is as follows: With a suitable piece of wax take an impression of the part with the plate in the jaw. At the same time, having impressed the wax thoroughly well into the vacancy, a bite may be obtained on the soft wax if it be deemed necessary. The denture with wax having then been removed and taken to the laboratory, oil the palatal surface of the plate and make a shallow plaster model. In the meantime, we assume that a suitable tooth has been selected, and—if the patient remains during the progress of the work—perhaps fitted directly to the vacancy in the mouth. If it is thought desirable to try in the plate with the added tooth, then fix the latter to the space with hard wax in the manner described on page 100. When the case again returns to the laboratory with the tooth in proper position, place it carefully on the plaster-cast, make a cross cut on the front wall of the latter, and after oiling pour a sufficiency of plaster over the face of the model and tooth to give the accurate position of the latter.* When this is set and separated, it will be seen that we may now remove the tooth from the plate, and proceed with the subsequent operations with full assurance that we can at any time replace the tooth in the exact position it occupied in the mouth. The next step is to fit a piece of plate of sufficient dimensions to fill the vacant space and to lap over the main plate, at its border

* See page 94.

towards the tongue, to the extent of about two-eighths of an inch. This may be done by bending with the pliers, but if the addition is a large one, or the parts irregular in shape, it is best to take a sand impression with the denture on the model; it takes but little time to obtain a zinc and lead reverse. Having fitted the piece of plate, perforate or drill two holes in the part that laps over the main plate; enlarge them sufficiently to allow of the rivet wire to enter somewhat tightly. But before inserting and soldering the rivets, wax the plate to the denture in position; pass the centre-pointed wire, tipped with vermilion, through the holes, and thus mark the true position of the corresponding ones that are to be drilled in the main plate. These having been drilled (perforators should never be used for this), then solder the rivets into what we may term the auxiliary or branch plate, and leaving the wire so long that when placed *in situ* it will project fully a sixteenth of an inch beyond the inner or palatal surface of the denture. Supposing that this has been effected, and that the rivets pass without difficulty, yet not loosely, through the holes in the main plate, cut depressions in the plaster model at the joints where the rivets touch, to allow of the whole attaining the true position. We now apply the little plaster-mould to the face of the model and settle the tooth in it, cement tooth to auxiliary plate, then carefully remove from denture, invest and solder. What has already been observed at p. 104 with regard to riveting need not be repeated. Instead of the lead-rest for the work just described, the head of an iron or steel punch fixed in the jaws of the large vice is perhaps more convenient. It is difficult to obtain such a contour on the lead as will permit of successful riveting, without running some risk of injuring neighbouring teeth.

Before passing from this subject it is well to remind the reader that the position of rivets, their distance from each other, and their position in relation to the borders of the plates with which they are connected, must be well considered. For if the holes be situated in close juxtaposition, so that the dividing wall is narrow and weak, this latter will give way under strain, and produce a state of things which would be very difficult to set right. Yet neither must the rivets be too far apart, as this also weakens their force. In fact, in engineering there are well-understood rules which govern this branch of construction, and the writer cannot do better than give the following table and remarks taken from 'Lloyd's Rules':

| | | | |
|---|---|---|---|---|
| Thickness of plates in inches: | $\frac{5}{16}$ $\frac{6}{16}$ $\frac{7}{16}$ | $\frac{8}{16}$ $\frac{9}{16}$ $\frac{10}{16}$ | $\frac{11}{16}$ $\frac{12}{16}$ $\frac{13}{16}$ | $\frac{14}{16}$ $\frac{15}{16}$ $\frac{16}{16}$ |
| Diameter of rivets in inches: | $\frac{5}{8}$ | $\frac{3}{4}$ | $\frac{7}{8}$ | 1 |

It will be perceived that the thinner the plate the greater in proportion is the rivet in diameter. For if we take the half-inch plate, $\frac{8}{16}$, the diameter of rivet is three-quarters of an inch, while in the inch plate the diameter of rivet is not an inch and a half, as one might anticipate, but one inch. We thus see that, taking the most suitable wire for riveting a strong gold plate as pin size, when we come to insert rivets in a much thinner plate—though the wire should be *less* in diameter—the *difference* should be slight. The remarks upon the position to be given are as follows: The rivets should not be nearer the edges than a space not less than their own diameter, and not be further apart from each other than four times their diameter, or nearer than three times their diameter.

The ordinary pin-wire, if used for riveting, should be thoroughly annealed before commencing operations. But there is a special kind of wire prepared for the purpose, called green gold, on account of the larger amount of silver in the alloy giving it a slightly green tinge; this wire permits an excellent rivet to be made, and with facility.

*Swivel Repairing.*—The worn-out swivel which at last parts from the bolt is the most common of this class of repairs. If the bolt be through the vulcanite and fastened with silk or riveted, it is easy to remove it, put in a new swivel, and refasten. But there are many cases in gold and combination work, as the reader knows, where to replace a swivel in its integrity would entail an amount of time and harassing labour altogether out of proportion to so small a matter. Naturally, therefore, expedients have been resorted to for avoiding so much unnecessary, and perhaps unremunerative, work. First, we have that which consists in bending a piece of wire—considerably thinner than pin-wire—round the head of the bolt; previous to bending, the wire should be filed or beaten flat along those parts which, as the bending is accomplished, will approach, and meet each other to form the shank of the swivel.

The second method by which we may effect this purpose is to take an ordinary depot swivel; slit it with the small frame-saw and force open the circlet or eye until the gap is sufficiently wide to allow of the swivel being passed on to the bolt-head; then close again around the bolt until the separated parts meet again and complete the circle. If this method of attaching a swivel is properly executed, it is undoubtedly the better of the two.

A few words regarding the *modus operandi* may not be superfluous. In the first place, the eye or circlet of the swivel should be annealed, so that it will yield in the process of bending, and not break. Second, the point at which the slit is made by the fret-saw should be as near as possible to where the circle meets the shank, and, in connection with this, it is a matter for consideration as to which side of the shank the piercing should be made. This should be decided by the working position of the swivel to be replaced. That part of the circle which in working bears the most strain will, of course, be left intact, and the slit ought, therefore, to be made at the opposite extremity. The accompanying figure will at once make clear what is meant. The reader is to suppose that two swivels are to be attached

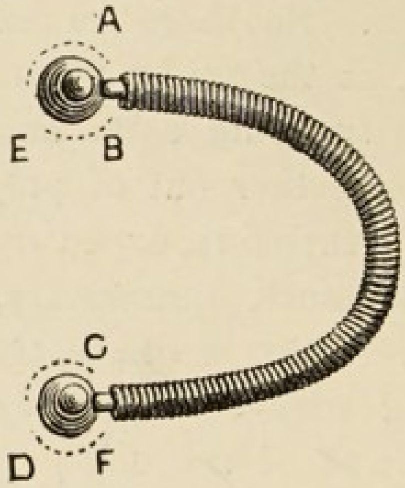



FIG. 66.

to the left side of an upper and lower denture. It is clear that the strain upon the swivel while the spiral spring is acting is the segment of the circle E B in Fig. 66, which represents the upper swivel; the slit should therefore be made at A; the principal strain on the lower swivel is around the segment C D, hence the slit should be made at F.

Having made the scissure with the saw, and carefully opened out the swivel circlet sufficiently to pass it on to the bolt, the *re*forming, or closing, is easily accomplished by using suitable pliers.

Before entering upon this work, it need hardly be stated that the operator should be certain that the thickness of the *new* swivel is not greater than the space will allow. In such cases, indeed, it is best to fine file the surface to allow of easy action.

*Swivel Soldering.*—The several methods of fixing swivels to dentures are described in the text-books, and need not be recapitulated. Nevertheless, a few observations by way of amplifying what has already been written may not be without interest. First, with regard to bracket or branched swivels—that is to say, swivels which must occupy a position with their backs so close to the gum that there is no holding-room for their bolts. In such cases a narrow strip of plate is used; a pin or bolt being soldered at the most suitable point for holding in the rubber, while at the other extremity the swivel is soldered in its required position. In such cases it is advisable that the swivel-bolt should be of *gold*, as there is a better amalgamation with the solder and the parts than where dental alloy is used. And, further, before inserting the swivel and bolt, it is well to countersink the plate where the bolt emerges, and even to slightly rivet the latter (having cut it to the right length) before soldering. The reader will of course understand the necessity of minutely covering the *not to be soldered parts* with moist whiting. It may be well to again describe the process. With a suitable instrument—such as the flat shank of a needle-file—paint the fluid whiting over and under the head of the bolt, and also completely over and through the eye of the swivel. Having inserted the bolt, the whiting which may have come through must, of course, be removed and the joint to be soldered scraped. If these precautions be observed, the operator will avoid the awkward predicament of a fixed swivel.

*Swivels in Rubber Dentures.*—Whether it is better to vulcanize the swivels into rubber dentures, or to drill and insert them afterwards, is a difficult question to decide. By drilling after the case has been filed up to shape we can, without doubt, secure with greater certainty a more perfect action of the swivel. But it requires longer time, and if due care be exercised in the inserting of swivels in their proper line of action in the wax, and the plaster is made to flow about them in perfect contact—that is to say, taking the utmost care that no air-holes shall be in their neighbourhood, and that the head and shank of the swivel are absolutely *sealed* in the plaster—there is but little chance then of it veering from its true position. In such cases, however, special attention must be given to the packing. When this method of inserting swivels is adopted, the writer makes it a rule to solder a washer behind the eye of the swivel. It is readily done, aids in preventing a change of position, saves time in finishing, and the swivel of course works more smoothly upon a soldered washer than upon a possibly irregular surface of rubber. On the other hand, if the swivels are to be pierced after the case is vulcanized, a washer may be dispensed with. But in order to have them acting properly under these circumstances, sufficient bulk of wax should be given in the making-up of the denture, so that afterwards the hard rubber may be cut to an even facet, or block, so to speak, for the steady working of the swivels.

Another matter, which is well worthy of notice in this connection is the form which should be given to the rubber along the line of action of the spiral springs. Ample bulk of wax from the first bicuspid to beyond the range of the last molar should be added in the building-up of the denture, so that when the case is being furnished after vulcanizing, curved channels of a grooved form may be cut in the rubber to correspond with the curve of the closed spring, and make, as it were, a cradle or socket for it. There can be no doubt that much of the discomfort experienced by those who have worn dentures with spiral springs attached has arisen from the cheek getting fretted by their unprotected movements. Provided with these plumpers, on the other hand, the cheek is kept out sufficiently to make it clear of any unpleasant contact with the spiral springs. Lastly, it is well, if the protruding part of the faces of bicuspids and molars is pronounced, to flatten that part with the corundum-wheel. The flattened or facetted surfaces of these teeth are to be preferred in every way, for the easy and safe working of the springs. The teeth are, of course, defaced to a certain extent, but the grinding surfaces are maintained ; and as this latter point, viz., the grinding surface of these teeth, and the former point, viz., the accurate and comfortable action of the springs, are practically the only considerations that claim attention for teeth placed so far back in the mouth, the matter of defacement is of but little consequence.

*On Timing Work.*—Much has already been said on the *conditions* which must regulate the time required for the accomplishment of specified work ; and it is not necessary, in a *general* sense, to go further than repeat the three main factors. First, the aptitude and natural quickness of the operator ; second, the surrounding circumstances, and possibility of further cases intervening ; and thirdly, the chances of accident. This last, namely, the chance of an accident occurring during the process of construction or repair, should be taken into account where it is possible to do so ; for even the most careful and skilful operators are not without an occasional mishap. The two first-mentioned factors are, however, of really essential importance when one comes to compute the stretch of time required for the several classes of work.

*Estimate of Time required for Certain Work.*—It goes without saying that in laboratory practice, which is so varied in its routine, no very exact time-table for the accomplishment of specific cases can possibly be given. In fact, the writer is fully conscious that, in touching upon such a matter at all, he is treading upon exceedingly uncertain and shifty ground. Yet surely it is appropriate that in a manual devoted to laboratory practice an *attempt* should be made, as far as possible, in this direction. And though the divisions of time here given from individual experience and observation may appear excessive to some, and too contracted to others, they nevertheless may serve a useful purpose, if only for that of comparing notes.

