From Lt. Arthur
to Thos. W. Clymer,
and from him
to Geo. Clymer.

A TREATISE

ON THE USE OF

ADHESIVE GOLD FOIL.

BY

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PREFACE.

Frequent applications have been made to me for further information in relation to a "New and Improved Method of using Gold Foil," of which I gave an account in two short articles published, within the past two years, in the "Dental News Letter." It appears that a large number of dentists have, to a greater or less extent, adopted in their practice the method of filling teeth, briefly explained in the articles referred to, but have found it attended with some difficulties; and that others, after a few imperfect trials, have rejected it. I have, now, for more than two years, pursued this plan of practice, almost exclusively, and I am well convinced that it possesses very great advantages, and must be adopted, to a considerable extent, by every operator who fully understands it. But, with every new system a want of knowledge of what appear to be unimportant details, leads to difficulties which embarrass those who attempt to adopt it, and prevents such attention to it as is necessary to an appreciation of its true value. Although the use of gold foil, as I propose, seems to be, and is, an exceedingly simple matter, the very general expression of a desire

for fuller detail than I have already given, has induced me to prepare the following little treatise.

The work will embrace a brief account of the common modes of using gold foil for filling teeth; a very careful description of the instruments necessary for working adhesive gold foil, with full directions for making them; a detailed account of the method of using adhesive gold foil.

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ADHESIVE GOLD FOIL.

The nature of that destructive process to which the teeth are subject, and to which the term "caries" has been applied, from its supposed resemblance to a disease of the bones, so designated, is easily understood. The teeth are, principally, made up of phosphate of lime, which is invariably decomposed when contact between it and a certain class of agents, acids, occurs. There is no part of the calcareous portion of a tooth which is not liable to be acted upon by the agents referred to.

The fluids contained in the mouth are generally more or less acid in their character. The quantity of acid, however, in proportion to the quantity of these fluids, is small, often scarcely perceptible under ordinary tests. So slight is the proportion of acid in the fluids of the mouth, that no injurious impression is made by them upon those surfaces of the teeth exposed to the friction of the lips and cheeks, and of mastication. In order to exercise upon the base of the teeth, their legitimate influence, it is necessary that the fluids of the mouth should be retained undisturbed in contact with the teeth for some time.

It is no doubt the case, also, that certain aliments taken into the mouth, and retained there, undergo chemical changes, (sugar, for instance, is converted into acetic acid,) and, although harmless in their original form, are, subsequently, in consequence of these changes, capable of decomposing the teeth. The fluids of the mouth, although when originally secreted, may be but slightly if at all injurious, may become so by long retention.

The whole theory of dental caries, as it is now generally admitted, rests upon the fact that the teeth are exposed to the action of agents capable of decomposing them, but that these agents are so feeble in power that other favoring circumstances are necessary to the development of their action. This received view is corroborated by the fact that dental caries always commences at some point where particles of food or the fluids of the mouth can be retained for a time in contact with them, as upon the proximate surfaces of the teeth, where they are in close contact, or at points where the enamel is defective. Although there are many other points necessary to a clear elucidation of this subject, (which this, of course, is not the place to present or discuss,) the theory of dental caries, here briefly set forth, is the one now generally received.

Whenever the decomposition of a tooth goes on so far as to occasion any considerable loss of substance, and to the formation of a cavity, the caries necessarily progresses in rapidity proportionate to the size of the cavity and the quantity, and degree of concentration, of the destructive agent admitted and retained.

The object of "filling" or "plugging" the teeth, as the operation is technically designated, is plain: it is simply to place the affected teeth in such condition that neither the fluids of the mouth, nor any destructive agent, can get into the cavity resulting from the decomposition and removal of a circumscribed portion of their substance.

A "filling" capable of accomplishing perfectly this end, must, in the first place, be of such material that it will itself undergo no change in the mouth; it must be capable, also, of being brought into close contact with every part of the cavity in which it is placed; it must retain its position immovably in the cavity; it must be capable of being made sufficiently dense to resist the force of mastication; it must be impermeable to fluids; and it must be capable of receiving and retaining a perfectly smooth surface.

For the purpose of filling the teeth there are now used three materials: tin foil, an amalgam of silver and tin, and gold.

Tin foil answers the purpose well. It undergoes no material chemical change in the mouth. Although it cannot be made so dense as gold, it can be made sufficiently so to answer all the requirements of a good filling, except, perhaps, where it comes upon a masticating surface. I feel bound to say that this material is of considerable value for the purpose in question. I have repeatedly seen good and serviceable operations with tin foil from the hands of operators who never could successfully make use of gold. The principal objection to it is

its color. It is more easy to work than gold under the old system of manipulation.

An amalgam of tin and silver has been used a great deal for this purpose. When first made it is so plastic that the carious cavity can be easily and quickly filled with it. In a short time it becomes very hard. The use of this material has been very bitterly condemned and very strongly advocated. Until within a few years, a great majority of the best practitioners of our profession regarded it as a bad material. Attention was some time since called to it, in what was supposed to be an improved form; but the result, so far, appears to have disappointed many who have entertained very sanguine hopes with regard to it. It may be that further experiment will show that there are defects about the manner in which it is now used, either in its manipulation or in the proportions in which it is mixed, which may be remedied and lead to the removal of the uncertainty of result which now appears to attend its use. Until these defects are removed we shall be obliged to rely, as we have principally done for many years, and as we still do, for the accomplishment of the most desirable ends in view, in filling the teeth, upon

GOLD.

The useful, the beautiful and wonderful properties of this metal are well known and understood. For all the purposes of filling the cavities of carious teeth, nothing, except some plastic material, could be imagined more desirable. It fully comprises all the qualities which a

material should have for the purpose. It can be beaten into sheets perfectly convenient for use; it is so tractable that it can be worked into any desirable form; if properly prepared, it is so adhesive that two layers, if brought forcibly into contact, are so intimately united that they cannot afterwards be separated; several portions of it can be so condensed into the cavity of a tooth, for example, as perfectly to resist the action of any force to which it can possibly be subjected; it can be brought into such close contact with the walls and orifice of the cavity as perfectly to exclude fluids of every kind; it is incapable of change from contact with agents which are secreted, generated, or which accidentally come into the mouth; its surface may be made to take so smooth and perfect a polish that nothing will remain attached to it; and, besides all this, experience has shown that, if carefully used, for filling teeth, with a due regard to all the considerations involved in what we know to be essential to good operations, it will effectually put a stop to dental caries.

But, notwithstanding all these advantages, it has also its drawbacks, for the purpose in view. Caries of the teeth is, of course, liable to occur upon any part of their surface where anything can be retained in contact with them, and this, as may easily be conceived, is sometimes in places which are by no means easy to reach, or even to see distinctly. The use of gold for filling teeth has always been considered difficult, notwithstanding its admirable qualities, and comparatively few operators out of a

multitude engaged in the practice of dentistry, have become distinguished for success in this department of the profession. In this operation, unlike the operations of general surgery, no assistance whatever, is obtained from nature; success in the arrest of dental caries treated in the way referred to, depends solely upon the perfection of the operation. It is true that the best operations will often fail for want of proper subsequent care on the part of the patient, but with all the care in the world, an individual will not succeed in preventing the progress of dental caries, if the operations are imperfect. This degree of perfection, as I have intimated, is not generally easy to reach. It is true that many simple and accessible cavities in the grinding surfaces of the teeth do not require any skill worth considering, to produce fillings which will prevent the further extension of the caries, but the usefulness of a dentist who is able to perform such operations, only, will be very limited.

It is well known, then, that the use of gold for filling teeth is difficult, notwithstanding the valuable properties of this metal to which I have referred; but as it is now the only material perfectly reliable, in all respects, known to dentists for the purpose, every suggestion which can in any degree diminish the difficulties attending its use, must be of importance. The object of this little treatise, as has been already stated, is to call particular attention to a method of using gold foil for the purpose in view, which goes a great way toward lessening the difficulties referred to. I shall first, however, very briefly describe the common methods of working gold foil.

COMMON METHODS OF USING GOLD FOIL.

The preparation of gold-foil for the operation of filling, and the method of placing it in the cavity, have varied considerably. Several general methods have, however, been commonly followed for many years.

It was formerly believed by, I will not say good operators, even for the time of which I write, that the gold used for filling the cavity should be in a single piece. It was supposed that if a portion were at all condensed, and more added in a separate piece, that the latter portion would come out of the cavity and the operation fail. Some curious expedients were resorted to, in order to avoid the necessity of using more than one piece. The sheet was cut nearly through, as widely as was thought necessary, and commencing at the opposite side, it was cut nearly through toward the side where the operation was begun. The strip thus cut, was twisted into one long rope. The cavity was filled by first carrying in one of these ends, withdrawing the instrument, taking up a fold of the rope, carrying in another portion, and so on until the cavity was filled. Such a method of practice would not, of course, be followed long by any operator of ordinary ingenuity, as its defects are too apparent, but we have had, and still have, I fear, in the practice of dentistry, many men who have followed, and who do follow, very bungling processes for years.

THE ROPE.

It afterwards became the practice to form the gold into small ropes, by cutting off a strip of the foil from the sheet, and rolling it up lightly. When a sufficient quantity of gold was prepared in this way, and the cavity ready, one end of the rope was introduced, and carried down to the bottom against one side; another fold was brought down parallel to the first, and the opposite ends of the fold allowed to project above the margin of the cavity. Fold after fold was placed in the cavity in this way, until it was full, the ends projecting somewhat; the gold was then condensed with heavy instruments, filed down, if too full, burnished and finished. As large a number of pieces as were necessary to fill the cavity were taken.

THE STRIP OR TAPE.

This method was varied by forming the gold into strips made of pieces of the sheet folded lengthwise. This strip was placed in the cavity in the same manner as the rope just described, the edges of the strip projecting above the margin of the cavity, to be condensed after the cavity was filled.

In order to give to the filling a greater degree of density than could possibly be obtained by the method of manipulating just noticed, it was proposed by Prof. C. A. Harris, of Baltimore, to force down into the centre of the filling, made as described, a wedge-shaped instrument, of suitable size, forcing the gold out in every direc-

tion toward the walls of the cavity. By this means a great deal of force could be very advantageously applied, a new cavity was formed in the centre of the gold, and between it and the walls of the cavity the gold was rendered very dense. The opening thus made, was filled in the same manner as the original cavity. Into the centre of this a smaller wedge-shaped instrument was forced, the opening filled, and so on until the wedge-shaped instrument could be no longer introduced. This was considered a very considerable improvement upon the old method of using the rope and strip, in which dependence for the degree of density obtained was placed upon the instruments used for introducing the gold.

The instruments employed for carrying the gold into the cavity, were at first thick and clumsy, but without regard to the manner of preparing the gold, there has been a gradual improvement in the points of the instruments for some years.

PELLETS.

An advance, it was supposed, upon the methods described, was the employment of pellets. They were formed by cutting or tearing off small pieces of the leaf of foil, and rolling them up lightly into pellets; or pieces of small size were cut off from the rope. One of these pellets, sufficient to retain its place, was forced down against the bottom and side of the cavity; against this, pellet after pellet was placed, until the bottom of the

cavity, if it were a deep one, was covered with a layer of pellets. This layer was consolidated: upon it another layer was commenced in the same manner as the first, and if the cavity were full enough, the upper portion of each pellet was allowed to project above the margin, and when all that was possible to get in was forced in, the gold was condensed, the excess filed off, and the filling finished in the usual way. The wedge-pointed instruments, above described, were used or not according to the judgment of the operator.