The reader of course accepts as an axiom that *quickness* in accomplishing work is a minor qualification to that of doing it *well.* The many conditions necessary to the production of the best examples of success in the prosthetic branch of dentistry are too well known to require recapitulation. But, though care and skill must always be the first consideration, it is, or should be, the *beau ideal* of the operator to combine, as far as he safely can do so, speed with skill. And though, as already observed, there are those who are able to accomplish work at a quicker pace than others, there are many again who, though perhaps naturally slower, yet by acquiring the habits of system and order, both with regard to the arrangements connected with the bench appliances, and the apportioning judiciously the time required for the work on hand, might very considerably facilitate and accelerate its progress. And, again, the operator may, so to speak, have a stereotyped idea of the time necessary for the accomplishment of the various kinds of work, derived from the experience of his pupilage. The pace may have been too fast for good results, or too slow for diligent work. What must therefore be insisted upon is that, in the first place, the work shall be done *well*; in the second place, every legitimate means should be employed to do it expeditiously. Some previous remarks may have suggested the manner in which the latter of these conditions may be assisted; and though it is a somewhat hazardous attempt, as already stated, we will endeavour to give what, in our opinion, is a fair time-table for certain classes of laboratory work.

To begin with repairs, regarding which a nearer approach to exactitude can be ventured upon than with other cases, let us take, first of all, such alterations as are continually required upon gold plates.

The simplest, generally speaking, are those in which all the teeth are flat-backs, and one of these has been broken. In a case of this kind the riveting of a substitute is the quickest, and if the plate-back and the new tooth are conformable, is the best method of repair. The time necessary for such a case (after the tooth has been chosen) may be taken as half an hour. For a repair of this character, if the new tooth must be soldered, an hour-and-a-half, from the time the case is ready to be put in the investment, is not too much for its safe accomplishment. Then we have those of a kindred character in which tube teeth are combined with flat ones; in such cases an extension of time must be allowed for the removal of the tubes and their subsequent refastening.

For gold repairs of a more extensive description—such, for instance, as those that require that an impression of the mouth be taken and a plaster model made, and possibly a zinc cast and lead die—an ampler allowance of time must be given, proportioned to the elaborateness or intricacies of the case. Indeed, in these circumstances, where a radical alteration is necessary, the dentist is surely well justified in advising his client to have a new denture altogether, while the former, repaired, will be a reserve for an emergency.

*Rubber Repairs.*—A very common form of rubber repair is that connected with the loss of a natural tooth or the breaking of an artificial one; in which case the vulcanite of the locality may be at once dovetailed, and the added tooth—or teeth—having been cemented with wax, and, if necessary, tried directly to the mouth, the flasking process may be immediately proceeded with. The time required for accomplishing such a simple repair, from the moment it reaches the laboratory for flasking, to the finishing touch on the polishing lathe, may be taken as between two hours and a half and three hours. A considerable reduction of time, however, may be gained by adding salt to the water before mixing the plaster. The quantity that should be added will, of course, depend upon the known setting-time of the plaster. If too freely used, we have not sufficient time to imbed the denture properly ; less than a teaspoonful will be found sufficient even with the freshest—and therefore slowest setting—plaster.

Another means by which the accomplishing of this work may be greatly expedited is by packing the case with rubber, which vulcanizes in fifteen minutes ; we thus shorten the time required for doing the work by thirty-five minutes. And there cannot be any possible objection to having the vulcanizer heated to boiling-point before inserting the flask, and so further economizing time.

There is one part of the operations which should on no account be hurried, viz., the opening of the flask after vulcanizing. If an entire rubber case, the flask and plaster should be allowed sufficient time to become *absolutely cold ;* if the denture be in the form of a gold base-plate with teeth vulcanized to it, there is less necessity for this precaution.

This hurrying on of work, however, should be avoided on principle, and only resorted to in an emergency. For the more extensive or complicated cases of repair in rubber dentures—those, for instance, which require that an impression of the mouth and bite be taken, a proportional extension of time must, of course, be allowed. From three to four hours may be given, generally, as what is required for this class of repair.

*Original Dentures.*—While we may, with something like an approach to accuracy, suggest what is a reasonable amount of time required for repairs, to attempt to do so with regard to dentures to be constructed *ab initio* is obviously a much more hazardous undertaking. But by taking certain types of work in stages, from commencement to accomplishment, and giving an individual opinion and experience of the fair average time required for the traversing of each stage, some assistance may be afforded as to the time required to complete the journey.

We will assume that the impression has reached the laboratory, and that it is in a fit condition for at once making the plaster cast.*

*Model-Casting.*—In pouring and shaping plaster models, it must be remembered that while it is possible to cast three or more with the one mixing of plaster, this capacity is subject to two essential conditions. First, we have to take into consideration whether the plaster is fresh, or has been a long time on hand; for with fresh plaster it is possible to cast a greater number of models—and do so efficiently—than with that which has been kept for a considerable time. Second, no attempt should be made to run and shape a greater number of models than what is well within our power to do *properly*.†

The next point to observe is that the plaster shall be thoroughly set before applying the heat necessary to effect the parting of model and matrix; and further, whether hot water or dry heat is used for this purpose, the impression-material should be allowed sufficient time to become *well* softened *throughout* before parting cases which have natural teeth standing. It is, indeed, a torture to have these patched-up teeth continually to cement during the construction of a denture; besides, there is the more important consideration that in the patching-up the contour of the teeth may be falsified, and so the success of the case

* By being in a fit condition for running the plaster cast, is meant that in the case of the impression-material being of a plastic nature, such as wax, it should be thoroughly *set* before casting (this may be hastened by placing it in cold water immediately after taking the impression). Second, if there is blood over any part of the surface, as there must be in many cases, this must be thoroughly cleansed from the matrix before casting.

† Of course, the number of casts which may safely be taken with the one mixing of plaster is dependent on the varying characteristics of the impression.

may be imperilled. For the casting of a model for a denture intended to have a plate-base, and for the thorough setting of the plaster, half an hour may well be allowed, and supposing that the impression-material is wax or composition, from five to ten minutes' immersion in sufficiently hot water should be sufficient time to soften it to the core, so that the parting may be made with safety to the teeth.*

*Stearining Models.*—In rubber cases it is not, of course, permissible to stearine the model upon which the denture is to be vulcanized; and even where a second one is taken for working upon, there is no necessity for subjecting it to the process.

For plate-work, however, it is surely an undoubted advantage to have a carefully dried and stearined model. Many practitioners, it is true, pass over the process of stearining such models. And it cannot be doubted that the plaster, which is allowed to remain unstearined, is stronger and less easily injured than that which has been carelessly and injudiciously heated and stearined. But for dentures with a plate-base, there can be no question but that the stearining of the model—if done carefully—is a distinct advantage.

If circumstances permit of it, we would advise that after parting the impression-material from the model the latter should be placed aside in a part of the room that is free from damp, and so allow it to get rid of the moisture in what may be termed a natural manner.

But, assuming that this is not possible, we obtain good results by placing the model, immediately after it is shaped, before a bright fire for the space of half an hour. And, having melted the stearine (particular care should be taken not to overheat the stearine; the moment it is thoroughly

* The temperature of the water used should be as near boiling-point as is possible without *melting*—or, rather, liquefying—the impression-material. The time allowed for immersion is, of course, dependent on the bulk of impression-material to be softened.

melted the hot model should be placed in it) then about forty seconds' immersion will produce good results. If, by accident, the stearine becomes overheated and burns, the material should be discharged and new material substituted before introducing the cast.

## Dentures with a Gold Base-Plate.

*Metal Casting.*—To obtain the zincs and leads necessary for a plate-base, probably an hour may be given as a fair allowance—an excessive time, no doubt, for many cases, but even inadequate where models present the well-known difficulties encountered in withdrawing them from the casting-sand. Such as represent the edentulous jaw are, of course, as a rule, the simplest to deal with. The most difficult are those which have long and straggling teeth placed at angles which make it impossible to withdraw the plaster model without injuring the sand impression. If, in such cases, the teeth are isolated (and particularly with incisors), to pass a thin fret-saw around the plaster tooth within an eighth of an inch of the neck, before casting in sand, is, we think, the best method to adopt so as to readily overcome the difficulty. Where this is required to be done the pins used for the plaster cast should be ordinary household pins; and, having first cut off the heads, insert the thicker diameter in the impression-material. After the model is stearined, and allowed to cool, and the process above described of fret-sawing around the obstructing teeth has been accomplished, these portions of the teeth can readily be removed for casting purposes, and afterwards reinstated in their exact position.*

* On no account should a stearined model be heated subsequently in the course of work, as, for instance, one might be tempted to do in parting the bite from the model. If the parts of the latter, where the plaster in casting the bite is apt to overrun, are touched with a parting medium, a tap from a riveting-hammer (after the plaster is thoroughly set) will effect the parting, leaving the wax matrix on the bite, which then can by itself be placed in hot water for removal.

In nearly all cases where teeth are standing, on the first zinc upon which the striking begins, the teeth should be reduced to *within* two-eighths of an inch of the gum-border; otherwise the striking process is rendered unnecessarily difficult. One means of doing this has just been described; but it is only in very few models that what may be termed the capital operation of separating the plaster teeth from the model is necessary or commendable. Outside of these, the ordinary practice is to fix the zinc model in the vice and rasp down the teeth to the required extent. This is, in general, a fatiguing as well as a tedious method. A much better method, in every respect, is to pack well-moistened sand into the impressions of the teeth in one of the moulds. If the packing-sand is made pencil-shaped, and of the consistence of putty or dough, this may readily be done, and the impressions of the teeth so filled will result in obtaining a zinc cast quite as fully conforming to the purpose in view as one upon which much time and force has been expended in rasping.

*Striking Plates.*—Having obtained the zinc models and lead dies (it is well to have three each of these for cases that present difficult features, and particularly where the gold used is of a hard type), the striking of the plate so as to accurately fit the plaster cast will occupy from half an hour to an hour or more. Some cases are so readily fitted that the operation may be satisfactorily accomplished much within the half hour; but, on the other hand, when we come to those which present the most difficulties—and of which a lower bridge plate with strengthener is a good example—even two hours may be found an insufficient allowance of time for satisfactorily completing this stage of the work.

*Clasp Fitting.*—In the first place, a sketch of the proposed fasteners is made with a pencil on the plaster teeth; next a piece of pattern lead is cut and fitted to conform to the sketch; and, lastly, gold plate having been cut to the lead pattern, the former is bent with suitable pliers to fit the contour of the teeth, as the pattern did. There is then the filing of the base-plate towards the necks of the teeth so as to allow the clasp to fit snugly in position, at the same time guarding against filing too freely from the plate, and so leaving a gap between clasp and plate. This latter consideration in all cases of soldering should have full attention, for a few careless thrusts of the file will not alone render the subsequent soldering operation more difficult, but also more tedious, and, it need scarcely be added, the result is less graceful. Upon this stage of the work, therefore, a *fine* file should always be used in reducing the plate for *letting in* the fastener to position.

The time required for fitting clasps is of course dependent on their character, some presenting more difficulties in shaping to the tooth than others: probably fifteen minutes, however, may be taken as usually sufficient for fitting and shaping a clasp and cementing it to the plate. We have then the investing of the case in plaster and sand, or pumice-powder, and the soldering. For this stage thirty minutes may well be allowed, even in comparatively simple cases, when we include the time necessary for dressing the fasteners after soldering. The foregoing may be taken as a rough estimate of time required from the casting of the impression in plaster to the stage of having a gold plate in a suitable condition to proceed with the tooth-fitting.

*Fitting and Backing Teeth.*—Certain teeth are so exactly shaped for the particular case in hand that absolutely no fitting at the lathe is required. In such circumstances there is only the backing of the teeth and attaching with cement to the plate to be considered—five minutes for backing teeth and dressing the backs is an ample allowance of time. But, then, as the reader knows, there are mineral teeth which require the most careful fitting at the lathe, in order that they may conform to model and bite. These more difficult cases of tooth-fitting are most frequently presented where there are natural teeth standing, the bite being irregular, and the space to which the mineral tooth is to be fitted more or less bounded by fastenings. The difficulties met with here are three in number; first, the space itself is an awkward one to fit a tooth accurately to; second, the position given to the tooth in the course of fitting must conform to the irregular bite; third, much nicety is required in fitting the teeth at the sides, so that the fasteners shall be overlapped and so concealed; this last being done *subject to the essential condition* that the pins are not denuded of mineral to an extent that will imperil the strength of the tooth.

For cases of this kind, where the fitting required at the lathe is not excessive in amount, or in point of difficulty, the average time required for the fitting, backing, and securing each tooth to the plate may probably be fairly stated at from fifteen to twenty minutes.*

*Investing and Soldering.*—For this stage one hour and a half to two hours may be taken as a sufficient amount of time—that is, of course, assuming that there are no special difficulties in the work.

*Finishing.*—The denture that is carefully and neatly constructed, it goes without saying, is much more easily

* There are two methods of adapting the base-plate to the teeth, so that the latter shall sit perfectly in the position required and to which they have been fitted. The first is the method of cutting from the labial border of the plate so freely that the latter does not absolutely reach the back of the tooth. The purpose in this is obviously to enable one to readily press the teeth to position on the natural gum when trying to the mouth. The advantage of being able to do so, without removing teeth and filing plate line by line, is, of course, quite apparent; but the system, though much expediting the work in the surgery, frequently renders the subsequent soldering operation exceedingly difficult. Besides, the teeth, not having the support which the lip of plate underneath gives them, are more liable to be fractured than those which rest *on* the plate.

and satisfactorily finished than one in which the soldering is rough and unshapely. Besides this, in the course of construction, a careless use of the file may have left traces of its wanderings which give subsequently a quite gratuitous amount of labour to remove.

There is a difference of opinion among dentists as to the fine polishing of a denture. Some consider it to be a waste of time, and that a run over with a piece of sandcloth is sufficient; while others give much attention to this final stage of laboratory work. If the well polishing of a plate were to be simply a matter of appearance, as in an article of jewellery, there would be little perhaps to justify the practice. But there is a more important consideration, which is, that a denture that is not well polished on its *lingual* surface affords a lodgment to the secretions, and becomes coated with a film which must be a cause of annoyance to most patients. It is for this reason that the smooth and bright polishing of a denture on the lingual and labial surface is to be commended. The under or palate surface, on the other hand, should not be subjected to the process of fine polishing. In rubber cases only so much manipulation should be employed as that which is *absolutely necessary* to remove the adhering plaster; and in those having a gold base-plate, ground pumice-stone moistened and used on a pencil-shaped piece of soft wood is all that is advisable to use over the palate surface. For the careful finishing of a gold plate from the moment it is withdrawn from the pickle acid, probably half an hour may be considered a fair average time.

*Fitting Tube Teeth.*—In former times (down to ten or fifteen years ago) tube teeth were very largely used in the construction of dentures; now, however, this type of work appears to be nearly extinct. In the days of tube work constant practice necessarily produced in the skilful operator great celerity and facility of action. Mr. Balkwill gives an instance wherein an operator, associated with himself, was able to rough fit, insert the pins, and fine fit four tube teeth within the hour. This was undoubtedly smart action, even if we assume that the case did not present conditions increasing the difficulty of fitting, such as clasps, or pronounced irregularities of contour. But even in the age of tube work (as Mr. Balkwill himself asserts) the above-mentioned time was inadequate for its satisfactory accomplishment by the average operator. And now that this type of work is so unusual that few are even fairly practised in it, a considerably extended time must be given. For the rough fitting of a tube tooth, soldering the pin, and fine fitting, half an hour may well be allowed in all cases; while in cases presenting features which require special care, an hour may be required, if not more, for the perfectly satisfactory placing and fitting of each tooth. One reason for regretting the decline of tube work is the facility and safety with which repairs can be done in comparison with dentures constituted of flat teeth. The fastening of a tooth which has parted from the pin is accomplished within a few minutes, and a tooth that is broken may be replaced well within the half hour; and (excluding *alterations*) it will seldom be found that repairs in tube work take more than forty-five minutes.

## Rubber Dentures.

Much that has just been said is of course applicable to rubber dentures as well as to gold. In partial cases, for instance, we have similar conditions existing with respect to the fitting of teeth and clasps; but less time may be allowed for this, from the fact that there is no plate to be shaped and accommodated for the reception of the teeth. As remarked above, much time and a more satisfactory result is gained in finishing a denture by exercising scrupulous care in its construction. And it must be remembered that this carefulness and neatness in the course of construction does not necessarily mean an *added* portion of time in the initial stages, which is made up for by a reduction in the *final* stage. For by exercising judgment, we may as quickly construct a well-proportioned case as a clumsy one, which subsequently entails much unnecessary labour in the finishing. Where no trying in of the case to the mouth is necessary, of course modelling wax will be used for the mounting of the denture. But where it is essential to obtain an impression of the articulation, and afterwards try in, it is—at least, in elaborate cases—desirable to have a plate of some hard material to work upon. Shellac melted and rolled out to the thickness of modelling wax serves very well; but a still better plate for trying-in purposes is obtained by using sheet block-tin (or pewter) of the requisite thickness. One zinc cast from the plaster model and one lead counter is sufficient to strike the plate into shape. This whole operation costs but little trouble, and we secure a sufficiently rigid plate, which has the great advantage of being perfectly uniform in thickness.*

Assuming that a reliable model and bite is obtained, the mounting of teeth for a rubber denture is generally a very simple process, and may be accomplished very rapidly. The simplest of all are complete sets with a moderately high bite. In such cases it is possible to have an upper and lower denture finished and ready for insertion within six hours from the time that the impressions are taken. But while this is possible, such a system of doing work will hardly commend itself to the conscientious practitioner.

Roughly speaking, we may give from two to three hours for the *setting-up* of a complete upper and lower denture;

* These plates should extend towards the labial aspect no further than the apex of the alveolar ridge, so that on opening the flask there shall be no difficulty in removing the plate. This is assuming, of course, that the teeth are covered over with plaster in the one section of the flask, and the packing is done on the model.

for the flasking and packing a similar time; vulcanizing one hour and a half; and finishing two hours. So that, according to this table—which, in the writer's opinion, approximates fairly to what may be considered a reasonable allowance of time for the simpler types of denture—we have an estimated total of seven and a half to nine and a half hours for the actual *construction and finishing* of an upper and lower denture for edentulous jaws. Added to this, however, we have the time necessary for trying to the mouth when the teeth are set up in wax, which may be much or little, according to the case. So that when one also considers the fact that other work is concurrently on hand which must be dealt with, or that cases—such as repair cases—demanding immediate treatment may unexpectedly intervene, it is obvious that an extension of time must be given proportional to the circumstances.

In concluding these remarks on this subject, the reader may again be reminded of what has already been said, viz., that the attempt to give anything like a specific apportionment of time for the accomplishment of work in the dental laboratory comes very near foolhardiness; nevertheless, an individual opinion from anyone of fair experience in laboratory methods cannot be without some interest, and perhaps advantage.

## On Preserving Models.

The system adopted in some laboratories with regard to the plaster casts is to preserve them only for such a length of time as is sufficient to satisfy the practitioner of the complete success of the case. And there is much to be said in favour of so doing, for unquestionably there is a considerable amount of time expended in the numbering and arranging of models, as well as inconvenience in providing them with shelf accommodation; while at the same time, as we are all aware, a very small percentage of the models crowding the shelves will ever give subsequent assistance in cases of repair or alteration. Nevertheless, it must be also admitted that from time to time we find the possession of the plaster casts on which a denture has been constructed is of the last importance. And in many other instances, though not absolutely essential, the model and bite of a few years' old denture gives great assistance to the operator into whose hands it returns for renovation or repair. And, though of minor moment, the fact of having an indisputable record of work accomplished year by year is a source of satisfaction. Upon the whole, therefore, we may take it as desirable to preserve the plaster casts for several years where there is space available for their shelving accommodation.

We have, then, to consider to what extent, as regards work, the casts should be preserved. There are some who give a permanent place on the shelf to even such casts as are made for repair cases. There does not appear to be any sufficient advantage in cumbering space with these. Again, with respect to rubber dentures which have been vulcanized on the original model, though a second cast may have been taken for working upon, it is practically of no advantage to preserve the latter, except in case of complete, or nearly complete, upper and lower dentures, when their retention may at some subsequent time prove convenient. Where the rubber denture is constructed upon the original cast, yet not vulcanized upon it—the original being reserved for after reference or fitting if necessary—then there is good reason for giving it a permanent place on the shelf.

*Arrangement and Numbering of Models.*—The plan which affords the readiest access to the model required is undoubtedly that of having shelves of just sufficient breadth to easily accommodate a single file of models. In certain circumstances, however—as, for instance, where the wall space is confined and the models are numerous—it is best to have broader shelves, sufficient to allow for two or three files to be ranged along it.

Respecting the manner by which models may most readily be discovered when required, the simplest and quickest method is that of giving them progressive numbers, these numbers being concurrently stamped, or cut, on the palate surface of the plate. Thus, when a denture returns for any purpose, towards which the plaster cast may be of assistance, the number on the plate points directly to the cast required. In a rubber case a finely-pointed steel instrument—such as may be shaped from an ordinary brooch—will serve thoroughly well as a graving tool ; for gold plates steel numbering punches of a small pattern will be used, and the plate stamped on the palate surface previous to beginning the striking process.*

Another system of model reference, and one that dispenses with the necessity of stamping or cutting the number on the plate, is that in which a book is used for recording the name of the patient, and alongside of the name the number of the model. If this plan is adopted, the book used should be of that sort which has the letters of the alphabet displayed on the outer border of its pages ; so that, upon learning the initial letter of the patient's name, we find at once the page on which it is written and the number of the model required alongside. By writing the names and numbers in strictly progressive order, on the other hand, we come to have such a series of mixed names that much unnecessary time is lost in searching for the one required.

* An extension of this plan, and an improvement upon it perhaps, is to stamp or cut in addition the month and year in which the denture was constructed.

## CHAPTER IX.

### CONTINUOUS GUM WORK.

THE porcelain process, adopted by Verrier and others —by which a continuous gum of natural contour and colour is obtained — is undoubtedly a most interesting one, requiring much skill and artistic ability in its production, and realizing in its results all that it appears reasonable to hope for in competition with nature. The process, however, is weighted with many conditions, which, for the present at least, must necessarily make it an exceptional method of constructing dentures. But there is so much intrinsic value in the idea, it is to be hoped that the method of putting it in practice will be further simplified, and so made more generally available, particularly for partial dentures, where the natural teeth remaining are of normal length, and the absorption in the vacant spaces is considerable.

In such cases it is, of course, the rule at present (in particular cases) to use teeth with porcelain gum, either singly or in blocks; and in other cases, which are of less consequence, vulcanite or a long tooth. But if some means could be devised whereby a gold plate constructed in the ordinary manner might satisfactorily be combined with a vitrified gum-facing, the advantage we would then possess can be readily understood.*

* Not having had much practical experience of this class of work, the writer cannot expect that his opinions will have any considerable

The Verrier process is too well known to require further description. Indeed, in this class of work, more than in any other, book-learning is insufficient. One must see the process in operation, and by patient and intelligent perseverance only can excellent results be obtained. It may, however, be of some assistance to the reader to give an extract referring to this subject from an American source. Mr. Haskell says in his 'Student's Manual':*

*Celluloid.*—This proposed substitute for rubber, as a base-plate and setting for teeth, has not certainly achieved that measure of success anticipated for it by many. The colour and appearance of the material is undoubtedly attractive, and if in other respects its properties only equalled those possessed by rubber, the latter would probably have fallen by this time entirely into disuse. But the opinion generally of those who have given celluloid a full and fair trial is that it contains two radical defects, which are: First, after wearing, the plate warps; second, the material does not hold the teeth with the permanency that rubber does. It must, however, be stated that by careful manipulation the tendency to warp, if it does not entirely disappear, is reduced to an extent that may be considered of trifling, if any, consequence. To succeed in this the machine should be given time to become *absolutely cold* before removing the flask.