The method of using pellets was varied by folding the gold together into regular square or oblong blocks. They were placed in the cavity with the edges upward and projecting. The filling, when a sufficient quantity of gold was got into the cavity, was finished in the usual manner.

The various plans of using gold for the purpose in question, which I have been briefly describing, are still, to some extent, in use, but no one of these plans possessed such striking advantages as to be adopted exclusively, or even very generally. Some operators preferred one method, some another, and many varied the mode according to the peculiarity of the case.

CYLINDERS.

Dr. J. S. Clark, of New Orleans, called attention, a few years since, to a method of using gold, which he had adopted. It certainly possesses advantages. The plan he described, consists in making a quantity of cylinders, of various diameters and lengths, by rolling up strips of

foil upon the end of a watchmaker's broach, and when formed, withdrawing the instrument. These cylinders are made harder or softer, as needed by the operator. The cylinders are used by placing them upon their ends, like cigars in a tumbler. When the cavity is filled loosely with them in this manner, an instrument is forced down between the cylinder, making an opening into which another cylinder is placed. The instrument is again introduced, another opening made, into which another, harder and more pointed cylinder than those at first used, is forced, and so on, until the instrument cannot be forced in between the cylinders. One advantage of this plan of operating is, that the gold is readily and certainly thrown out into contact with every part of the opening of the cavity. The cylinders being longer than the cavity is deep, their ends project above the margin; these are burnished down, and cut away to a level with the surface of the tooth, making a beautiful, and in my estimation, a very excellent filling. Dr. C. has adopted this method, exclusively, I believe, in his practice, and, judging from some few operations I have seen from his hands, with a great degree of success. I have tried the method; I find it advantageous in some cases, but do not feel disposed to adopt it generally. Like all new methods, however, it requires practice to be enabled to appreciate its full advantages.

In using gold foil by any of the plans described, no dependence was placed upon the cohesion of the different portions used. It was necessary that the cavity should be so formed as to retain the whole mass of gold after

the different pieces were forced closely together. The outer surface, when the cavity was full, was so blended together by heavy pressure and burnishing, as very perfectly to exclude the moisture of the mouth, with a variable degree of density of the filling beneath the surface.

FORMATION OF THE CAVITY.

In the formation of the cavity, it became necessary that the gold should have at least two strong abutments to rest against; sometimes it was made cylindrical, sometimes a furrow was cut below and around the margin, into which the gold was forced, and sometimes the cavity was made a little larger on the inside than at the orifice. Some such preparation as this was always regarded as essential. Such a cavity as is shown in the section, fig. 1., could not be successfully filled by any of the methods to which I am referring, although at the upper part (*a*) the cavity is so formed that it can readily be made to retain a part of the filling. When dependence was not placed upon the adhesion of the gold, no gold could be retained in the lower part of the cavity (*b*), unless a deep furrow were cut along the cavity toward the outer and inner walls, of the enamel, and this is not always practicable. It usually became necessary to modify the shape of the cavity, so as to furnish a hold at the lower part, (fig. 2.) The disadvantages of cutting away the entire dentine of the part referred to, of an incisor tooth, are sometimes considerable, rendering the enamel, forming the corner,

Fig. 1.

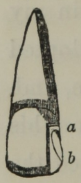


Fig. 2.

weak and easily fractured. The dentine at this point, too, is usually the most sensitive part of the cavity.

Fig. 3 serves further to illustrate the imperfect methods for many years relied upon, and still to some extent relied upon, for filling teeth. This figure represents a lower molar tooth, from which the pulp has been removed. The only parts of the crown remaining are a small portion of the lingual and anterior walls. These, however, are sufficiently thick and strong to bear the force of mastication for many years, if supported by a solid body of gold. Sometimes a tooth in this condition is of great value, and its loss becomes a serious matter, but unless the dentine and enamel of the portion of the walls, still standing, can be protected from the destructive contact of the fluids of the mouth, they will, of course, soon be gone. It is evident, that in a case of this description, nothing can be done toward saving the remains of the crown by the old method of using gold, either in the form of pellets, rope or strip. There is nothing here to hold the filling in; the abutment at one side is absent. This is a case which the operator, skillful, in the use of gold, would, a few years ago, have condemned as past the possibility of preservation. There were, it is true, some operators who could do more with ordinary gold foil than was commonly done, who would, possibly, have taken such a case in hand.

Fig. 3.

Until within a few years the methods of using gold foil described were almost universally relied upon. There

were some exceptions in several very successful operators. Prof. Elisha Townsend, of this city, unquestionably, as I have seen exhibited in operations from his hands, depended, in many cases upon his ability to make one piece of the gold adhere in a certain way to another. This was accomplished by the employment of instruments with very sharp points, by using small portions of gold and driving one layer into another. Other operators may have pursued the same, or a similar method, or may have reached the same result, that of attaching the different portions of gold in some other way. I, of course, write simply from my own knowledge.

EMPLOYMENT OF NO. 30 FOIL.

Without knowing, at the time, what had been done in this way, I proposed, some six or seven years ago, to use heavy numbers of gold somewhat in the same manner. I made a considerable number of experiments in this direction, and tried gold of thicknesses varying from No. 4 to No. 60. I finally settled upon No. 30 foil, rolled, not beaten, as most suitable for the purpose, and advised its use in single layers, with very sharp and hard single-pointed instruments, by means of which, each layer of gold was united to that previously condensed; by this means one portion could be built upon another to any desired height. This method of practice I pursued, exclusively, for more than a year, with satisfactory results, and abandoned it only because of the difficulty of keeping myself supplied with the instruments which were neces-

sarily very sharp and hard, and required frequent renewing. The points of these instruments were made as sharp as possible, by grinding down after they were filed.

ADHESIVENESS FORMERLY CONSIDERED A DEFECT.

As I have said, however, no dependence was generally placed upon the adhesion of one portion of the gold to another. Any advantage to be gained from this quality in gold, was neither looked for nor desired. Indeed, any adhesiveness of gold foil was regarded as such a serious defect, that manufacturers of foil taxed their ingenuity to get rid of this quality. As pure gold, when freshly made into foil, is adhesive, a particular method of depriving gold of this adhesive surface was devised by the manufacturers whose gold had the best reputation in the market.

I well remember, to this day, some of my early experience in practice, and the harassing difficulties I encountered in consequence of the defective manner of manipulating which then prevailed. I was taught to fill teeth by rolling the foil up into a kind of rope, as I have already described. I first used gold foil manufactured by a gold-beater, who seemed to be a very conscientious man, who, I am satisfied, made every effort in his power to produce a good article, but who was never able to establish a good reputation for his foil. In working his foil it appeared to become hard and unyielding; if any considerable quantity was used at a time, it appeared to be impossible to condense it. Not knowing anything, then, about what kind of foil was necessary, under the

system practised, I supposed the difficulties I encountered such as naturally attached themselves to the operation, and were augmented by my inexperience and lack of skill. I found these difficulties rapidly diminish when I got hold of a different article of foil. I did not then know, as I now do, that the harshness which the foil appeared to have, was attributable to its adhesive surface, of which the manufacturer had never been able to get rid, and which, under a different system of manipulation, would have been found of positive advantage.

"SPONGE," OR "CRYSTAL GOLD."

Some time as far back as 1849, my attention was first called, by Dr. E. J. Dunning, of New York City, to a new preparation of gold, for the use of dentists; it was called "Sponge Gold." It was first made, I believe, in England. It came in small bottles, in the form of little friable masses. Upon being put carefully into the cavity of a tooth, these little masses, upon slight pressure, broke down into a powder, which, upon heavier pressure, appeared to cohere, and under the burnisher, yielded a bright surface. It was, for the purpose in view, an exceedingly imperfect preparation; for all practical purposes, indeed, it was useless.

Nothing more was heard of "sponge gold" for several years, when advertisements appeared in our journals announcing the discovery of a new method of producing a greatly improved form of "sponge gold." Dr. A. J. Watts, a chemist of Utica, New York, claimed to be the

inventor of the new process, and secured a patent for it. The process, as given in his specification, consisted in making a fluid amalgam of gold, and dissolving out the mercury by means of nitric acid, leaving the molecules of the gold separated from each other, but in such condition that they could be welded together again by pressure. Dr. W. subsequently, I have been informed, made considerable modifications in his process.

The "sponge gold" of Dr. W. was certainly a most beautiful article. He succeeded in depriving it of its objectionable friability, and produced a spongy mass which had so much adhesiveness that it could not be easily torn apart, and when separated the parts welded together again upon pressure and became inseparable.

The new article of gold, when it was brought to the notice of the dental profession, was taken hold of with an avidity which indicated, clearly, that it was considered a great improvement. It was, indeed, for a time, regarded as the great desideratum in the way of a material for filling teeth, toward which dentists had been looking for years. An assay, as I am informed by Prof. Townsend, showed it to be the purest form of gold sold for dental purposes. A carious cavity could be filled, when this gold was employed, with the greatest ease; even the amalgams could be managed, it was supposed, with very little less difficulty than the "sponge gold." One piece, it was seen, could be added to another and perfectly welded to it, even after the first was thoroughly condensed. The difficulties attending such cases as were

referred to and illustrated in figs. 1 and 3, of the present work, disappeared. When the upper part of the cavity, shown in fig. 1, was filled with "crystal gold," as it was afterward called, the remaining part of the gold for the lower portion of the cavity, could be readily attached to it, and there was no necessity at all for altering the shape of this part of the cavity, more than to avoid leaving the lower part of the filling with a thin edge. After the pulp cavity of such a tooth as is represented in fig. 3, was filled with "sponge gold" the whole crown could be built upon it. Dr. W. H. Dwinelle, then of Cazenovia, N. Y., now of New York City, exhibited teeth which he had filled in the mouth, and afterward removed, the operations upon which were perfectly incredible to those unacquainted with the qualities of the new material. Dr. D. published a pamphlet detailing, at length, the best methods of using the "crystal gold," and describing operations unheard of before; similar operations performed by Dr. D., I can bear testimony to having seen in the mouth long after they were performed. A new era in operative dentistry seemed to have begun. The proprietor of the patent was looked upon as a prospective millionaire.

But, in a remarkably short time, its warmest and most enthusiastic advocates, with some rare exceptions, became its most violent detractors. Those who, a few months previously, had declared it the very *ne plus ultra* of materials for filling teeth, now decried it as a vile production upon which no dependence whatever could be placed. It

was declared that its apparent working qualities were deceptive, and that every one who ventured to make use of it at all, would sooner or later repent his imprudence. The revulsion of opinion with regard to it was as sudden as it was general.

A few individuals who, after some trials, perceived that this material would not greatly lessen the labor or time of the operation, were not misled. While they learned to estimate "sponge gold" at its true value, they, without difficulty, understood the causes which led to such general failure, and had given rise to such a hue and cry against it. The unsatisfactory results, they were satisfied, and time has proved the correctness of this opinion, were not attributable to any defects in the material itself, but to the manner in which it was employed. It was, in all respects, a new thing, and required an entirely different system of manipulation from that which was then common in the use of gold foil, for the same purpose. Its form and properties were well calculated to mislead. If heavy pressure were made upon a large mass of sponge gold, with an instrument having a broad condensing surface, the whole mass appeared, at once, to become very compact, while, in fact, the surface only, was condensed, forming a scale merely of compact gold, covering a spongy mass. In a short time this thin scale of gold, if a tooth were filled in this way, broke or cracked, admitting the fluids of the mouth, with which the mass underneath become saturated; and when the filling was removed or fell out, its particles were found to have no

more cohesion than so much wet sand. There is no doubt that, in addition to the difficulties necessarily attaching itself to the manipulation of a new material, it was not of uniformly good quality; the manufacturers themselves acknowledging that, for a time, it was defective.