*Crown, Bar and Bridge Work.*—This method of inserting artificial teeth is most ingenious and interesting, and, when done with sufficient patience and skill, there can be no doubt that in appearance, and at the time of insertion, no

weight; but he may be allowed to suggest to those who take an interest in and practise this branch of the art, whether it would not be possible to have a platinum plate, only a little larger towards the lingual aspect than what is required to hold the soldered teeth and gum material—and when this part of the work is completed, then by means of slight overlap solder to a gold plate of usual construction with ordinary solder. Or if this be not practicable, to adopt the alternative of riveting.

* Haskell's 'Student's Manual,' chap. xv. (Continuous Gums).

more perfect form of denture could well be conceived. But to begin with the theory on which this system is based. If the theory be true, then it only requires skill in carrying it out to establish its success in practice. But is the theory one upon which we can rely? The writer touches upon this question with much diffidence, having to acknowledge that, so far as practical acquaintance with the manner of doing this form of work is concerned, he has none. But it will not be thought presumptuous in one who is familiar with the construction of other forms of dentures, and who has well digested the literature connected with crown and bridge work, and seen most excellent specimens of it in the course of recent practice, to hazard a few observations upon the subject. The two main forms in which this type of denture may be completed are, first, that in which an anchorage is made in adjoining natural teeth by means of the engine, for the reception of the projections which are to fix the denture. Now, when we consider that the highest motive in dental science and art is the conservation of the natural organs, this method of cutting into sound teeth in order to secure an anchorage for the artificial ones is surely a very radical opposition to the conservative idea. Assuming that the plugging of these retaining points is accomplished with the greatest skill, and that the natura teeth are rendered, so to speak, as good as new, the condition of things that exists when the work is finished is, as the writer ventures to represent it, this: We have a denture resting on a yielding surface, depending for support on the solidly-embedded wires in the comparatively unyielding natural teeth. The strain, therefore, is upon the latter during the process of mastication, and with what possible or probable result the reader is well able to judge.

The second type of this class of work is less radical, or should we say less vandalistic, in its method, consisting, as it does, in ringing and capping the natural teeth required for support, and sending the denture home with a film of cement, and so making it practically a fixture. This system appears to have less objectionable features than that just alluded to, but it still retains the vital objection, as it appears to us, that it cannot be removed for cleansing; and as all such cases have a tendency to loosen under wear, the results thus arising from the continuous lodgment of destructive elements must necessarily have an unfortunate effect upon the natural teeth. These observations, which (with perhaps exceeding temerity) the writer has ventured to make with respect to this class of denture, appear to have sanction from the fact that a system of crown and bridge work which shall be removable at will has lately been explained; and if it should prove by results to be entirely successful, a really beneficial step in advance in the dental art will be secured.

See also Notes to chapter viii. (page 152), where the views held on these subjects by the gentlemen referred to in the preface are fully set forth.

## CHAPTER X.

### On the System of Capping Teeth to prevent the Sinking of Dentures.

That lower bridge-plates—vulcanite or gold—which pass around the lingual aspect of the eight front natural teeth, to carry bicuspids and molars, are liable to drop from their original position after wearing for some time, is a fact very familiar to everyone in fair practice.

This is a condition of things, no doubt, most frequently met with in dentures which have spiral spring attachments; yet a similar result is by no means uncommon in lower dentures not so provided; and even upper plates are not entirely exempt from this tendency to sink out of their true position in the jaw.

A typical instance of what is here referred to is excellently described in a casual communication contributed by Mr. William Hern before the Odontological Society of Great Britain.* In the course of his remarks, Mr. Hern thus describes the appearance of the denture in the jaw, when first he examined it:

'On looking into the mouth without a mirror, hardly any portion of the lower plate could be seen, as a large mass of granulations under the tongue obscured the central portion, while the sides were so deeply embedded that the springs appeared to work out of the gum and granulation-

* 'British Journal of Dental Science,' May 1, 1889.

tissue.* On examining the mouth with a mirror, portions of a metallic plate could be seen between the exuberant granulations; this plate had slipped downwards, backwards, and to the right of its original position, in such a manner as to cut through the frænum of the tongue and to imbed itself deeply into the floor of the mouth and the inner surface of the ramus and body of the lower jaw on each side.

'The right anterior pillar of the fauces was also cut through at its junction with the tongue. . . . The springs were cut and the upper plate easily removed, but the lower one with considerable difficulty, accompanied with a good deal of pain and somewhat free hæmorrhage.'†

To prevent this tendency to slip out of position, or 'true seat' in the jaw (a tendency which, as remarked above, is not confined to lower dentures), a system of capping the crowns, or cusps, of the natural bicuspids and molars is the usual method that is adopted—the cap, or 'tongue,' being, of course, soldered to the main plate if the latter is of gold, and imbedded in the rubber if the base plate is of that material. If this system is properly carried out in practice, it most satisfactorily achieves its purpose; if, on the other hand, certain essential points be not attended to, the experiment will result in disappointment and failure.

*Method of Procedure.*—It must be thoroughly understood, in the first place, that in providing a denture with caps for the crowns of bicuspids or molars, the object in view is not to have the denture *resting—ab initio—*on the crowns of the

* It would be interesting to know whether in this case the tissues were protected from the effects of the action of the springs by pronounced rubber shields or (as these latter are frequently termed) 'plumpers.'—See p. 92.

† It is to be remarked that the dentures referred to by Mr. Hern, and by those gentlemen who took part in the discussion which followed, belonged to individuals who did not remove them for cleansing purposes. In one case the denture had remained undisturbed for seven years and in another for ten years.

teeth by the aid of the caps, but to make such a provision as will, when the base plate has reached its true position in the jaw, prevent the undue sinking already described. And it should not be forgotten in connection with this point, that the denture, on being inserted in the mouth, will settle to a position slightly *lower* if left to itself than that which it occupied on the hard plaster cast. Hence, if for this reason alone, it is necessary, in order to obtain satisfactory results, that the caps should not come into direct contact with the cusps of the teeth on the plaster model. It is also to be remembered that in such cases (if the denture has a *rubber base particularly*) the graver may have to be used to free the parts that come in contact with the lingual surfaces of the capped teeth, in order to permit of final insertion. Hence the 'tang' A (Fig. 67), which is to be

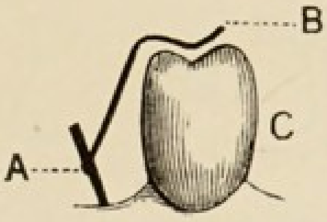



FIG. 67.

imbedded in the rubber, should be sufficiently free of the wall of the tooth to allow for *excavating*, without any danger of weakening the hold of the 'tang' in the rubber. The sketch appended (Fig. 67) will assist the reader in grasping what is meant. It gives in profile the cap B, and the tang A; C is, of course, the face, or labial surface of the tooth. This space between the plate and the corresponding surfaces of the tooth is slightly exaggerated, as it will be understood, for the purpose of illustration. A good example of the necessity of acting in the manner described is afforded by such a case as that represented by Fig. 68. Here we have the molar tilting over towards the incisors, or central line of the jaw. Now, it will be at once perceived that if the tang A is bent to the conformation of the molar as in Fig. 68, it will be impossible to insert the denture after it is finished, without denuding the gold at A to such an extent as to undermine the support of the cap B, and render it useless. It is therefore necessary, under such circumstances, to have the tang bent in the direction of the line C, not in that of A; and the rubber filling the interspace between tooth and gold may subsequently be removed sufficiently without detriment to the stability of the latter. Holes are punched in the tang—one or two, as the particular conditions may require—for the purpose of holding it securely in the rubber, and for the same reason saw cuts, or sharp file cuts, should be made around

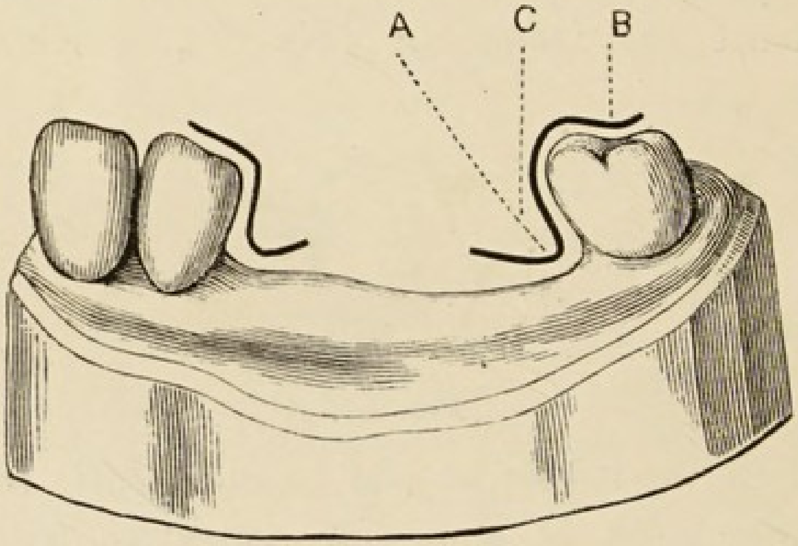



FIG. 68.

the borders. In doing so, care must be taken that the points chosen for both punching and file-cutting are not such as will impair the required strength of the gold.

To maintain the cap B sufficiently free of the crown of the tooth, one, two or more layers of pattern-lead should be carefully burnished over and between the cusps. How much 'lee-way,' so to speak, is to be given in this manner will necessarily depend upon the depth and other characteristics of the case; or, in other words, on the proportionate possibilities of its sinking.

We are, of course, now considering *rubber* cases mounted in this manner, those having a gold base-plate being dealt with differently, as shall be presently explained.

*Method of Procedure in Rubber Cases.*—Assuming that a lower denture is completely modelled in wax, and the necessary layer or layers of lead-foil moulded to the crowns of the teeth, and fastened at its borders by the flowing of a minimum tracing of hard wax: we then bend the gold plate (cut to pattern, as intended for cap and 'tang') with suitable pliers to, as nearly as possible, fit the crown surfaces, and otherwise, according to the principle already indicated. Having then adjusted the cap to its proper position on the crown, and the tang being suitably embedded in the wax plate, the flasking is proceeded with in the usual manner. All traces of plaster should, however, be cleared from the surfaces of the caps after setting the case in the lower part of the flask, and that for the purpose which will be presently alluded to.

On the flasking being completed, and the matrix cleared of wax and ready for packing, it will be at once apprehended that with the wax the gold caps and lead undercaps have also been dislodged. But we are done with the lead ones, as rubber will take their place. And as this is to be so, it is necessary to roughen the under-surfaces of the gold caps in order to make the rubber hold. This may best be done by using the quadrangular-shaped graver. The caps may then be laid aside upon the rubber heater, and the packing proceeded with and virtually completed. Then adjust a stretched-out and softened morsel of rubber over the tooth crowns, and settle the gold cap down to its true position, as accurately as may be, embedding the tang at the same time completely in the rubber behind. We then close the flask in the usual manner, *i.e.*, with damp cloth between the parts (the interleaving cloth of the rubber boxes, for example); and on reopening the flask we shall find that the superior surface of the gold caps, having come into direct contact with the opposite plaster, have been pressed into the position they were intended to take.