It was soon discovered by those who succeeded with "sponge gold," that it was no labor-saving discovery; that its use required more time and labor, in order to insure successful results, than any other form of gold. It was found to be necessary to introduce and condense it thoroughly, in small portions at a time. The only advantage it offered was, that when this additional time and labor were bestowed upon it, superior results were obtained; it enabled the operator to take cases in hand and treat them successfully, which, under the old plan of operating with foil, were hopeless. The system of manipulating it was entirely different from that required for using gold foil. Gold foil was introduced into the cavity in considerable masses, and, for thorough condensation, more or less dependence was placed upon outside pressure, after the cavity was full, adhesion of the gold was not looked or cared for; in using "sponge gold," it was condensed from the bottom of the cavity to the surface, in small masses, dependence being placed entirely upon its adhesive qualities, and with no reliance for the consolidation of the whole mass of filling upon outside pressure after the cavity was full.

The different results which attended its use, in the hands of different operators, led, of course, to a discussion

of its merits. A great variety of groundless assertions were made in regard to it by those who had not been successful in its use. It was stated, repeatedly, that one of the most conclusive facts against it was, that its particles could not be brought into as close contact as the layers of gold foil, as could be proven by the alleged fact, that so large a quantity, by weight, of sponge gold, could not be got into a given cavity, as of ordinary gold foil, worked in the usual way.

"ANNEALED GOLD."

In order to test the truth of this assertion, I requested Dr. Louis Jack, with whom I was at that time associated in business, to make two fillings in a cavity in a piece of ivory, from which the filling could be removed, one of each material. I had in my case some old scraps of gold foil, which had been knocked about so long that they had become quite brittle; these scraps I gave him and advised him to anneal them before using. I stood by him when he began to use the foil, and, to my surprise, I found that the small pieces of gold foil, when used with the "sponge gold" instruments, welded together in precisely the same manner, and with as much apparent readiness as the sponge gold. When the filling was completed, we found it a perfectly united mass, which could, without difficulty, be hammered or rolled into a plate, or drawn into a wire. I did not pursue the comparison between "sponge gold" and gold foil any further, for I was convinced, at once, that if gold foil could be used in precisely the same manner as "sponge gold," the latter really possessed no

advantages over it. I immediately went into my office, prepared some gold in this way, and filled several teeth in the first case that offered.

Since the time referred to, I have been depending entirely, in filling teeth, upon the adhesive qualities of gold foil, a quality which, I must confess, I never before suspected it possessed, in so great a degree. I have strongly advocated the use of gold upon this plan; I have stated, and am confident that the assertion is fully and exactly true, that any of the operations performed with "sponge gold," any of those described by Dr. Dwinelle, in the treatise to which I have referred, can be performed equally well with gold foil, which really possesses all the advantages without the defects of "sponge gold."

WHAT IS EFFECTED BY HEATING THE FOIL BEFORE USING.

I now began to consider more attentively, this plan of re-annealing foil before using. It became quite clear, that re-heating could not produce that change in the intimate relation of its particles, which takes place when hammered gold is heated to a red heat. The last part of the gold-beater's operation is to anneal his foil, and it is not, subsequently, in the hands of the dentist, usually subject to such handling as to render re-annealing necessary. Besides, it is not necessary to heat it red hot to accomplish all that is desirable in the process under consideration. It is found, too, that the adhesive quality of the gold is very much impaired, even after re-annealing, by exposure to the atmosphere for a few days, or even hours; after a certain time it is lost altogether, but is

immediately restored by slight heating, far short of red heat. It became clear, then, that the change referred to is confined to the surface. What this change may be I shall not, in this place, undertake to inquire, whether it is a slight oxydation, a film of moisture, or, as supposed by Mr. Smee, a film of air, which is easily dissipated by heat.

Any one who has experimented in electro-metallurgy, need not be told that the deposit of gold or silver, in gilding or plating, cannot be made to adhere to a plate which has been exposed for a time in the open air; but if heat is applied to the plate, and it is, in other respects, in proper order, the deposited metal will, at once, adhere. Mr. Smee, the author above referred to, attributes this condition of the plate to the deposit of a film of air upon the surface, which is dissipated by exposure to heat; this, it is more than probable, is its real condition.

This adhesive surface, so desirable a quality of gold foil, at least in the estimation of many who are now using it with great satisfaction and success, requires no art to produce. All the efforts of manufacturers, until recently, have been in the opposite direction. The degree of adhesiveness does not depend merely upon the purity of the gold, but upon the manner in which it is worked out. Mr. David Morgan, of this city, prepared, at my request, for exhibition to my class, last winter, three specimens of foil, from the same refining, which differed remarkably in character: one was so adhesive, that when one part of a leaf fell upon another part, it could not be separated, the

second required some pressure to make it adhere, and the third possessed no adhesive qualities whatever, the pellets of which, after annealing, could not be made to adhere by any amount of pressure.

INSTRUMENTS.

One great source of difficulty in the use of "sponge gold," and a very frequent cause of failure, at the time it was introduced, was the deficiency of suitable instruments. Without instruments well adapted to the purpose, nothing can be satisfactorily accomplished with adhesive gold. An attempt to make a filling with this material, and with ordinary flat or round, but smooth pointed plugging instruments, will lead to entire failure. The instruments must be so constructed that every layer of gold, after it is thoroughly condensed, will have a rough surface. If the surface of a layer becomes burnished, no adhesion can be obtained between the condensed portion and the foil added, except in the manner referred to, and to be more fully described. Every operator must learn to rely upon himself for the production of the working parts of his instruments. If he does not know how to make them, he must learn, for even if he can get them perfectly made by an instrument-maker, which I have found very difficult, the points, necessarily delicate, will need renewal from time to time, and he will find himself at a great disadvantage if he is unable to do this for himself. I generally have all my instruments made in the form of simple sockets, in which I fit the working part, made of very fine steel, and finish to suit

my wants. It is necessary that the character of the instruments required for working adhesive gold, and the method of making them, should be carefully described.

Instruments of two classes are required for working gold foil upon the system proposed: the first, with long, sharp points, from a single one up to four, upon the condensing extremity of the instruments; the second, with a greater number of points, in proportion to the size, and not so deeply cut.

Fig. 4.

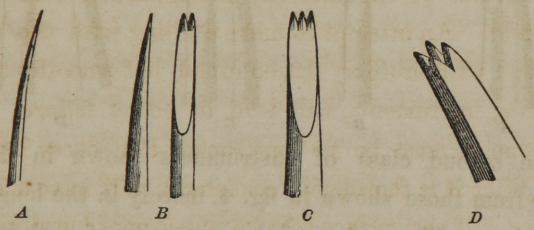
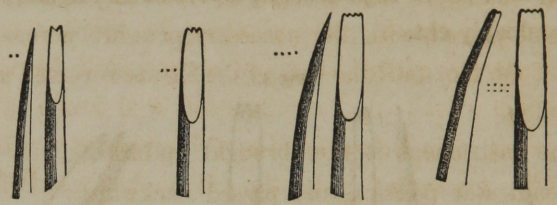


Fig. 4 is an enlarged view of the first class of instruments referred to. The drawing is intended to show the points only, and not the necessary curves required to adapt the instruments to different cases. (*A*) is a single point; it is first filed into shape and rubbed down on the oil-stone, so as to give to it a smooth finish, as well as a perfectly sharp extremity. (*B*) is a front and side view of the same character of instruments with two terminal points. This is made by hammering the end of the instrument flat, filing it to a sharp edge and dividing it into two points with a fine knife-edged file. The file best suited, for this purpose, is what is known by watchmakers as a "screw-head" file. It must be so directed

as to cut off the corners of the cones formed by the division of the end, leaving two well-formed points. The outer side of the points are best finished on the oil-stone as with the single point. (*C*) and (*D*) are merely variations of this instrument, with additional points. It requires some practice to form these points so as to work well.

Fig. 5.



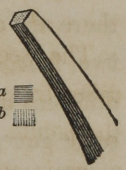
A *B* *C* *D*

The second class of instruments shown in fig. 5, differ from those shown in fig. 4, merely in the length of the points. The surface of the extremity of each instrument is cut into as many points as it will receive. In the above drawing, the points are considerably magnified; in the instrument they cannot be made out with the naked eye. These instruments cannot readily be made in the usual manner, with a knife-edged file. Dr. Louis Jack, of this city, has, however, devised a method so simple and so easily put into practice, as effectually to remove all difficulty in making them. Dr. J. described his method in the April No. of the "Dental News Letter." The plan must be adopted by every one who understands it and who appreciates the value of good instruments.

After the working extremity of the instrument is properly formed, (and it is better that it should be

square or oblong at this part, instead of round, as all its points will be more perfectly defined,) the face should be made smooth and level, by means of the oil stone. A moderately fine, flat, Stubs' file, (I use one about a half inch wide and four inches long,) is then laid on the side, upon the bench, and held firmly. The edge of one side of the instrument, held at about the same inclination as a pen in writing, is then brought down evenly against the file, and passed, with the necessary pressure, across the face of the file, until the cuts of the file are reversed upon the edge.

Fig. 7.



The instrument is then brought up into a perpendicular position, and passed backward and forward across the file until the surface is cut, as shown in *a*, fig. 7. It is important that these cuts should be made exactly parallel to the sides of the instrument. When this part of the process is completed, the instrument is turned, and another series of cuts are commenced in the same manner, at right angles with those first made, beginning first at the edge of one side. In making the cross cuts, the instrument must be pressed very lightly against the face of the file, and the cuts made slowly. When this is done, the end of the instrument should be thrust several times into a piece of tolerably hard wood, so as to remove the wiring; the roughness of the outer sides of the square should be removed by means of the oil stone. The instrument should now be carefully adjusted to the file, as can easily be done exactly where

the cuts have been already made, and passed *very lightly* over the surface, in both directions. When completed, if an impression is made upon a piece of white paper, it will give, under a magnifying glass, a series of points arranged in parallel lines, exactly corresponding to the points upon the file (fig. 7 and fig. 5.) The instrument should be tried in this way, upon paper, and passed over the file, as directed, until under the magnifying glass the paper shows a series of perfectly sharp points. After it is hardened, it may again be passed lightly over the file.

The above is a description of Dr. Jack's method of making a considerable number of points upon the square condensing end of the plugging instrument. Where there are only a single range of points, or two lines, of two, four, six or eight, parallel to each other, a somewhat different method of proceeding is followed, although the same general plan is pursued.

Where a single range of points is desired, (A, B, C, fig. 5,) the end of the instrument is hammered flat, and dressed down to a sharp edge upon the oil stone. It is then passed over the face of the file as described, the wiring removed by plunging into the wood, then again passed lightly over the file, and finished with light touches on the oil stone.

When two ranges of these points are wanted, (D, fig. 5,) the flattened end of the instrument, of proper shape, but thicker than is needed, is divided by cutting down longitudinally into the centre, with a knife-edged file. The "screw-head" file will give, if carried down straight,

the desired bevel to the side, or it may be slightly inclined. In making this instrument, the file need not be carried deeply, as the object is merely to cover the instrument with a series of sharp points, with no greater depressions than are necessary to make them well defined points. The cross cuts are now given by passing the face of the instrument across the file, as just described in making the larger instrument. The thin file should now again be lightly passed through the groove originally made, and the instrument should again be passed lightly over the file, so as to remove perfectly all the wired edges. The face of the instruments will, at this stage of the process, when impressed upon paper, represent two ranges of short lines. It is now finished on the oil stone, by cutting away the sides and making impressions with it on a piece of writing paper, until, under a magnifying glass, it exhibits two ranges of perfect points. In this simple way it is easy to perceive that any number of sharp points may readily be cut upon the surface of an instrument. Although not represented in the drawing (fig. 5,) the most generally useful instrument of this class is one with four points.

Instruments of the same general character have been described for using sponge gold, except that so much importance is not attached to sharpness of the points. Instruments of precisely this character would, I am convinced, give additional facility in the use of sponge gold, but they are perhaps not so necessary as in the use of adhesive foil.

HARDENING.

After the instrument is properly formed and bent, it becomes necessary to harden it, so that the fine points will not turn when it is used. In order to accomplish this object, the steel is first made very hard, too hard for use, and is then gradually softened or tempered, as it is called, down to the point at which in use it will neither break nor bend.

The mode of hardening steel, is to heat it up to a certain point, and plunge it suddenly into some substance greatly below its own temperature. It may be slightly hardened by hammering. In heating steel for this purpose, care must be taken not to raise the temperature too high. Some kinds of steel will bear a higher degree of heat than others, but that in ordinary use, if heated to a white heat, is burned, as it is termed, and the fine, tough and adhesive qualities, characteristic of good steel, are destroyed; it becomes brittle and useless. It may readily be supposed that the small size of the working points of our instruments must render them readily liable to such injury. The proper temperature is a cherry red.

It must be known, however, that the degree of hardness acquired by steel, in the process described, depends, after the steel has been heated up to a certain point, upon the temperature of the cooling medium into which it is plunged; the lower the temperature when it is heated up to a given point, the harder the steel will become.

I have, sometimes, repeatedly attempted to harden a small instrument, and failed to do so in consequence of

the high temperature of the water used for cooling it, and was compelled to heat it up to a higher point, running risk of injury, before a satisfactory degree of hardness was obtained. The hardening of steel depends upon the relative temperatures of the steel and the cooling medium. If the steel is heated up to a very high point, it may be hardened by plunging in comparatively warm water.

The danger of injuring the steel by overheating has led workers in steel to adopt the general rule of heating the metal merely up to the proper temperature, viz., a cherry red, and keeping down the temperature of the cooling medium. Water, at about the temperature of cold spring water, is generally employed, and for our purpose is probably as useful as anything else.

When steel is heated in the open air, it undergoes rapid oxydation, and on cooling will be found covered with a coating of black scales. To protect the steel from contact with the atmosphere, when it is heated, it is previously covered with some substance, forming an impervious coating. The article to be hardened may first be slightly heated and plunged into a piece of soap, which will give it the desired coating. Calcined borax, or prussiate of potash, are used for the same purpose; it is supposed that a lower degree of heat is required, when the steel is covered with the latter substance.

TEMPERING.

The instrument subjected to the heating and sudden cooling, just described, becomes very hard; the points of

which the working extremity is composed are so brittle that they would break down under the force necessary for the consolidation of the gold. It is necessary, therefore, that it should be somewhat softened before it can be used. This is called tempering, and is accomplished by again exposing the steel to heat. Before this is done, the surface is brightened, either by rubbing the side upon a piece of emery paper, or upon the oil stone. Upon this bright surface may be observed certain changes of color, which indicate the degree of softening occasioned by the heat. The changes of color are caused by the oxydation of the surface; these changes pass through various gradations from a very light straw color to black, viz: light straw color, dark straw color, yellow, dark yellow, copper color, purple, light blue, dark blue and black.

The points of instruments for using adhesive gold require a very slight reduction of temper, after they are hardened. A light straw color is the most useful; the second class of instruments with this temper, will last, unimpaired, for a long time. For the first class a copper color is required. It has been a common mistake to reduce the temper of these plugging instruments too much. If this is done, it will be found, after slight use, upon examination under a magnifying glass, that the points are bent and burnished; they are then useless. This rule should be observed: the points are to be left as hard as the purpose for which they are intended will permit. A little practice will enable every operator to

determine this. As I have stated above, I have found a light straw color the most serviceable temper. But it must be borne in mind that the steel out of which our instruments are made differs very much in quality. Some kinds will not bear the same temper as others, and this can only be ascertained by trial. It may be said that the best quality of steel for our use comes in the form of small square bars, and is manufactured by Stubs, whose name is familiar to every worker in steel. This is considered superior to the steel wire from the same manufacturer.

When the instrument to be tempered is comparatively large, the small flame of a spirit lamp and a cup of cold water are all the appliances necessary. By simply holding the shaft of the brightened instrument in the flame, the changes of color, running down upon it, can be observed and the temper caught at the right point, by plunging into the water.

Tempering a very small instrument, however, is quite a nice operation, requiring a great deal of care and no little practice to catch the temper at the right point. There are various modes of managing it which lessen the difficulties.

The general plan is to heat the shaft of the instrument at some distance from the point, watch the color run down, and when the point is softened sufficiently, as indicated by the change of color, to plunge it into the cooling medium. In order to prevent the heat from running down too suddenly, Dr. Jack proposes to lay the point of the

instrument upon a flat steel surface, with a drop of water near, into which the instrument is quickly passed at the right moment.

A plan has been practiced of heating a pair of tongs, holding the hardened instrument in them until the heat is conducted toward the point, and plunging both into water at the proper time.

A bar of heated iron is sometimes used, upon which the instrument is laid, with the end projecting over the edge. It should be heated up so high that the desired change of temperature will be effected.

A plan which I find more reliable and convenient, in my own hands, than any of these, I have lately adopted altogether for very small instruments, and I am certainly saved a great deal of trouble since I have practiced it. Instead of exposing the instrument directly to the flame of the lamp, I interpose a thin plate of metal; upon this, holding it in a pair of pliers over the flame with one hand, I place the end of the instrument, holding it by the handle in the other. If the instrument is curved, (and nearly all plugging instruments are more or less so,) I take care not to let the extreme point touch the plate; this I turn upward, preferring that the heat should run up to it. A little practice with this mode of tempering will give such facility as to save a great deal of trouble and uncertainty of result.

When the shaft of the instrument is small, it should be given a spring temper; that is, the color should be blue, except at the point. This may be readily done after it

is otherwise completed, by holding the point of the instrument against a piece of cold metal, so as to avoid the accident of softening the point too much, and plunging it into water when the part to be tempered has become blue.

For instruments of ordinary size, however, it will be found sufficient to hold the shaft of the instrument near the point in the small flame of a spirit lamp, and plunge it in cold water when the point is properly tempered.

PREPARATION OF THE GOLD.

The character of the gold should be well understood, before it is used. It may be sufficiently adhesive, as it comes from the manufacturer; but it is necessary to be sure that it is so. Its degree of adhesiveness may be tested by rolling up a part of a sheet into a rope, cutting it into pellets, taking up one of these pellets and pressing it lightly against another one. If it is very adhesive, as adhesive as I like to use it, the two pellets will adhere, so that a third may be taken up by touching the two to it, and so on, until in this manner a chain of pellets is formed. Or a number of unannealed pellets may be laid upon a sheet of thin metal, and if very adhesive, will adhere by merely shaking them together. If they do not adhere, and the gold possesses the requisite quality, it will be found that by holding the plate for a few minutes over the the flame of a spirit lamp, and again shaking the pellets together, they will adhere so tenaciously as to be separated with some difficulty.

If, on examination, it is found that the gold is not adhesive, it should be exposed to a degree of heat sufficiently high to restore this quality, if it has been lost by exposure. If, on heating, it still remains unadhesive, it will not answer for use by the method proposed.

HEATING THE GOLD.

The most convenient method which I have tried, for office practice, of heating gold, is to lay the entire sheet of foil upon a thin metallic plate, or piece of fine iron-wire gauze, and hold it over the large flame of a spirit lamp until it is sufficiently heated. It will save time, if a bright coal fire is used instead of the flame of a lamp, as the plate or wire gauze, absorbs a considerable quantity of the heat, before the gold can become heated. It has been advised to make a frame of wire of such form as to expose the gold, in heating it, to direct contact with the flame. I do not like this method, except for a heavy number of gold, as the heat cannot be applied uniformly, and it will be found that some parts of the sheet will be melted, while other parts are not heated at all; over a level coal fire this method would, no doubt, answer well. It has been also advised to pour alcohol into a saucer or broad vessel, and setting fire to it, hold the gold in the frame or place directly over the flame. This plan I do not like so well, as employing the large flame of the lamp. The time consumed is not, indeed, very great, but in full practice, during business hours, every moment is, of course, valuable. For this reason, I frequently

prepare my gold in the morning for the day's operations.

The degree of heat required to restore the adhesive surface of the foil, when it becomes impaired by exposure, is considerably short of a red heat, as I have already stated, yet the degree of heat should be great enough to produce the desired change. This is a very simple matter, and after a few trials, it will be found easy to know when the requisite heat has been applied.

Some kinds of foil appear, very soon, to lose the very adhesive surface obtained in this way. A single day, and sometimes a few hours, will bring about so great a change as to render re-heating necessary.

I have explained that some of what is considered the best gold foil in the market, is not adhesive when made. The re-heating I advise, it must be borne in mind, cannot produce any change in the character of the gold itself; it merely has the effect of restoring it to its original condition, after having become impaired by exposure to the air. An operator may, therefore, expect, by annealing at the time of using, to render his gold adhesive, and he will, of course, be disappointed in the result, if his gold should be of the character referred to. I am acquainted with some excellent operators, however, who make use of, altogether, and prefer, the ordinary unadhesive gold, annealing it at the time of using, and obtaining, they state, as much adhesion as they desire. But the degree of adhesion is comparatively slight, and I am satisfied that this unadhesive gold cannot be used to such

great advantage as that which is very adhesive, if the latter is properly managed.

SOME GOLD DOES NOT REQUIRE HEATING.

On the other hand, some of the gold now manufactured is so adhesive that it will retain this quality for a long time, and, therefore, not require re-annealing in the hands of the dentist. I have seen some specimens of foil, which have retained their adhesiveness in such a degree, as to work well for several weeks; how long it would remain in this condition I am unable to say. It is more than probable that, from the time it is exposed, the surface of the foil gradually becomes impaired, in this respect, and finally loses its adhesiveness altogether, and it is a question whether, after a few days, if the operator depends upon this quality of the gold in his operations, it will not facilitate the use of the foil by heating it, as described, just before using.

METHODS OF PREPARATION FOR USE AFTER HEATING.