It may be objected that by adopting this plan there is a possibility, if not a probability, that the plate-covering may be shifted from its proper seat while closing the flask; but if due care be observed, this is less likely to happen, according to the writer's experience, than when the alternative plan of covering them over with the plaster of the lower part of the flask is adopted. In the latter case there is the risk, in packing, of breaking the plaster covering, which causes annoyance and possibly failure. Besides this, it may be found impossible to remove the lead-foil, and so we cannot have rubber packed to the under-surface of the gold. Whichever of the two methods may be adopted, however—and in certain circumstances one or other may be the best—the all-important conditions of success in this class of work are that there shall be no possibility of the denture rocking upon the crowns of the natural teeth; and second, that the superior surfaces of the caps are perfectly free from contact with the antagonizing teeth. How to secure the first of these essentials has been, we hope, explained with sufficient clearness. To comply with the latter condition, if the antagonizing teeth are artificial it is a simple matter to grind the cusps to accommodate the caps; if the opposing teeth are natural ones, however, we must fit the *caps* to accommodate *them*. In cases of the latter description it is therefore necessary to study well the occlusion of the jaws and fit the caps to those parts of the crowns only that are free when articulation is complete. Under these circumstances an extensive covering of the cusps is manifestly impossible; so that in order to secure our object, and at the same time have the bite clear, we must make the caps in the form of clips or tongues, filling the depressions *between* the cusps which afford a sufficient space.

Where the denture has a gold plate for 'base,' there is not the same necessity—nor is it desirable—that a like loose fitting of cap and tang should be given, as in rubber cases; for presumably the plate has been tried to the mouth and found to be easy of insertion and withdrawal, and so the close fitting of the *tang*, at least, may be safely and beneficially indulged in, in its connection with the wall of the tooth. Over the crown, however, there is still the necessity for having the cap perfectly free from contact with it, which is satisfactorily effected by having one, or it may be two, layers of pattern-lead fitted and fastened to the crowns before proceeding with the casting in sand. The slip of gold plate which is to serve as cap, with a continuation behind to connect the main plate by splicing and soldering, is cut to pattern, and first of all being bent by the aid of pliers to a shape approximate to the position it should occupy ultimately, it is then placed between zinc and counter and struck so as to fit accurately. The steel punch may have to be used to assist in accomplishing this satisfactorily.

A modification of this system of capping may have to be used in many cases, where an 'advanced' swivel has to be fixed, as, for instance, when the natural teeth, up to and *including* the first molar, are in sound condition. Under such circumstances, wire to form a bridge over and between the bicuspids, and flattened at the part which terminates at the labial necks of the teeth, with a piece of plate or flattened wire continued around the molar as far as may be necessary, the two being soldered together near the lingual necks of the teeth, provides a platform on the labial aspect upon which a narrow strip of plate with swivel may be mounted. The whole thus makes what may be called a skeleton frame, the back part formed to hold in the rubber, and the labial portion to carry the swivel. The secret of success in this, as in the former cases described, is contained in having the bridging wire, etc., absolutely free from contact with the natural teeth.

## CHAPTER XI.

### COMMUNICATION BETWEEN SURGERY AND LABORATORY.

THE most convenient method of communication—when both rooms are in juxtaposition—is by means of a door which gives immediate entrance to the laboratory from the surgery. There is, however, the following objection to this plan, viz., that the sound of hammers and files vigorously used (as they often are) must be irritating to many patients, and also must be a cause of distraction to the operator himself. So that—assuming that these rooms are being specially designed and constructed for dental purposes—it is most desirable that a smaller room should be situated between surgery and laboratory; so that, by having this intervening space and double doors, the sounds already referred to are much deadened, if not made quite inaudible.

In circumstances where the laboratory is on the basement floor, and the surgery on the higher one (yet in the same *neighbourhood*), a similar arrangement, with the addition of a flight of steps, provides the most facile means of communication.

If the methods just described cannot conveniently be adopted in practice (while at the same time the working rooms occupy a similar relative position to those already referred to) an excellent substitute will be found in what may, perhaps, best be described as an elongated wooden box of about six inches square, internal measurement. A knee-joint added to the apex permits the contrivance to be introduced to the most convenient part of the surgery, or to a location easily accessible from it. The accompanying sketch, Fig. 69, will perhaps enable the reader to more precisely understand what the writer wishes to convey.

The letter A represents the opening to the laboratory and the little platform upon which the box C rests when

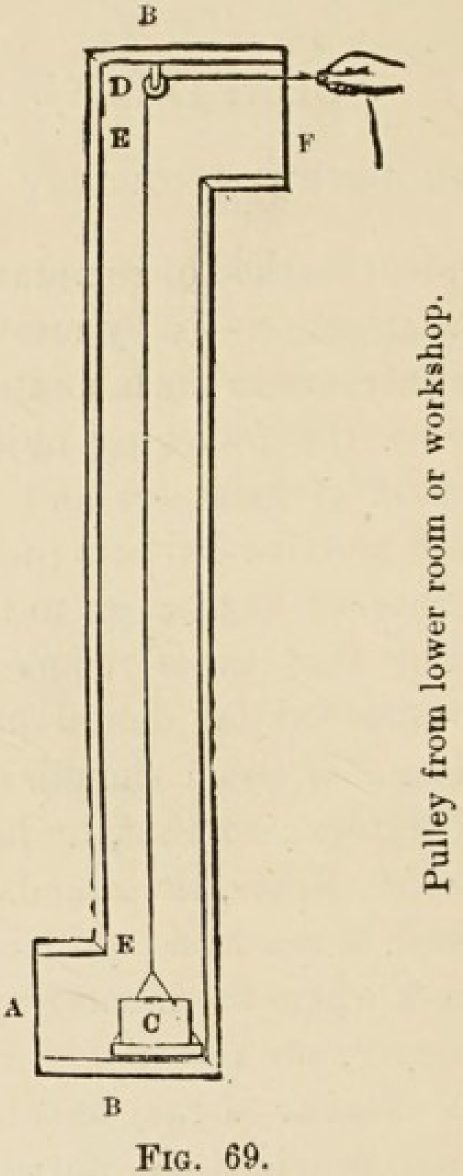



Fig. 69.

not in use. B B represents a section of the square box, up and down which C, containing cases, etc., is raised or lowered by using the cord E; D indicates the position of the pulley over which the cord E E runs. F is the point of communication with the surgery or room adjacent and convenient to it.

It will be obvious to the reader that a contrivance of this kind serves not only as a means of conveyance, but also as a means of communication by *word of mouth* between the two departments. A bell arrangement suited to the circumstances is, of course, adopted for signalling.

If the situations of operating-room, or surgery, and laboratory are distant one from the other, we have then to choose for verbal communication one or other of two modes, viz., the ordinary speaking-tube or the telephone. With regard to the speaking-tube, it is, perhaps, not going too far to assert that it is, for several reasons, as unsatisfactory as it is antiquated. Should the line of tube be direct, or nearly so, no doubt the speaking tube will be found a sufficiently convenient medium; but assuming that there is a considerable distance for the sound to travel and that knee-joints on the pipe are necessitated by a tortuous passage, then, surely, the telephonic system will be adopted. It is in such cases not only the most completely satisfactory means of conveying verbal messages; but it is also the least expensive.

## NOTES TO PRECEDING CHAPTERS.

*Chapter I.*—The following observations, made by Dr. Trueman, and which specially have regard to the dental laboratory, are taken from the 'American System of Dentistry.'

'In a dental laboratory light and ventilation are of the utmost importance. Although an operator who does his own mechanical work may spend in it but a few hours a day, they are usually made up of spare moments that would otherwise be devoted to much-needed rest, and should therefore be made as much as possible a relaxation, and not a continuation of the labours of the chair. Laboratory manipulations conducted in a close, crowded, poorly-ventilated room, selected solely because it is undesirable for other uses, and can on that account be better spared, are not conducive to the operator's health, while a few hours so spent in a well-appointed workroom, at an employment so different from that of the office, and which brings into active use muscles comparatively inactive at the dental chair, may prove a pleasant recreation and a rest. It may at the same time enable him to accomplish with his own hands operations that could not be satisfactorily explained to an assistant, however skilful. The progressive dentist usually makes the laboratory a study as well as a workshop. It is here, surrounded by the conveniences it affords, that most of his microscopic work is done, and chemical and other investigations are conducted. It thus becomes important that its conveniences and healthfulness should be carefully considered.'

*Ventilation.*—The question of ventilation is a consideration of so much importance, and has so direct a bearing upon the comfort, health, and capacity for work of the operator, that no apology need be offered for referring to the subject more in detail than has been done in the above-named chapter. In doing so, and in quoting from those writers who may be accepted as authorities, only such salient points, however, as are of primary importance are presented to the reader. Lakeman (whose lectures on 'Health in the Workshop,' will well repay perusal) says: 'Under the most favourable circumstances the air of an inhabited room cannot be maintained in as pure a state as the external air; therefore, the object of ventilation is to keep it so pure that it shall not be injurious to health. . . . The chief point, therefore, to be determined is, what is the maximum amount of impurity consistent with the maintenance of perfect health? or, in other words, what amount of carbonic acid shall be accepted as the maximum standard of permissible impurity? Dr. Parkes has given it as his opinion that, allowing 4 volumes as the average amount of carbonic acid in 1,000 volumes of air, the standard ought not to exceed ·6 per 1,000 volumes, because if this ratio is exceeded, the organic impurities, as a rule, become perceptible to the senses. With a ratio of ·8, ·9, or 1 per 1,000 volumes, the air smells stuffy and close; and beyond this, it becomes foul and offensive. In a variable climate like ours, the allowance of cubic space is a most important element in any such scheme of ventilation, and should be ample enough to permit of a sufficient supply of fresh air, without creating injurious draughts, and yet not too large to interfere with the maintenance of a sufficient and equable temperature during cold weather.

The simplest way of obtaining change of air in a room is to take advantage of the movement of the air produced by changes of temperature, or by the action of the winds. In every room in which there is an opening at the upper part, out of which the warmed air can pass, and an opening either level with or below it through which fresh air can flow in, the system of ventilation by difference of temperature will operate.

Various forms of window-pane ventilators are in use, the best of which are the Hopper ventilators, but these are only as makeshifts, for it is profitable to adopt ventilation independent of window-openings.

Where a room has two outside walls, and is provided with openings on both sides, the inflow and outflow of air is almost certain to go on continuously in consequence of the movement of the outer air, which is rarely at rest. The Sherringham valve inserted at regular intervals in the wall, about eighteen inches from the ceiling on both sides of low rooms, or about ten feet from the floor of lofty rooms, is the most convenient form of ventilation for rooms so constructed.

The most suitable method for ventilating the smaller workrooms is probably that devised by Mr. Hinckes Bird, which consists of raising the lower sash of the window two or three inches and filling in the opening under the bottom of the sash with a piece of wood. This leaves a corresponding space between the sashes in the middle of the window, through which the entering current of fresh air is directed towards the ceiling.*

*Water Heater* (p. 7).—In the engraving (p. 8) the dimensions of the heater appear greater than what is really the case. The length of barrel is about fourteen inches, and the reader must understand that it may be fixed in any position over the basin which will best serve the purpose in view; the situation of the outlet in the engraving, for

* J. B. Lakeman, Esq., H.M. Senior Inspector of Factories.

instance, would be an inconvenient one for the plotting out of wax from flasks.

An arrangement for this latter purpose suggested by Mr. Lombardi will be found to be a great convenience in many

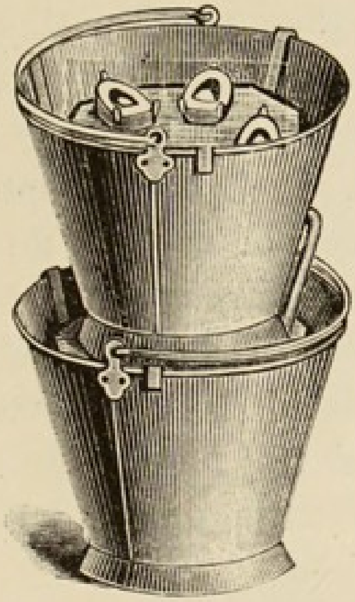


FIG. 70.