After the sheet is annealed or heated, as proposed, it is ready for use. When my attention was first drawn to the use of adhesive gold, the method I adopted was, first, to roll up a portion of a sheet into a loose rope, pass it through the flame of a spirit lamp, and afterward cut it into pieces of a suitable size for use. This method I advised in my first article on the subject. It has, however, this serious disadvantage: the pellet, when cut from the rope, becomes compressed at each end, by the

action of the scissors upon it, and the different layers are united into a hard, unyielding mass. The pellet, formed in this way, has, at each extremity, a solid, unyielding boundary of partially condensed gold. When the pellet is taken up, on the instrument, as will be explained hereafter, it is pressed together before it is brought into place, which will be found disadvantageous when pellets made, in any way, are employed. The layers of foil forming the rope, too, will adhere to each other, giving the gold an apparently hard and harsh character. A very loose and yielding pellet cannot be made in the manner referred to, and there is no doubt that many of the difficulties encountered by beginners in the use of adhesive gold, and many of the erroneous notions entertained of its characteristics, have originated from the use of the gold in this way; and from the fact, too, that, not appreciating fully the value of the direction to make a very loose rope, the foil was rolled up tightly, so much so, that all the layers becoming adherent, in the operation of annealing, a number of little, hard masses of gold, almost incompressible, were formed

I then proposed first to cut the pellets from the loose rope, and heat them on a thin sheet of metal. By this means one of the difficulties referred to was avoided. This is an improvement upon the first plan. I now, however, pursue an entirely different method, and merely refer to this to indicate the various steps of my experience in using adhesive gold, and to save others the trouble of going over the same ground.

I now very rarely ever make my gold into pellets, but tear it as I want it, from the sheet, in such quantity as may be required for any part of the operation in hand. The sheet, after having been annealed or heated, as directed, if this is regarded necessary, is laid upon the operating tray or table, with a small weight on one part. I use it, after the cavity is ready, by tearing it off with my plugging instrument, in pieces of suitable size, placing it in the cavity and condensing it before I tear off another piece from the sheet. This plan I always follow, when the cavity is small, or of medium size; but where the cavity is very large it may be thought advisable to prepare a number of pellets before commencing to operate. The plan I now pursue for this purpose, when this seems desirable, is to heat the entire sheet, as above directed, and tear off pieces of a suitable size for the pellets required. If the piece thus separated from the sheet is held down with an instrument at one side, it may be very expeditiously drawn, with another instrument, into a pellet of any desirable degree of density. In this simple way, a pellet may be made from the smallest part of a sheet of foil to the entire sheet, as loose or as dense as may be deemed important.

WHAT NUMBER OF GOLD IS MOST SUITABLE.

But the form in which it should be used depends somewhat upon the thickness of the gold. This, indeed, is a matter of sufficient importance to claim some special attention.

I use gold foil in numbers varying from No. 4 to No. 10; but principally depend upon No. 6 and 10.

If the walls of the cavity are frail, and liable to be broken down in the course of the operation, I prefer No. 4. Some very excellent operators, who are perfectly well acquainted with this method of using foil, employ No. 2. I have not tried it, but can easily conceive that it would be well adapted to a certain class of cavities with frail walls, such as we sometimes encounter in the incisor teeth. In filling such cavities, I rarely ever make pellets at all, but tear the gold as I want it, from the sheet, as already explained. By pursuing this plan, the greatest degree of density, with the smallest amount of force, is obtained; and it is easy to bring the thin and yielding layers of the gold, by direct pressure, into exact contact with the thin walls of the cavity.

For ordinary cavities of moderate size, I find No. 6 preferable, for general use, to any other. I sometimes prefer to make pellets as directed, by tearing pieces off the annealed sheet, but my general practice is to tear it off from the sheet as I want it, and carry it in that form to the cavity I am filling. After the filling is advanced so far that a portion of the gold is "fixed," I very generally use No. 10, in the manner I employ the No. 6.

In filling cavities of very large size, the walls of which are strong, I invariably commence with No. 6 or 5, and go on until I get a portion of the gold fixed; I then use No. 10, exclusively, to complete the operation. This I tear off from the whole sheet in pretty large pieces, being

sure that I do not get any very large quantity under the instrument before condensing, but carrying the instrument, with a few layers of gold before it, down to the condensed portion of the filling. Sometimes I cut the No. 10 into strips of convenient width, and, commencing with the end of one of these strips, draw it into the cavity as it is condensed. The No. 10 is to be preferred, simply because it saves time in the operation.

METHOD OF FILLING WITH ADHESIVE GOLD.

We will suppose now, for example, and for the purpose of more clearly illustrating this method of filling teeth, that a cavity to be filled, is situated on the grinding surface of a superior molar. The cavity is large, but not very deep; there is no danger of exposing the pulp in the process of preparation for filling; it is perfectly accessible, and can, without difficulty, be kept free from moisture. Let us suppose such a cavity prepared for filling, and the gold and necessary instruments ready for the operation.

FIXING THE FIRST PIECES INTRODUCED.

There comes up now, an important point for consideration. In using adhesive gold it is essential that it should be condensed, thoroughly, from the very commencement of the operation; the fixing of the first part of the filling is the principal difficulty encountered by beginners in the use of this material, and demands, therefore, careful attention.

If a pellet, insufficient to fill up the entire calibre of

the cavity, so as to retain its position, when condensed, is carried down to the bottom of the cavity and consolidated, it will form a plate of gold, which will fall away from its place, when the instrument is removed. If more gold is forced in and attached to the first piece, if this has not fallen out of the cavity, in the hope of keeping it in place, the difficulty will not be remedied; the whole cavity, indeed, may be filled up in this way, as each portion adheres closely to the other, with a mass of gold, which, to the annoyance of the operator, will be found to move about in the cavity, and which he will find himself entirely unable to fix. If he has thoroughly condensed the gold as he has gone on, he will now encounter another serious difficulty. He must, of course, be satisfied that such a filling will not answer; it must be taken out, and he proceeds to remove it. If, however, his cavity is a little larger than the orifice, he will find it no easy task to remove the gold; although it can be moved about in the cavity, it cannot be got out without considerable difficulty, as it is a solid mass of metal, somewhat larger than the opening through which it is to pass. One of two things must, of course, be done: either a portion of the margin of the cavity must be broken away, or the filling must be drilled and cut to pieces, or reduced in size, so that it can be removed. The difficulty to which I am referring is, no doubt, one which has met a number of operators who attempted (after my first article appeared) to use "annealed gold," as it was called, and led them to abandon it.

When the cavity is small and deep, in proportion to its diameter, no difficulty will be encountered in making the first pieces of gold retain their position. In a cavity of this description, a pellet of adhesive gold, large enough perfectly to fill the whole of the bottom of the cavity, and occupying its whole calibre, firmly, can easily be condensed. Whenever this can be done, effectually, this method will be found most convenient and satisfactory. In almost any deep cylindrical cavity this may be done, unless it is so large as to require a quantity of gold which cannot be condensed. Where this is the case, the operation may be commenced, in the usual manner, with ordinary unadhesive gold, filling the lower part of the cavity with a large pellet, condensing it, and then completing the filling with adhesive gold. In a great number of cases, this will be found the simplest and best method. The first layer of adhesive gold must be attached to the condensed unadhesive gold, carefully, with the sharp instrument of the first class, (fig. 4.) After the first layer is perfectly united, the operation may be completed, without further difficulty, with adhesive gold.

I have lately made trial of a specimen of gold furnished me by Mr. David Morgan of this city, the result of an attempt made by him to produce a foil which could readily be condensed, like ordinary non-adhesive gold, but still possessing sufficient adhesiveness to answer all the purposes of adhesive gold. I found that large pellets could readily be condensed, but it did not possess

the requisite degree of adhesiveness. For the entire operation, therefore, it did not satisfy me, but for commencing the filling, I have found such gold useful. Light numbers of adhesive gold, which have been exposed to the air for a few days, will answer the same purpose.

The fact that a small cavity may be very readily filled, with the most adhesive gold, has led to a very excellent method of obtaining a fixed point, as a basis for a filling in such a cavity as that now under consideration. I am indebted to Dr. Louis Jack for the suggestion. At some part of the cavity where there is no danger of reaching the pulp, one or two small cylindrical cavities are made. When these supplemental cavities are perfectly dried, they may be filled without the slightest difficulty with the most adhesive gold, and the gold for the rest of the cavity readily and securely added

But it is not always, perhaps not often, necessary to resort to this method of securing the first piece of gold. Sometimes, however, it is an important and indeed indispensable method of proceeding.

A method I have pursued for a number of years, and which, indeed, is followed by many operators, even with ordinary non-adhesive gold foil, and which I still practice a great deal, is to hold the gold, first introduced into the cavity, in place with an instrument in the left hand. When this is attempted, the gold must be held carefully in position until a sufficient quantity is put into the cavity and condensed, so as to keep its position immovably. Some practice is required to make use of

an instrument, in the left hand, for this purpose; it should be untempered, in order that it may be curved, so as conveniently to reach any cavity or any part of a cavity under treatment. The lips are held back with the fingers of the hand not employed in using the instrument. To the operator unpractised in the use of an instrument in this way, the number of cases in which this method can be resorted to, with advantage, will be found very limited. After facility is gained, it will be found applicable in a great many cases.

A very excellent and expeditious method of filling some cavities upon the grinding surfaces of the molar teeth, is to make a cylinder, so large that it can just be pushed into the cavity, and when there, will perfectly retain its position; this cylinder is then to be forced on one side, and the space made filled with adhesive gold; no difficulty will be found in getting it to retain its place. Some operators use cylinders, as already described, not depending upon cylinders entirely, but finishing with adhesive gold, employing the cylinders only so long as they can be used with facility and with advantage.

I have lately practised still another method, which, in some cases, may be followed with advantage. A tolerably close pellet, somewhat larger than the cavity to be filled, is placed in it, with a slight degree of force, so that the whole cavity is filled, but not very solidly. A small plugging instrument is now forced in at one side, and an opening made, which may be enlarged, considerably, without disturbing the position of the whole mass.

This new cavity is densely filled, the gold becoming attached to the large pellet. A similar opening in the gold is made on the opposite side of the cavity and filled. A third and fourth one against the walls of the cavity are filled, and they will all be found to retain their places very firmly. The gold in the centre of the cavity, may now be condensed, and the filling at this point completed.

It would no doubt strike a reader of these minute details, if he had not himself travelled some way over the same, or similar ground, that a great deal of importance is given to very trifling points. But I can scarcely suppose this will be the case with any practising dentist, who must know how very generally success, in this nice operation, depends upon the care and attention given to these apparently minor details. It must be considered, too, that it is experience which has given importance to these points, because of the very effectual manner in which attention to them has assisted in rendering more easy an operation attended with a great many difficulties.

Up to the present time I have been considering the means of commencing the filling, a part of the operation generally the most difficult. Any one of the methods described, may be resorted to as the particular case may demand. After a portion of the gold in any of these ways, is fixed, in its place, the remaining part of the operation is simple and free from difficulties, which may not easily be surmounted.

The instruments most suitable for this part of the ope-

ration, and indeed, for all parts of the operation, so long as the gold can be kept perfectly dry, are of the second class, (fig. 5.) The surface may be as broad as the size of the cavity will allow to be used with facility; it will, however, be necessary to employ several sizes in every operation.

We will suppose the bottom of the cavity covered with a condensed layer of gold, securely in place, with the surface in such condition, that new layers of adhesive gold will readily adhere to it. The sheet of foil is placed on the tray or operating table, with a weight laid upon one side. A piece of gold is torn off with the instrument intended to be used for carrying it into the cavity, and for condensing it. It will be found most convenient to lay the sheet of gold on a wooden tray, covered or not, as may seem desirable, with a napkin, (I prefer the uncovered wood), and to take up the pieces of gold, as they are torn off by striking them a slight blow with the instrument. If the points of the condensing surface of the instrument are sharp enough, the piece of gold will readily adhere to it. In this way the napkins being properly arranged, to prevent it from getting wet, it is carried to its place, and with no larger quantity of gold under the condensing surface of the instrument than is necessary to take it up by, it is forced against the condensed portion of the gold. A single layer, or a small number of layers, of foil, over the whole surface, is in this manner, inseparably attached to the consolidated gold in the lower part of the cavity. The foil projecting

from the cavity is now gathered in, not altogether, but in small portions, each portion carried where it is most needed, and condensed. If a single layer, only, of the gold is under the instrument, one of the largest size that can be used, conveniently, may be employed; but if any considerable quantity is gathered under it, a smaller instrument must be used.