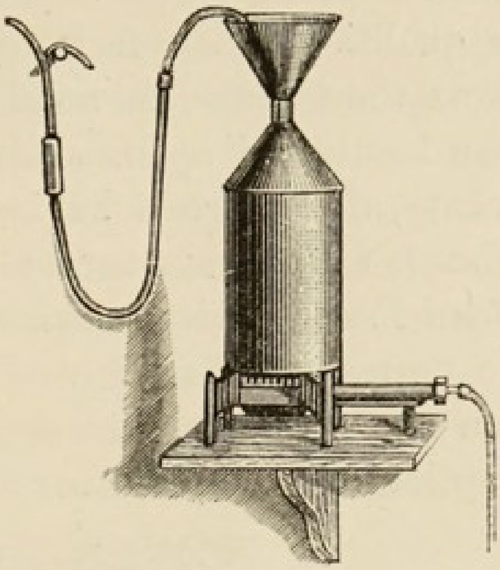


FIG. 71.

laboratories. The method of using it is described as follows:

Put water into the can (fig. 71), place it upon a burner; when it boils it is ready for use. Pour cold water into the upper pail (fig. 70) until it reaches the top of tube seen on the right hand side of pail. Place the models on the wood support, as shown, and with the blow-pipe nozzle from can direct the stream of boiling water on to the wax, the whole of which will be removed in much less time than by any other method. To obtain a slight steam-pressure, which increases the force of the jet, a metal tube is bent over the mouth of the can, and weighted where it enters the constricted neck. The higher the can is placed the greater will be the weight and pressure of jet. The india-rubber tubing should be long enough to reach the pails standing on the floor. The lower pail is, of course, empty at starting, the water running into it from the upper pail will be quite clean. Particles of plaster, metal filings from the bench, etc., remain at the bottom of the upper pail, the wax collects on the surface of the clean water, and when about 2½ inches thick it may be lifted out in one cake perfectly clean and usable.

*Investment Heater.*—This heater, if used with the dome, should be carefully attended to in the process of preparing the case for soldering. With a full supply of gas, and the dome in position over the invested teeth, sweating of the plate may result from temporary neglect.

*Chapter II.—Bench.*—The thickness of wood recommended by Dr. Trueman for the working bench is two inches; and if he errs at all on this point, he errs on the safe side. It is better to have a bench of full thickness, rather than one that is of slender build. Not only is the latter wanting in the qualities which facilitate operations, but, as everyone knows, the thinner the wood the more piercing is the sound when hammered upon. Nevertheless, it may be accepted, perhaps, that a bench having a thickness of one and a half inches is fully commensurate with our requirements.

*Gold Tray.*—This pattern of tray, which has been brought into notice by Mr. Howarth, is a decided improvement upon the ordinary shell-shaped metal trays used for the reception of gold and other filings and cuttings; and where

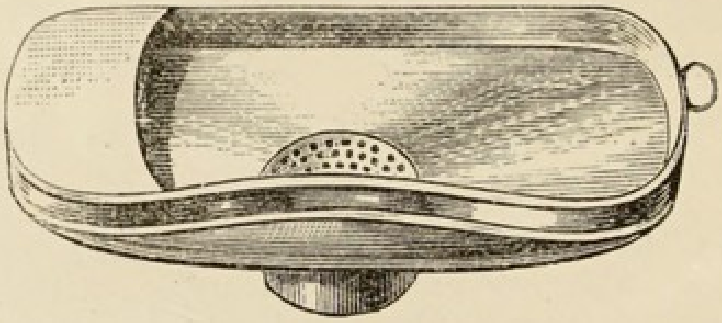


Fig. 72.

a drawer is not used such as that described on a previous page, it is the best substitute that can be had.* The advantage of having the hood is at once apparent; and without risking the loss of cuttings or filings, the tray may be hung up when not in immediate use, within easy reach of the operator.

*Chapter III.—Plaster Bowls.*—The rubber bowls introduced some years ago are not, in our opinion, to be preferred to those made of ordinary earthenware for the mixing of plaster. It is asserted in their favour that they are more easily cleared of *débris* by the simple closing in of the rubber wall; but

* This tray is supplied by the Dental Manufacturing Company.

this can hardly be maintained as a fact. They are not, in the first place, so congenial for the *mixing* of plaster as the ordinary glazed bowl ; and, in the second, with the latter a glassful of hot water will instantaneously loosen the waste plaster when set, *in toto*. After being in constant use for a few months new ones should be substituted; for by that time the glazed surface has been lost which makes their cleansing so easy, and the insignificance of their price renders this renewal a matter of little consideration, and besides, the discarded ones will be available for other purposes. The rubber bowls, on the other hand, are expensive, and soon become difficult to use satisfactorily.

The knife on swivel-block, for cutting plaster, here represented (Fig. 73) is doubtless an acquisition to the plaster-

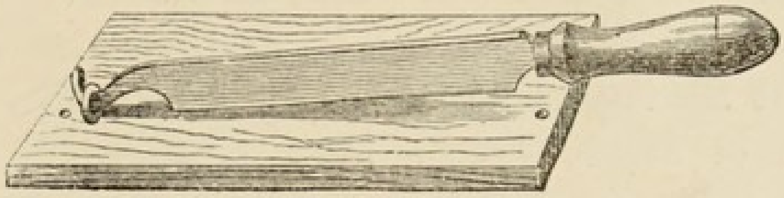


FIG. 73.

bench ; it is not, however, an essential implement, and if the bench space is confined it may easily be dispensed with.

*Plaster Bench.*—In addition to the plaster mixing-knife, spoon, or spatula, and the paring-knife (a shoemaker's knife makes a good one), it is well to add a small carpenter's saw to the belongings of the plaster bench; this, when fixed between the jaws of the large vice, will be found most useful when it is necessary to cut a thick section from a hard or stearined model, as, for instance, when it is desired to prepare a plate model for setting in the articulator. The swivel-mounted cutting knife illustrated here, although not an essential appurtenance to the plaster bench, may be considered an acquisition where the bench space is liberal.

*Chapter IV.—Lathe.*—There is to be had, from the firm of

S. S. White, of Philadelphia, a laboratory lathe which is worked by an electro-motor. This is an undoubted acquisition, and it is to be hoped that we are within a measurable distance of having such in all laboratories. As each individual possesses only a specific amount of energy, it is certainly unfortunate that so much of it must needs be expended upon the very mechanical function of driving a foot-lathe. At present, however, if for no other reason, the price is a deterrent which will prevent the general adoption of this form of machine. For the lathe complete—*i.e.*, including lathe-head and ten mandrels, lathe-stand, Rhodes' motor (variable resistance)—the price is in the neighbourhood of £15; added to this original cost there is the cost of maintenance.

*Guillermin's Dynamomètre.*—Like all who have had much experience with spiral springs, M. Andrieu impresses upon his readers the importance of having both springs belonging to a set of absolutely the same measure of elasticity. Springs taken at random from the same packet and asserted by the dealers to be of equal strength are found, on careful trial, to differ in degree of elasticity; hence M. Andrieu recommends testing them before adjustment to a denture by means of a Guillermin's Dynamomètre. For those who have a fairly delicate sense of touch, however, probably the usual test between finger and thumb is sufficiently accurate.

*Chapter V.—Vulcanizers.*—Through the kindness of Mr. McLeod and Mr. Cormack, of Edinburgh, and Mr. Biggs, of Glasgow, the writer is enabled to give the mature opinion upon this subject of these well-known practitioners, acknowledging at the same time freely the better title their judgment has to consideration. In his own words, Mr. Macleod says of Campbell's Vulcanizer: 'My opinion of "Campbell's New Mode" is that it is a most ingenious machine, and the best vulcanizer and celluloid machine on the British market, but it is not suited for general workroom or moderate fee and rapid work. It takes an *expert* to handle it; therefore the labour is costly. It can only vulcanize one case at a time; therefore the "turn out" is limited, and the remuneration must be in proportion to these two factors, which will always restrict its use to high-class and limited practice, or special cases in general practice. But I would not therefore say it is an expensive luxury, but rather class it as a profitable luxury in ordinary practice, and a necessary in high-class ones.'*

The favourable opinion of this machine formed by Mr. Biggs is quite as emphatic. He says: '. . . Your statement in regard to the capacity of vulcanizers is so far from correct that I thought it better you should thoroughly understand the difference. Now, I can promise you that a case may be vulcanized in the "New Mode" with teeth having no pins or other attachment, and they will adhere as firmly as if they had, proving conclusively that there is not the slightest shrinkage or warpage with rubber so treated; nor after years of wear will *débris* of any kind permeate between the tooth and rubber.' Again, Mr. Biggs remarks, in concluding a previous letter, 'Campbell's "New Mode Vulcanizer and Celluloid Apparatus," I venture to say, cannot be equalled by any other maker in the market up to date, for high-class work. It is, however, not in demand, for one or two reasons. The time it takes in doing its work well involves nearly an hour longer than that required by other vulcanizers; it is a costly tool, and requires a first-rate mechanic to thoroughly understand it and get its best results.' The views entertained by Mr. Cormack with regard to the same matter are not apparently so warmly in favour of this machine. His opinion is ex-

* The words in these last passages have reference to the opinion hazarded in our letter of inquiry to Mr. Macleod, to the effect that 'Campbell's Vulcanizer' was an expensive luxury.

pressed in the following words: 'It requires so much care in its use that it cannot be left to the tender mercies of assistants; therefore it is quite useless in a busy workshop. It makes a very good rubber, but it takes four to five hours to fire it.'

So that practically there is a consensus of opinion of these practitioners, so well qualified to speak with authority upon this subject, which resolves itself into this, that the machine is an excellent one, but not likely to come into favour where there is a constant and hurried general practice.

*Chapter VII.* (p. 95).—Duplicate rubber palates very nearly approaching to perfect accuracy may be made in the following manner: Flow plaster of Paris over the lingual surface of the original rubber case, bringing the plaster up to the tips of the teeth, and allowing a considerable bulk of material. When set and parted, cut available parts dove-tailed fashion, with the view of locking this mould into the fresh plaster of the last section of the flask. Assuming, then, that the second, or intended duplicate case, is mounted and placed on the firing-model, fasten securely around the labial border the case to the model with melted wax; we may then cut out the wax palate and all of the wax that is in the way of the plaster cast taking its position. On putting the parts together, the posterior border of cast and model should be hermetically sealed, when the flasking is proceeded with in the usual manner.

*Chapter VIII.—Celluloid.—Continuous Gum Work.—Crown and Bar Work.*—The writer would not have ventured to touch upon the subjects which form the heading for this chapter, if only his own personal knowledge had been his attempted justification for doing so. For, though well acquainted theoretically with these different systems of accomplishing prosthetic work, and not without practical experience in the *modus operandi*, yet there is wanting that thorough practical knowledge which alone can make an expressed opinion of value. Through the generous assistance, however, of Mr. Cormack, sen., and Mr. Macleod,* of Edinburgh, and of Mr. Biggs,† of Glasgow, the writer is enabled to give the opinion on these specialities of practitioners who have had more than ordinary experience, and whose judgment must necessarily be respected and valued.

*Celluloid.*—Whatever may be thought of celluloid as a lasting and otherwise satisfactory material to form a base plate for artificial teeth—whether those are right who state that, with sufficient care exercised, *most satisfactory* results are produced, or those are who as confidently maintain that for prosthetic purposes it is quite an unreliable material to use as a base—there is a consensus of opinion that there is but little probability that celluloid will ever come into general use.