The principle of the condensation of adhesive gold is this: the area of the portion condensed must be comparatively smaller, in proportion to the quantity of gold carried before the instrument; the reverse also holds good; when a single layer is to be attached to the consolidated portion, it might be forced into the contact with an instrument large enough to cover the whole surface, if it could be well adapted to the inequalities. But just in proportion as the number of layers is increased, the condensing surface of the instrument must be reduced in size.

When this principle is kept in mind, it will readily be understood how single or double layers of No. 10 may be made to adhere over a large surface, for the gold may be rendered so adhesive as to make an almost perfect union when forced into contact with the surface previously condensed. It may easily be understood, too, how with slight force, as compared with that required to condense large masses of unadhesive gold, a very dense filling may be produced.

If, however, an irregular piece of No. 10 foil is used, and this piece is much larger than the area of the filling, it will be impossible to condense it layer after layer, but

it must gather up into regular folds, and a number of layers be brought under the instrument. In this case, after the whole piece is condensed as well as can be done with the larger instrument, it must be gone over again with a smaller instrument, and gold added at points where the filling gives way. This, indeed, may and should be done, in all cases.

The operator should always be careful, at every stage of the operation, when a new piece of gold is added, to carry it well against the walls of the cavity, after the piece or pellet is attached to the centre of the filling. For this purpose the form of instrument shown at *c* (fig. 5,) will be found of value, and should be freely used around the edges of the cavity as the filling approaches completion.

After the cavity is entirely full, it is well, if it can be done, before the moisture is allowed to reach it, to condense the surface, first with the large rough instruments of the second class, and finish with those having a smooth surface, or with a burnisher. It will be found, however, if the proper steps have been pursued in the course of the operation, that there will be very little condensing necessary after the cavity is full, as the whole mass of the filling will be so dense throughout, that no considerable impression can be made upon it. It is only necessary to condense the last layer, as described, so as to force down the points left by the rough surfaces of the condensing instruments. It may then be filed down, a smooth condensing instrument used from time to time, or from the salivary glands, from the mucuous membrane,

a burnisher, until the surface is left perfectly smooth and polished; before burnishing finally, or polishing the surface by any means thought best, every part of the filling should be condensed with a small sharp-pointed instrument, and, if found defective at any point, more gold should be added.

DEFECTS IN THE FILLING.

I suppose there are very few, if any, operators who have not found, after they have filled a cavity apparently to their entire satisfaction, some slight defect about the filling, which is very unpleasant to look at, but scarcely of importance enough to oblige them to remove the whole or a large part of it to remedy. Sometimes, indeed, the defect is of importance, and after a great deal of patient labor the conscientious operator feels himself obliged to undo what he has done and begin his piece of work over again. But, where adhesive gold is employed, new portions may at any time be added. If there is a defective spot, it is only necessary to dry that part thoroughly, and to be sure that all moisture is removed, to cut away a small portion of the surface, roughen it, and add the gold needed. For this purpose I prefer No. 10, as adhesive as I can obtain it. It is fixed in small pieces, and, in order to do this effectually, instruments of the first class must be used. The first piece of gold added must be surely attached to the filling by the free use of the very sharp-pointed instruments (fig. 4); after the gold of the filling has once been thoroughly consolidated and bur-

nished, the addition of more gold is not so easy, as where the surface has been kept dry and rough. The first addition is made somewhat after the manner of uniting layers of unannealed gold, by forcing one into the other; but after the first piece is securely attached, as much gold as is desirable may be added, with as much ease as at any part of the operation.

I have now given some account of the general features of the method of using adhesive gold. It differs totally from any method of using gold foil for filling teeth, employed before the introduction of "sponge gold." Its advantages consist in the fact, that it is condensed in small quantities, so that, with comparatively light force, a very dense filling is made. Each piece introduced into the cavity, too, becomes fixed, at once, as soon as it is brought into contact with the part of the filling previously condensed, the portions remaining uncondensed can be torn away, and carried to any part of the surface of the filling where it is needed, requiring pressure only, which can be employed with great convenience, and to the greatest advantage, to bring the gold into its most compact condition.

The advantages of this method of practice have been well illustrated, by reference to the method employed in some large establishments, of packing flour in barrels. A pair of light rollers placed end to end, and both together corresponding to the diameter of the barrel, are attached at the centre to a revolving upright shaft. The rollers are placed in position in the bottom of the barrel, and as

they revolve, a small stream of the flour falls into the barrel; as it fills gradually, the rollers rise with the flour, toward the top, and when the barrel is filled, it is packed more tightly than it could have been if many tons had been brought to bear upon the surface after it had been filled loosely. The arts, indeed, are full of illustrations of the advantages of this method of using gold for our purposes.

OTHER DIFFICULTIES ATTENDING THE USE OF ADHESIVE GOLD.

I have now described the method of filling one of the most simple cavities. A case in which any form may be given to it by the operator, as he may think best, and in which the gold can be kept free from moisture. It is all plain sailing after the first pieces of gold are fixed in place, and I would strongly advise those persons who have no experience with this new method of using gold, first to try it in just such a case, and to continue to employ it in such cases until facility is acquired. I have said that the method described is the most simple and easy of practice of any now known; in the large majority of cases this is unquestionably true, but no one who proposes to adopt it, or any method to which he is unaccustomed, must expect all to go on smoothly at the outset. No system is perfect, no mode of practice so easy that it can be successfully employed by a beginner, without more or less difficulty. The class of cavities, to which I have referred, may readily be filled by any method of operating, and yet a beginner will meet with difficulties when

he first attempts to fill them. A practised operator, when he changes his method, has, to a certain extent, the same kind of difficulties to encounter. It is this fact which keeps many men all their lives on the track upon which they happen to start; when a new way, and a better one is offered to them, they look at it, perhaps venture a little upon it, and because they cannot at once, before their eyes get familiar with the new light, or they feel accustomed to the different surface upon which they are treading, travel with the same ease as before, they prefer to go on groping and stumbling in the old way. It is a common remark in our profession, that a man can obtain better results by his old methods than by adopting new ones; but every new plan of practice proposed, if the principle is correct, and it promises to lead to greater facility or better results, should be examined and tried until its merits are fully appreciated. At first the old method may seem the better, but when a thorough acquaintance with the new one is acquired, it will be found, if it is really an improvement, that results are obtained which make an ample return for the time and labor spent upon it, and which develop, in a light never suspected before, the imperfect character of the old plan. It seems strange that men should so constantly remain blind to the fact that the world is ever progressing, that in every art, in every branch of knowledge, advances are continually being made. In our own profession we all know that this is eminently the case; the truly progressive man is he who is on the alert for new sugges-

tions, never failing to get out of them all the good they may contain, and no better assurance is needed that a dentist, no matter what his present skill may be, will soon fall behind his fellow-practitioners, than to hear him say he is perfectly satisfied with his methods of practice, and wants no better.

We come now to the consideration of some other difficulties, besides those already mentioned, which attend the use of gold in the manner proposed. One essential feature of complete success is, that the gold during the process of filling should be kept absolutely dry. This is not always easy; in some cases, indeed, it is very difficult; in some absolutely impossible.

It may be said that this precaution applies to all methods of using gold. There is no question that a more perfect filling can be made, no matter in what manner the gold may be prepared or used, if it is kept dry, than if it is allowed to become wet, and yet every operator must have met with cases in which serviceable fillings have been made, although the cavity has been submerged in the fluids of the mouth during the whole of the operation. When no advantage is expected from the adhesion between the different portions of gold, moisture is a matter of less consequence than when adhesion is depended upon. In the latter case, however, it becomes a matter of the very first importance. I shall, therefore, give this subject some special attention.

There are three sources from which the fluid, with which we are troubled in filling the teeth, comes, viz.,

and from the bloodvessels of the gum, when wounded in the course of the operation.

THE SALIVA.

The secretion of saliva, as is well known, is very copious in the mouths of some individuals; in others it is comparatively slight. In all cases the presence of any foreign substance in the mouth will lead to increased secretion, and a copious flow usually follows a painful operation upon any part of the mouth. Operations on the teeth then, give rise to increased secretion of the saliva from two causes: the stimulus of a foreign substance in the mouth, and the pain very often attending these operations. Every dentist, I presume, has seen the saliva spurt out in a free stream, from the openings of the ducts of Wharton, as a consequence of some touch of an instrument producing pain.

In taking measures to escape the inconveniences and disadvantages, occasioned by the saliva, in operating upon the teeth, the localities from which it comes must be attended to. The saliva, is principally secreted by three pairs of glands: the parotid, the sub-lingual, and the sub-maxillary, and very nearly the whole of the secreted fluid passes into the mouth, through two pairs of ducts, viz.: the ducts of Steno and the ducts of Wharton. The duct of Steno passes from the parotid gland along the inside of the cheek, covered by the mucuous membrane, and opens near the first superior molar. The duct of Wharton conveys the saliva secreted by the sub-maxillary gland, and the greater part of that formed by

the sub-lingual gland, and opens on the side of the frænum of the tongue. To any one not familiar with these facts, the points at which the ducts open may be easily ascertained, by examining of the mouth at the points indicated.

When the upper teeth are under treatment, the saliva may be, for the time, kept from passing out of the duct, on the side where the operation is to be performed, by first wiping the adjacent parts perfectly dry, and covering it with a small piece of napkin, folded so as to make it about an inch square, and some half dozen folds in thickness. The napkin may be kept in place with the fingers of the left hand. It has been advised to cover the opening of the duct with a piece of thick blotting paper, previously drying the mucous membrane at this point thoroughly. I have never found the plan successful. A simple spring might easily be made, to keep a small piece of napkin or paper in place over the duct, acting like the finger and thumb brought into opposition on the outside and inside of the cheek. Dr. Garrett, of Wilmington, Delaware, informs me that he has in successful use such a contrivance.

When the head is thrown back, and the mouth kept open for a long time, the accumulation of the saliva in the lower part of the mouth, becomes, sometimes, not only a source of great annoyance to the patient, but is occasionally a serious obstacle in the way of the completion of the operation. As the saliva accumulates, it, sometimes, encroaches upon the nerves of the fauces, which

being of the excito-motory system, are beyond the control of the will, the irritation occasioned by contact of the saliva, excites the muscles to which they are distributed, so that, in spite of any effort the patient may make, an act of deglutition takes place, a portion of the saliva is swallowed, and a portion, very probably, overflows the cavity you are engaged in filling. Even when this does not occur, the mouth becomes filled to overflowing with saliva, making it necessary to cover the breast and shoulders of your patient with napkins, to prevent the garments from becoming soiled.

Several years ago I proposed a simple contrivance, to get rid of this annoyance. It has been got up by the firm of Jones, White & McCurdy. It is merely a glass tube, with a bulb in the centre, bent slightly at one end, and a hollow ball of India rubber attached at the other.

Fig. 8.

As I have never explained the purpose for which I intended this instrument, its use has not been fully understood. The statements made in the notice of it and the advertisement of Messrs. Jones, White & McCurdy, have had a tendency to mislead those who have attempted to avail themselves of its advantages. It was not intended, as stated in the "News Letter," to obviate the difficulty occasioned by the encroaching saliva in filling the lower teeth; for this purpose it is useless, but

it will be found of great service, occasionally, to remove larger accumulations of saliva in the lower part of the mouth, during operations upon the upper teeth. I have, repeatedly, in a long operation, emptied the mouth, in this way, greatly to the relief of the patient, and to my own advantage. The instrument has been rendered almost entirely useless, however, by an attempted improvement. It was found, when the end of the "saliva pump," as it has been called, was placed in the mouth, after the air was forced out of the ball, if it rested against the mucuous membrane, that this was drawn into the opening which it completely closed. This difficulty was attempted to be obviated by making the end of the tube impervious, and cutting two or three small holes on the sides near the end. But in many cases the fluids of the mouth, owing to a large secretion of mucus are so viscid, that they will not readily pass either in or out of these small holes. I prefer it as originally made, and would advise those who may have one of the instruments with this alteration, to cut off the end with a coarse file; then when using the instrument, let the end rest against the inside of one of the teeth near the gum and no difficulty will be encountered. It will be found, oocasionally, so useful that no one, in practice, who becomes aware of its advantages, will be satisfied, unless it is within reach of his hand in the cases referred to. It would be really an improvement if made of colored glass, as the white glass is soon rendered unsightly by deposits from the fluids of the mouth, which it is not easy to remove.

The annoyance encountered from the saliva is not, of course, so great in the upper jaw as in the lower, where the products of all the glands accumulate by their gravitation. The means of preventing an overflow when filling the lower teeth is especially worthy of attention. It is necessary not only to stop off the saliva from the glands of the lower, but also the glands of the upper jaw, on the side upon which the operation is being performed.

My plan of procedure is simple. I have napkins of fine bird's-eye linen, about three inches wide and twenty-four inches long; these are not hemmed, but when used, the cut and frayed edges are folded in. Beside these, I have other napkins about one-fourth the length and the same width.

METHOD OF APPLYING NAPKINS IN THE LOWER JAW.

Direct the patient to place the point of the tongue against the roof of the mouth, as far back as possible. Dry the lower part of the mouth with a napkin. Then take one of the smallest napkins mentioned above, and fold it, with the frayed edges in, about an inch wide, apply one end to the mucous membrane under and on the side of the tongue, beginning near the tooth to be filled. Bring it now, in regular folds, using, for the purpose, the point of the fore-finger, or a suitable instrument, around under the tongue and well against the mucous membrane, until the space between the back parts of the teeth and the lower part of the tongue, extending to the opposite side of the mouth, is filled,

avoiding, of course, such pressure as will give pain. When this is done, let the tongue come back into its place. Now place the end of another napkin on the tongue, and direct the patient to place the fore-finger of the hand opposite to the side on which the tooth is to be filled, upon this napkin, to hold the tongue in place, allowing the elbow to rest on the arm of the chair. In some positions the tongue may be held down by the operator with the fingers of the left hand.

Now, on the side on which the tooth is to be filled, place the end of one of the larger napkins, referred to, against the opening of the duct of Steno, and, gathering it in regular folds, against the cheek, bring it down to the lower jaw, carrying it along between the outside of the alveolus and lips, to the gum opposite and somewhat in front of the tooth to be filled. This napkin is to be held in place with the fingers of the left hand.

In this manner the flow of the saliva from all, except the parotid gland of the opposite side, can be completely stopped; in cases where the flow of saliva is so great as to make it desirable, a napkin might also be applied so as to stop the flow from this gland, although generally, even in a long operation, it is not necessary. If the napkins are properly applied, the mucous membrane being dried, carefully, before they are brought into contact with it, they will be found to adhere so closely as to be removed, with some difficulty, when the operation is completed. They must not be torn suddenly and roughly away, as I have sometimes seen the mucous

membrane torn in consequence, but if found to adhere closely, after a gentle attempt has been made to remove them, they should first be wetted, when they can be taken out without further difficulty.

I find the method described more effectual for the accomplishment of the object in view, than any I have tried or heard suggested. It is certainly not very agreeable to the patient to have the mouth crammed with napkins, as, indeed, very few of our operations are; but if the arrangement of the napkins is properly managed, it will not be found so objectionable to the patient as might be supposed. A very simple, and I am inclined to believe effectual, instrument, might be made to do away with the necessity of using so large a quantity of the napkin in the lower part of the mouth as is usual. The saliva from the gland of the lower jaw, comes from a small point of the surface of the mucous membrane; if an elastic substance were kept, with some pressure, upon the openings of the ducts, the flow from them would be completely arrested. A spring, or clamp, of proper form, bearing upon a small piece of napkin placed upon the openings of the ducts, and having its point of resistance outside of the mouth, underneath the chin, might be easily, I think, contrived to answer the desired purpose fully.

The proper use of appliances, for the purpose now under consideration, is a matter which requires careful attention from every practising dentist; although it seems a very simple matter, it requires care, and some practice, to make use of them effectually. It must be remem-

bered, too, that no matter what method of operating may be adopted, success depends very much upon attention to little things, which are sure to be neglected, or disregarded by the careless and indifferent operator. Success, indeed, in any nice process, depends upon attention to every feature of it which can contribute to its perfection, or can militate against it. It is not usually difficult to provide against the contact of the saliva with the filling; sometimes, however, the flow is so exceedingly copious that no ordinary appliances will prevent it from escaping into the mouth and overflowing the operation. Cases sometimes present themselves, in which the whole of the lower teeth will be almost continually submerged. But these are exceptional cases.

MUCOUS SECRETION.

Where the carious cavity is situated near the gum, however, a great deal more difficulty is experienced in keeping clear of the mucous secretion than the saliva. Any one who has attempted to use adhesive gold in filling a cavity situated on the proximate surface of a tooth, near the gum, will readily understand the difficulties occasioned by the accession of the mucous secretion, which, though small and imperceptible in quantity, creeps gradually into the cavity and over the gold, and as effectually prevents its adhesion as if it were completely submerged. There are cases, too, in which the gum encroaches upon the margin of the cavity, and sometimes projects into it. In these cases, it is almost impossible to avoid wounding the gum, and even where it is not cut

with the instrument, the slightest touch will, sometimes, start it bleeding; it is often so turgid with blood, that even pressure against it of the material used to dry out the cavity, will be sufficient to give rise to this annoying difficulty. Sometimes it becomes necessary to cut away the portion of gum projecting into the cavity, and the bleeding which follows is very often quite troublesome to arrest. The same means have been employed both to put a stop to the mucous secretion and any accidental bleeding from the gums in the cases now under consideration.

STYPTICS.

Styptics and escharotics of various kinds have been used for this purpose. I have found none which answers the purpose better than chloride of zinc. Its action is rapid and effectual. It may be used by taking a small portion out of the bottle in which it is kept, breaking it up, as may be readily done, into a wet powder, and applying on the end of a stick, cut into proper form, directly to the part where it is needed. As it produces a great deal of pain when it comes into contact with the sensitive dentine, it is necessary, before using it, if the cavity is sensitive and the chloride cannot otherwise be kept away from it, to fill the cavity with wax or some other substance. The chloride deliquesces with rapidity, and as it becomes fluid, will, unless some precaution of this kind be taken, run into the cavity. There are cases where nothing else will answer the desired purpose, but some agent of this kind, as, for instance, where the

cavity under treatment is situated upon the labial or lingual surface of an incisor tooth near the gum. The chloride may also be conveniently applied by kneading it with wheat flour, the deliquescence of the chloride furnishing moisture enough to give to the mass the desired consistency.

Tannic acid may also be used, with advantage, sometimes, for the same purpose.

PRESSURE.

In the more numerous class of cases, however, where the carious cavities are situated on the proximate surfaces of the teeth, reliance is principally placed upon pressure made upon the adjacent gum. By means of pressure, properly applied, the encroaching gum may be forced out of the way, and the mucous secretion can be, for the time, completely arrested; if wounded, the bleeding may be effectually suppressed. The usual method of applying pressure has heretofore been to force into the triangular space formed by the margin of the alveolus and the necks of the teeth, a properly formed wedge of wood. By this means, in most cases, where the cavity to be filled is situated between two teeth, the end in view can be perfectly accomplished. Some pain, it is true, is occasioned, as it is necessary to put in the wedge with considerable force. In cases where the tooth adjacent to the one to be filled is lost, this method cannot be employed.

A very simple and effectual means of applying pressure

suggested itself to me a short time since, which, in my own hands, supersedes entirely the use of the wooden wedge just referred to. It is another of the myriads of uses to which the remarkable substance caoutchouc may be applied. It was suggested some years since, (I do not now remember who deserves the credit of this suggestion,) that bands of India rubber might be employed with advantage, in changing the positions of the teeth in the treatment of irregularities. These bands were obtained by cutting rings from tubes of the material, made for the purpose. The tubes were of various sizes. These little rings are invaluable for the purpose of which I am now treating. If a ring of this kind, somewhat smaller than the tooth under treatment, is stretched over it and brought up with some force, under the free edge of the gum, it will compress this portion of the gum so forcibly as to arrest, perfectly, the secretion of the mucous membrane, or stop the mouths of bleeding vessels.

The best method of applying this little ring, is to take it up in two pairs of spring forceps, or with one pair of spring forceps and the fingers, or a curved instrument, and stretch it over the tooth, and between it and the adjacent tooth, keeping hold of the ring and carrying it up with a sawing motion until it has reached its proper position, when it is allowed to assume its original condition. It is, generally, desirable to pass it under the free edge of the gum on each side of the tooth. It is, sometimes, desirable to pass another one of the rings, in the same manner, around the adjoining tooth.

For nearly all cases, I find the rings cut from the smallest sized tube, which is but little more than a line in diameter, best adapted. It is sometimes necessary to use a ring from a larger tube embracing two or more teeth. The best article of this kind, and the only suitable one I have met with, is manufactured in France. It possesses a very remarkable degree of elasticity and toughness. For the purpose indicated, I certainly find this little appliance invaluable.

It is scarcely necessary to caution any practiced operator to be careful to remove the ring after the completion of the operation; but the history of a curious case which lately came to my notice, will serve to show that serious consequences will follow neglect of this precaution. A student, a short time since, made use of the gum elastic ring, for the purpose I have recommended. The operation was partly completed, and the patient sent away. After the lapse of several days, she returned to have the operation completed, but the tooth was so tender to pressure that she was sent away. In the course of a week the patient returned, and on examination the tooth was found to be so very loose and annoying, that it was taken out. On removing it the cause of the difficulty was at once apparent. The ring had not been taken off, and as the fang of the tooth, a second bicuspis, was conical, the ring had worked its way toward the apex, until it had very nearly broken up its connexion with the socket. The periosteum was as perfectly removed up to the point where the ring was found, as if the fang had been scraped with a sharp knife.

In conversing with Dr. Charles W. Ballard, of New York, about this contrivance, I found that he had been using these little rings, for the same purpose, several months previously to myself.

The elastic rings will be found to exert pressure, if properly applied, to such great advantage, that a projecting portion of the gum, a very annoying obstacle in some cases, may be cut away without the slightest hemorrhage ensuing.

These rings, in cases where they are needed, and I use them in all cases of proximate cavities, may be applied either before or after the cavity to be filled is dried out, as all the moisture may, of course, be as perfectly removed from the India rubber, as from the cavity itself.