To take the most flattering account of the results obtained when this material is manipulated with the utmost care, we give the experience of Mr. Biggs in his own words. 'Celluloid undoubtedly is as reliable and lasting in every respect as the best rubber cases made. It has been abandoned by me, as it involved my personal supervision to too great an extent.' Mr. Macleod expresses his views less confidently as to the inherent value of the material for prosthetic purposes. He observes: 'With regard to celluloid, it has many good qualities, but for general adoption it lacks one thing which is absolutely necessary in moulding where thin and frail porcelain forms part of the combination, viz., flowing power when at its softest stage. This almost restricts its use to plain contour

* Dean, and Lecturer on Dental Mechanics, Edinburgh Dental School.

† Lecturer on Dental Mechanics, Glasgow Dental School.

upper and unders, unless wrought with exceptional skill and patience. I find it wears very well for five or six years, after which it becomes fibrous, and presents the appearance of a frosted turnip. When it reaches this stage it will not repair.' Mr. Cormack has not had so much experience with celluloid, being afraid to introduce into general practice a kind of base plate which appears to him to have many drawbacks. He does not 'consider it reliable, as it wastes very rapidly in the mouth. Then the great difficulty—almost impossibility in some cases—of repairing it is another great drawback.' The reader has thus presented to him the optimistic views upon the subject of Mr. Biggs, and the rather pessimistic views of Mr. Cormack; but it will be observed that in one essential particular all are agreed, and that is that celluloid is not likely—from one cause or another—ever to take an assured place among dental bases.

*Continuous Gum Work.*—The beauty of this class of work, when properly accomplished, leaves little to be desired as a substitute for the natural gums. There is, however, a difficulty in obtaining 'uniformly' the best results; and even assuming that the utmost skill is exercised, and that the results prove eminently satisfactory, we are met with the fact that the great cost of production renders what may almost be termed a prohibition fee absolutely necessary. Such cases could not be made promiscuously in a general practice; and so we find a general concurrence of opinion among those who have adequate experience, that, for the present at least, 'continuous gum work' is not likely to be adopted to any considerable extent. In the following words, the authorities already quoted express their opinions: Mr. Biggs states: 'The Verrier process for continuous gum work is bound to make headway, and become a more important feature in dental practice in time. At present the great desideratum is a better furnace that will thoroughly overcome the tendency to gassing. The difficulty of getting mechanics with sufficient ability to manipulate continuous gum work in a highly artistic style will prevent it becoming a thing of common practice.' Mr. Cormack has had full experience in both the Verrier and the Allen systems. He 'condemns the former, as the firing by gas causes a much too sudden change in the temperature, making the gum and teeth liable to crack in vulcanizing and afterwards in wearing. By the Allen method, strong and pretty work can be done, but the difficulty and length of time required in the manufacture is often quite out of proportion to the results gained. Here, again, the difficulty of repairing or altering becomes a very serious consideration. Our late assistant (Mr. Turner) has been very successful lately with some work he has done by the "Allen" method, but he used Ash's new and easily fused body, instead of the old Allen mineral.' The expression of opinion just recorded coincides with that of Dr. Haskell, who has had a very extensive experience of this type of work. He says: 'For *furnace,* both the coke and gas and "hydro-carbon" are being used. For some reasons I prefer and use the coke furnace. I like a large-sized muffle; it is more convenient to work in. I have always used the large-sized Philadelphia furnace, taking a 14-inch muffle. I arrange the bars so as to dispense with the bottom, and pull the bars to drop the ashes. The furnace should be arranged with a shelf in front of the muffle, on which to place the work for slow entrance into it. The muffle should be luted with fire-clay only at the front, leaving the rear free, as there will be less danger of cracking across the middle from shrinkage in a high heat.

'The clinkers should, from time to time, be removed from the sides of the furnace with a cold chisel, striking sudden blows, so as not to injure the lining. Tees' Lilliput Furnace I have used often in demonstrating. It works nicely; my principal objection to it is that the muffles are small and thin. There is a hydro-carbon furnace make by Hoskins, Chicago, which does good work: the heating arrangements may also be used for a melting furnace for refining gold, etc.

'The Verrier Gas Furnace is very objectionable for two reasons—its constant liability to "gas" the work, and the lilliputian dimensions of the muffle; some sets could not be put into it.

'Anyone intending to undertake the construction of continuous gum work had better take instructions from some competent dentist who has had experience in the work, as there are many little details which can only be learned in this way.'

The writer has refrained from attempting to give a description of the *modus operandi* either in celluloid or continuous gum work; for that the text-books and journals will be consulted; yet it can hardly be without advantage to the reader to be put in possession of the opinions of those who are entitled to speak with authority.

## LABORATORY HINTS AND SUGGESTIONS.

**Anvil.**—Dr. Trueman, in the 'American System of Dentistry,' recommends that the anvil should weigh not less than twenty to thirty pounds.

While striking, flatting, or breaking small objects on the anvil they should be wrapped up in one or several folds of strong paper or cloth before striking.

**Cleanliness and Order** are of first importance in a dental laboratory; a few tools sharp and in good order are far better than a large number carelessly kept. (W. H. Trueman, D.D.S.)

**To Clean the Hands.**—In the first place, see that the basin used has no trace of plaster about it; rub the hands well in warm oil, then sprinkle with powdered borax, and wash off in the usual way.

Another method suggested is to use Hudson's dry soap, which, if sprinkled on the hands while washing, will effectually remove all dirt. To counteract the tendency to roughness after using apply glycerine and rose-water 1 in 10. (*Dental Record*, 1889.)

This subject of cleanliness and order in the laboratory cannot be too much insisted upon. Let this habit be thoroughly grounded into one, and he will find in it that great source of facility and readiness in manipulation which is not less valuable in what appear *common* operations than it is in those that are of greater importance. A *per-*

*suasion* and *conviction* must exist that arrangement, order and cleanliness are essentially necessary in the laboratory. In the words of Dr. Johnson, 'These are trifles, it may be justly said; but when aggregated, they are then no longer trifles.'

**Lubrication.**—The following are the principal oils used for general purposes in engineering workshops:

*Sperm Oil.*—The best in ordinary use for machinery. For such as is accurately fitted and run at a high speed or under a light pressure, sperm oil is especially well suited, and it is to be regretted that its cost frequently causes inferior oils to be substituted for it.

*Olive Oil.*—For general machinery. Open to the objection of freezing readily.

*Lard Oil.*—Used as a substitute for sperm oil for light machinery. Freezes very readily, and becomes very fluid with heat.

*Rangoon Oil.*—This name, originally given to an oil derived from Burmese tar, is now applied to a similar product extracted in this country from American petroleum. It possesses valuable qualities in its absence of gumminess after exposure to air, freedom from action on brass and copper, and fluidity at low temperatures. These render it especially suitable for preserving metal-work from oxidation, and have led to its recommendation and adoption by the War Office authorities for the preservation of small arms. For lubricating machinery, except under light pressures, it is rather deficient in 'body,' but this is sometimes corrected by adding to it a small percentage of some animal oil. (*Science Series*, Shelley.)

**Models.**—After being stearined, plaster models should never be immersed in hot water, as one might do, for example, in separating model and bite after casting the latter; the stearined cast, if so immersed, becomes much injured in tone, and will probably give much subsequent annoyance from breaking or becoming abraded. The parts of the plaster cast should be well lubricated over which the 'bite' plaster is likely to flow, and when the latter is *thoroughly set*, the tap of a hammer will disengage model and bite, which last is *then* placed in hot water to soften the wax, or other material with which the bite has been taken.

**Softening Wax, etc., on Models or Bites.**—In separating wax or composition from the cast, full time should be given for the *sufficient softening of the entire material*. Though the outer parts may be soft, the parts which grasp the teeth may be hard, and so endless trouble and vexation will be encountered by the breaking of essential parts of the plaster cast. This is an important point to be observed, and the operation should only be entrusted to a substitute whose carefulness can be depended upon.

**Models for Exhibiting.**—When it is desired to have specimen models of singular cases met with in practice, the plaster should be mixed with a solution of borax ; and after the model is carefully dried, it should be placed in a bath of paraffin slightly coloured with gamboge or 'dragon's blood.' It then has the appearance of the beautiful Italian marble. One can then wash and clean it as often as may be required. It is the borax which gives it that peculiar 'demi-transparence' to which it owes its fine appearance.

**Drills and Drilling.**—The following observations on this subject cannot but be of interest to the reader : 'To arrive at the best results in drilling, each of the cutting lips should make the same angle with a central line taken through the body of the drill ; in other words, the angles should each have exactly the same number of degrees, say 60°. The clearance angles also should be identical, and the leading point should form the exact centre-point of the drill. From practice it is found that if these proportions are not correct, the drill cannot pierce the metal it is drilling at more than about half the proper speed, and the hole produced will also be larger than the drill itself.' Again, 'small drills, such as are used by watchmakers, are generally made by filing the round steel wire slightly tapering, and then spreading the small end with a single blow from a tolerably heavy hammer. Using a light hammer, and effecting the spreading by a series of gentle taps, will effectually spoil the steel. There is no occasion to anneal the steel for hammering, providing it is moderately soft. Very small drills can be made from good sewing needles, which are of convenient form to be readily converted into a drill. Firstly, the needle must be made sufficiently soft for working, by heating till it assumes a deep blue colour. The extreme end may be made quite soft, and filed, slightly tapering to a trifle less than the size of the hole to be drilled. The point is now spread out by a sharp blow of a hammer—not by gentle taps that would cause the metal to crack—and filed up to shape, the point being made more blunt than would be used for drilling ordinary metal. The thickness of the drill across the flattened part should be about a third of the diametrical measurement. Finish up the end on a strip of Arkansas stone. . . . It is the great difficulty of getting such a very small piece of steel to an exact predetermined degree of temperature—hot enough to harden, but not so hot that it is burned—which makes the manufacture of these small tools so uncertain. The justice of this remark must be appreciated by all who have been in the habit of forming and tempering drills for general or particular purposes. This is abundantly proved by the fact that of half-a-dozen drills made from the same wire it often happens that some are exceedingly good, while others are of no use whatever, the difference being caused by the manipulation during handling.' By heating the drill and plunging it into the body of a tallow candle, the *hardening will be effected*; yet the steel will not be rendered so hard that it crumbles away under pressure in use. Thus, in one operation, the drill will be hardened and tempered. 'Instead of tallow, white wax, sealing-wax and such like materials are adapted to the purpose. . . . The best plan (for tempering small drills) is to exercise the greatest possible care not to overheat the drill, and harden and temper in one operation by plunging into tallow.' ('Workshop Appliances,' Shelley.)

**Black Diamond Drills.**—With respect to these, Dr. Hunt* considers them invaluable for counter-sinking the tubes in pin teeth; 'they never seem to wear out, although their setting does. They are mounted at the end of an iron or soft steel wire, about the size and length of an ordinary engine burr, and may be had from $\frac{1}{32}$ to $\frac{1}{8}$ of an inch in diameter at a cost of two shillings each. They can easily be fitted into the workroom lathe-head, or, when of burr size, run in the dental engine.'†

*Rolling Mills.*—When these are not in use the rollers should be carefully covered, and their surfaces slightly coated with cosmoline, to prevent their being injured by dirt, rust, etc. (Dr. Trueman.)

*Sweating teeth off Plates.*—This process is not so absolutely safe as that of cutting the soldered teeth with the fret-saw, but in many cases of repair (especially where no delicate fasteners are adjoining) it is a very satisfactory and facile means of accomplishing our purpose. The danger to be apprehended is, of course, the cracking of the teeth under the blowpipe flame while sweating them, but this risk may be reduced to almost a nullity, if the simple precaution be taken at first of freeing all trace of moisture about and between the teeth, by a careful application of the bunsen flame. If this be effectively done, it is then only necessary to give a thin coating of whiting or plaster to

* 'Dental Record,' 1889, p. 581.

† The address of the supplier of these is 356, King's Road, Chelsea.

the teeth surfaces; and when this is *thoroughly* dried over the bunsen, heat up plate and invested teeth, and *well melt the solder* before tipping, with the nozzle of the blow-pipe, the teeth away from the plate.

*Setting Edge Tools.*—In theory the operation of setting a cutting-tool—like that of grinding it—is simplicity itself, being merely the formation of two flat facets inclined to one another at a certain angle, their intersection forming the cutting edge; and, indeed, in tools which are ground with a single bevel it is only necessary to produce one of these facets, the flat, unground side taking the place of the second. But in practice there is great difficulty in continuing the operation just so long as to obtain the complete intersection of the facets at all parts of the edge, without anywhere throwing up the wiry film already mentioned, which is formed upon the oilstone as well as upon the grindstone. Its presence, however, is quite incompatible with the possession of a keen and durable edge, and its removal must therefore be effected whenever it occurs, which may be done, though not very effectually, by drawing the edge across a piece of soft wood or over the thumb-nail In any tool ground with a single bevel, slight treatment of the unground side also upon the oilstone will be found to assist in removing the wire edge, but in doing this care must be taken to keep it flat on the stone and in no case to form a facet on its edge, which, as already pointed out, in almost all cases, is a certain method of destroying its efficiency.*

*Teeth-setting.*—In such partial cases as have natural canines or first bicuspids remaining, with clasps for fastening—which it is desirable to have covered by the artificial teeth as far as possible, for appearance' sake—we should proceed as follows: First, reduce the labial extremity of the clasp to an extent compatible with retaining the den-

* 'Workshop Appliances' (Shelley)—Text Books of Science Series.

ture securely in the mouth; this, to be done properly, requires careful consideration before commencing operations, for a careless or ill-judged cut of the shears or passage of the file may have a disastrous result as regards the retention of the denture in the jaw. We should then (having chosen teeth for such cases of a roundish contour, if possible) carefully groove, or, as it were, 'tunnel,' that part of each tooth which comes in contact with the clasp. The point in view is to free the *side* of the tooth only, while its *face* surface remains intact, and approaches to the natural one so nearly as to sufficiently cover the clasp. It need hardly be said that the judicious tapering away of the latter, and the grooving of the former, require the nicest manipulation.

There are, again, instances repeatedly met with in practice where prominent natural teeth, by reason of the occlusion, would give to the artificial ones in the opposite jaw an objectionably irregular position, if the latter should be set in what, perhaps, may be termed the usual way. To give an instance of what is referred to: Suppose we have a case in which the bite is close, and the lower natural tooth protrudes in closing upon the backs of the artificial upper ones, and which latter are placed by the side of a natural upper canine or bicuspid. The result will be—if the setting is carried out in the usual orthodox manner—that the artificial tooth or teeth will be thrown into a position that is objectionable in appearance and probably detrimental to comfort. In such cases we should, in fitting the artificial teeth, give the first one—that next the natural tooth—a turn inwards towards the latter, while its distal, or posterior wall, is turned outwards; exactly the contrary setting should be given to the *second* artificial tooth, which, in meeting the other, forms with it the segment of a circle. We are, in this instance, supposing that the lower natural tooth closes in a pronounced manner *between* the artificial uppers. But in all cases of isolated teeth protruding excessively this system of meeting the difficulty may be to a greater or less extent successfully adopted. In short, it consists in setting the teeth according to, and *accommodating* the character of, the opposing natural, instead of setting the artificial after any arbitrary rule.

*To find the Specific Gravity of Metals.*—Suspend the piece below one scale of a balance by a fine filament of raw silk and weigh it. Then lower the balance so as to allow the metal to be submerged in water, and weigh again. Divide the weight in air by the difference between the two weights, and the quotient is the specific gravity. The water must be pure.

**Aids to Polishing.**—A celluloid disc, used at the back of a sandpaper disc, not only stiffens the latter and keeps it in place, but adds also to its cutting qualities. The celluloid disc can be easily made out of thin sheets of celluloid. Again, strips of the same material used with corundum make excellent polishing strips; the celluloid used should be rough, not glazed or highly glossed, as it holds the powder much better.—'Laboratory Gossip,' J. B. D. A., August 15th, 1892.

**Gas Governors.**—The advantage, not alone in economy, but in other respects, of being provided with gas-governors is now generally conceded. Which of those supplied by the various makers is best, it is difficult to determine. Even Mr. Fletcher appears to be somewhat undecided upon this point; his latest opinion is, however, that for domestic and office use the governor made by Carter and Lees, of Oldham, is to be preferred on account of its simplicity and superior staying qualities; where the greatest accuracy is required, however, he is of opinion that such as are made by Hearson and Co., of Regent Street, W., are superior. The drawback to these last is their liability to get out of order.

**Oil Stone.**—In a former page has been expressed the opinion generally held that the Arkansas stone is best for our purpose; but M. Andrieu asserts that those which come from the Levant, and are of a white inclining to a blond or flaxen hue, are best of all. They are mounted in a small wooden box, with a lid or cover to protect their surfaces from dust, etc., and prevent their being broken by an accidental fall.

**Filtered Water for Laboratory Use.**—M. Andrieu maintains that for certain purposes filtered water should be used—as, for instance, for the borax slate—for water as it is commonly supplied in towns sometimes contains such a percentage of lime, etc., as may interfere considerably with the successful accomplishment of certain work.

**Rusting of Tools.**—To prevent the oxidizing or rusting of steel instruments, it is well to rub them lightly with mercurial ointment. To *remove* rust, rub them with oil, then, forty-eight hours after, with quicklime, until the rust disappears. (Andrieu.)

# APPENDIX.

Metric System.—It is much to be regretted that this admirable system of designating the gradations of weights and measures has not yet been adopted generally in Great Britain; and that not only on account of the simplicity of the principles upon which it is based, but also because the metric system being now the standard adopted by nearly every civilized country, we are continually being brought into contact with a manner of stating measures of weight and capacity which is entirely strange to us. It is for the latter reason—viz., to enable such as may perchance meet in the course of reading, or otherwise, with this difficulty—that the following table is submitted to the reader:

The mètre (unit of measure) = 39.37 English inches.

The litre (unit of capacity) = 1.0567454 English quarts.

The gramme (unit of weight) = 15.43234874 English grains.

The kilogramme (unit of commercial weight) = 2.20462125 English pounds avoirdupois.

The higher denominations have their derivatives from the Greek; the lower from the Latin, thus: décamètre, hectomètre, kilomètre, and myriamètre represent progressively 10 mètres, 100 mètres, 1,000 mètres, and 10,000 mètres. The *decreasing scale* from the mètre being designated by the Latin prefix is then décimètre, centimètre, millimètre; the $\frac{1}{10}$th, $\frac{1}{100}$th, $\frac{1}{1000}$th part of a mètre.

## TABLE FOR CONVERTING MÈTRES INTO FEET AND INCHES.*

| Mètres. | 0. | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 |
|---|---|---|---|---|---|---|---|---|---|---|
| | ft. in. | ft. in. | ft. in. | ft. in. | ft. in. | ft. in. | ft. in. | ft. in. | ft. in. | ft. in. |
| 0 .. .. | 0 0 | 0 3.9 | 0 7.9 | 0 11.8 | 1 3.7 | 1 7.7 | 1 11.6 | 2 3.6 | 2 7.5 | 2 11.4 |
| 1 .. .. | 3 3.4 | 3 7.3 | 3 11 2 | 4 3.2 | 4 7.1 | 4 11.1 | 5 3.0 | 5 6.9 | 5 10.9 | 6 2.8 |
| 2 .. .. | 6 6.7 | 6 10.7 | 7 2.6 | 7 6 6 | 7 10.5 | 8 2.4 | 8 6.4 | 8 10.3 | 9 2.2 | 9 6.2 |
| 3 .. .. | 9 9.1 | 10 2.0 | 10 6.0 | 10 9.9 | 11 1.9 | 11 5.8 | 11 9.7 | 12 1.7 | 12 5.6 | 12 9.5 |
| 4 .. .. | 13 1.5 | 13 5.4 | 13 9.4 | 14 1 3 | 14 5.2 | 14 9.2 | 15 1.1 | 15 5.0 | 15 9.0 | 16 0.9 |
| 5 .. .. | 16 4.8 | 16 8.8 | 17 0.7 | 17 4.7 | 17 8.6 | 18 0.5 | 18 4.5 | 18 9.4 | 19 0.3 | 19 4.3 |
| 6 .. .. | 19 8.2 | 20 0.2 | 20 4.1 | 20 8.0 | 21 0.0 | 21 3.9 | 21 7.8 | 21 11.8 | 22 3.7 | 22 7.7 |
| 7 .. .. | 22 11.6 | 23 3.5 | 23 7.5 | 23 11.4 | 23 15.3 | 24 7.3 | 24 11.2 | 25 3.1 | 25 7.1 | 25 11.0 |
| 8 .. .. | 26 3.0 | 26 6.9 | 26 10.8 | 27 2.8 | 27 6.7 | 27 10.6 | 28 2.6 | 28 6.5 | 28 10.5 | 29 2.4 |
| 9 .. .. | 29 6.3 | 29 10.3 | 30 2.2 | 30 6.1 | 30 10.1 | 31 2.0 | 31 6.0 | 31 9.9 | 32 1.8 | 32 5.8 |

The method of interpreting the table is as follows: Taking, for instance, the second of the top row of figures, 0.1, we have that quantity, viz., the $\frac{1}{10}$th part of a mètre, expressed immediately below in inches as 3.9 inches. Then if we follow 1 under the designation of mètres we have its (the mètre's) equivalent in feet and inches = 3 ft. 3.4 in.; continuing on same parallel, and in next space we get the mètre with the $\frac{1}{10}$th part of a mètre added = 3 ft. 7.3 in, In the following space to the mètre is added $\frac{2}{10}$ths of a mètre (0.2), the addition resulting in 3 ft. 11.2 in.

BRITISH AND FOREIGN COINS COMPARED.—For a somewhat similar reason to that advanced for inserting a table regarding the metric system, there is also here given a table by which at a glance will be observed the equivalent of the English coins in those of other civilized countries. In consulting foreign catalogues especially this table will be found useful.

* One of the tables prepared by Professor Hubert A. Newton, of Yale College, New Haven ('Metric System,' Barnard).

## Comparative Table of British, German, French, and United States Coins.*

| British Coin. | German value. | | French, Belgian, Swiss, Italian, and Greek value. | | United States value. | |
|---|---|---|---|---|---|---|
| | Reichs-marks. | Pfen-nige. | Francs. | Cen-times. | Dollars. | Cents. |
| Gold coins : | | | | | | |
| Five pounds ... | 100 | 0 | 125 | 75 | 24 | 20 |
| Two pounds ... | 40 | 0 | 50 | 30 | 9 | 68 |
| Sovereign ... | 20 | 0 | 25 | 15 | 4 | 84 |
| Half-sovereign . | 10 | 0 | 12 | 57 | 2 | 42 |
| Silver coins : | | | | | | |
| Crown ... ... | 5 | 0 | 6 | 24 | 1 | 21 |
| Double-florin ... | 4 | 0 | 5 | 0 | 0 | 96 |
| Half-crown ... | 2 | 50 | 3 | 12 | 0 | 60 |
| Florin ... ... | 2 | 0 | 2 | 51 | 0 | 48 |
| Shilling ... | 1 | 0 | 1 | 25 | 0 | 24 |
| Sixpence ... | 0 | 50 | 0 | 63 | 0 | 12 |
| Fourpence ... | 0 | 33 | 0 | 41 | 0 | 8 |
| Threepence ... | 0 | 25 | 0 | 31 | 0 | 6 |
| Bronze coins : | | | | | | |
| Penny ... ... | 0 | 8 | 0 | 10 | 0 | 2 |
| Halfpenny ... | 0 | 4 | 0 | 5 | 0 | 1 |
| Farthing ... | 0 | 2 | 0 | $2\frac{1}{2}$ | 0 | $\frac{1}{2}$ |

* 'Money, Weights and Measures of all Nations,' W. A. Brown, M.A., LL.D.

# INDEX.

THE END.



*Baillière, Tindall & Cox, 20 and 21, King William Street, Strand.*