There are certain cases, where the form of the carious tooth, the situation of the cavity, and its relation to the gum is such that neither the rings nor the wedge of wood can be used with any advantage. Sometimes I have found it necessary to force in between the teeth a roll of bibulous paper very tightly, and have found this to answer when nothing else would.

After the proper precautions are taken to prevent the accession of moisture during the operation, the next step is thoroughly to dry the cavity and all the adjacent parts. For this purpose I employ, to remove from the cavity the principal portion of the fluids of the mouth, a pledget of cotton, then completely drying it out, with the French bibulous paper, an excellent article for the purpose. By means of this paper, every particle of moisture may be taken up.

I have intimated that, notwithstanding all the precautions I have advised to be taken, to get rid of the trouble and inconvenience of the accession of the fluids of the mouth, to a cavity, that, in some cases, it is impossible to exclude them. This is so; the secretion of saliva in the mouths of some individuals is excessively copious, and is so much increased by the irritation occasioned by operations upon the teeth, that it becomes impossible to prepare the cavity for filling, or even to examine it, without first resorting to some of the means described to keep the teeth under treatment from being overflowed.

It is generally the case, too, in treating the teeth of little children, that it is impossible to use the napkins, as they will frequently be found unable or unwilling to suffer the inconvenience long enough to complete a filling occupying any considerable time. There are many children who will not, or cannot, bear any of these appliances, at all. I have met with adults, too, who could not bear them. Some time since, I had a gentleman in my hands who could not bear the slightest touch of a napkin to his tongue.

Sometimes, too, in favorable cases in other respects, the gold becomes moist or wet before the filling is completed. Very often the amount of moisture is so slight that no fluid can be seen, and its presence is only known by the surface of gold, as it is condensed, losing the bright appearance it presents as long as it is kept perfectly dry, and appearing dull and tarnished. Another

indication, and the first generally observed is, that the gold ceases to adhere, in spite of all the force that may be brought to bear upon it. What is to be done in such cases?

When the gold becomes wet, no matter how adhesive it may be, it will certainly no longer adhere. A species of union, however, may be effected between two layers, similar to what is accomplished when ordinary unadhesive gold is used somewhat after the plan of adhesive gold; that is, by employing instruments with very sharp points, by means of which one layer is thrust into the other. The use of the adhesive gold instruments of the first class, (fig. 4,) is to effect this kind of union. With these, if properly made, this can be done, but a great deal of direct force must be used.

In the majority of cases, when the gold is of a partially completed filling, becomes wet, it is best to stop the introduction of the gold. The filling so far as it is completed, should then be burnished, and the patient allowed to void the saliva and close the mouth. The napkins should then be rearranged, the cavity dried out, and the surface of the filling scraped, so as to remove any portion of the gold, which may have become moist. The whole surface should then be roughened with the sharp-pointed instruments. (A and B, fig. 4.) The most adhesive, No. 10, gold, well annealed, immediately before using, should be employed to make the first additions; it should be torn off from the sheet, in small pieces, and should be added in a single layer. The

instruments used for attaching these pieces should be of the first class, (fig. 4,) and where it can be done, the portion first added should be attached by one side, and this part held in place with an instrument in the left hand, until the other side is firmly attached also. It must be carefully remembered, that the first pieces added must be securely united, before the operation is proceeded with; when this is done, the rest of the operation is as easy as if the filling had not become wet.

I have occasionally found it necessary to go on with the operation, entirely regardless of the moisture, and in this case it is best to fill the cavity, at once, with a large pellet, complete the filling by adding gold at several points, with small instruments. The instruments, where any attempt is made to use gold, under these circumstances, must be very *sharp and hard*, and the gold must be thoroughly driven into the preceding layers. I prefer, for operations of this kind, No. 10 gold. A longer time is necessarily consumed in the operation, and less satisfactory results are obtained.

It is immaterial, indeed, whether adhesive or unadhesive gold is used. Cylinders, in many of these cases, will be found preferable to adhesive gold. I have seen it somewhere asserted, that adhesive gold is cut up in the course of the operation, into small particles, by the sharp instruments employed; this is not the case when the gold is kept dry, as an inseparable union between each particle of gold coming into contact, takes place with every effort of the instrument, but when the gold becomes wet,

and many efforts are made to condense it, it is cut up into small particles, as stated.

Where direct and convenient force can be used, as upon the grinding surfaces of the teeth, a very dense and useful filling may be made in the manner described; it is important, however, in all cases to use every possible precaution to keep the cavity perfectly dry during the performance of this important operation.

It may be asked here, if a filling, made under such circumstances, saturated, as it were, with the fluids of the mouth, containing elements capable of decomposing the dentine, can subserve the purposes intended by the operation? There is no question that layers of gold, even when wet, may be driven into such a close and compact condition, as to be rendered perfectly impermeable to fluids, and that by the heavy force used in filling, very nearly all the moisture is driven out, leaving merely an inappreciable quantity. What can this small quantity of the fluids of the mouth do toward decomposing the dentine with which it is in contact? The proportion of acid it contains, in the vast majority of cases, must be so slight, as soon to become neutralized as it acts upon the dentine, and to be incapable of further action. Experience has confirmed the truth of the reasoning, as in repeated instances, teeth filled under the circumstances described, have been preserved for years, as perfectly as if the operation had been performed under the most favorable circumstances. When, however, it becomes necessary to disregard that important feature of filling

teeth, viz: keeping the gold dry, it is of course, advisable, subsequently, to watch the condition of the filling, if possible. The operation must so far be regarded an imperfect one, and the result uncertain.

TIN FOIL.

Where force cannot be employed to advantage, as upon some of the cases of cavities of the proximate surfaces of the teeth, I do not regard a filling made with gold, under the circumstances referred to, as reliable. I greatly prefer, in such cases, to use good tin foil. I am satisfied from observing the condition of tin foil fillings, after the lapse of years, that this material, for dental purposes, has not been estimated at its real value. It is softer than gold, in any form, and more readily adapts itself to the form of the cavity; it may be used in much larger quantity than even unadhesive gold foil, and comparatively serviceable operations completed in a much shorter time. I suppose every dentist who has been in practice many years, has met with patients in whose mouths, a number of very poor tin fillings were preserving the teeth, while every tooth, filled with gold from the hands of the same operator, was rapidly decaying. I do not, of course, mean to say that tin is a better material for the purpose than gold; but I am satisfied, that in the hands of a poor operator, or in cases where gold cannot be used to advantage, and such cases do occur, tin foil is a valuable substitute. So far as I have had expe-

rience in the use of amalgam, and I have tried it in a few cases, I think pure tin foil decidedly preferable.

There is one feature of adhesive gold which renders this quality, under the old system of manipulation, objectionable; I refer to its apparent harshness or hardness. When any considerable quantity is taken up in the form of a pellet or rope, it becomes unmanageable, it cannot be condensed, and a great desire has been expressed, by operators partially acquainted, practically, with this method of using gold, to obtain an article at once, very adhesive, and soft and yielding. If I understand, clearly, the cause of the objectionable quality referred to, this is an impossibility. If the gold is very adhesive, each layer coming into contact, when it is formed into a pellet or rope, adheres; these layers cannot slide one upon another, as is the case with unadhesive gold, giving to the latter an appearance of softness the former does not seem to possess. Adhesive gold, also, after having been exposed sometime to the air, appears to be softer than immediately after it has been reannealed. But this cannot, of course, be the case, as heat applied to gold does not render it denser, but has a contrary effect. It has been proposed to manuufacture a foil possessing only a slight degree of adhesiveness, but which, upon being subjected to the usual pressure exerted in making a filling, will adhere. In this

way the advantages of the adhesion of the foil with the use of pellets, of considerable size, is proposed to be combined. The result of my own experience is, that if adhesive gold be employed, an entirely new system of operating must be adopted, if its full advantages are to be obtained. It must be used in thin layers, and if heavy numbers of gold in pieces torn from the sheet as described, are substituted for pellets, it will be found that there is nothing lost in point of the time necessary for the performance of a good operation. By pursuing the method which I have endeavored to make plain, in the foregoing treatise, I find the quick adhesion of the gold not only no disadvantage, but, on the contrary, so great an advantage, that I want it as adhesive as I can obtain it.

I am repeatedly asked whose gold foil I prefer. I have used adhesive foil made by several manufacturers, and I am satisfied that it requires no art to produce it. For many years past, as already stated, the effort has been in the opposite direction. I have found no material difference in the various specimens I have tried. I should have no hesitation in purchasing from any manufacturer in whom I had confidence, and I should expect to obtain what I wanted. In procuring foil, however, it should be stated whether it is wanted adhesive or non-adhesive.

CAN GOLD BE WELDED?

It has been stated that gold is a metal which is not susceptible of being welded. The definition, by Ure, of the term "welding" is, that it "is the property which pieces of wrought iron possess when heated to whiteness, of uniting intimately and permanently, under the hammer, into one body, without any appearance of junction." The German synonym of the verb "to weld," as given by Ure, is "*schweissen*," to sweat; the derivation given by Webster is "*wellen*," the plural form of "*welle*," a wave. From Flügel's definition of "*schweissen*," as applied to the process of welding, as well as the derivation of Webster, the idea seems to be that the two pieces of metal, to be united, are heated until the surfaces are brought into a state of fusion, or liquefaction, when they are joined by being driven into contact, the molecules of each portion intermingling. Wrought iron and platinum are said, by writers on the subject, to be the only metals capable of this kind of union.

I have called attention to the fact, in reference to the wants of the dental profession, that when two thin layers of pure gold, at a temperature not above that of the atmosphere, are brought into contact, with a slight degree of force, they become united. The term "welding," is applicable to this union, so far that the two bodies are united so perfectly that no appearance of the junction remains, heat not being required. The purport of the denial that gold is not possessed of this capability

of being welded is, I suppose, that when two surfaces are brought together, in the manner indicated, such a union cannot be effected as takes place between two pieces of wrought iron when they are welded.

This is a subject in relation to which it is my intention to make some careful experiments; the results I will publish when I have gone through with them. I will now, however, call attention to experiments which have already been made, going very far toward establishing the correctness of the opinion that two pieces of gold may be welded, by simple pressure, as perfectly as two pieces of iron are united in the process of welding.

I. Two sheets of No. 6 gold foil were heated, but not nearly to a red heat. One was laid on a wooden tray, and the other placed directly upon it. With no other force than gentle taps given with the fingers, they were united. They could not be separated. The piece was heated again, doubled upon itself, and united by means of the same force, until it became so thick as to be unmanageable in this way. It was then folded upon itself lengthwise, and the opposing surfaces brought together with a small hammer. When the strip became so narrow that it could be no longer doubled lengthwise, it was folded upon itself in the other direction, and united by means of slight blows with the hammer. It was folded in this way several times, and was finally formed into a four-sided bar. It was then passed through the draw-plate until it was reduced to a wire

less than the one-hundredth part of an inch in thickness; it could, of course, without difficulty have been drawn down much further.

II. Dr. C. O. Cone, of Baltimore, informed me, some time since, that he turned, in a piece of ivory, the form of a finger ring. This he filled with pieces of adhesive gold, in the same manner he would have filled a cavity in a tooth. When full, the ivory was cut away so as to release the gold, and the ring was completed in the usual way. It was then placed upon a jewellers' stretcher, a piece of steel, of conical form, and made considerably larger, (as I have mislaid Dr. C.'s letter, I am unable to state, definitely, how much it was stretched; it is my impression it was increased in size one-third,) without exhibiting any appearance of separation between any of the innumerable pieces of which it was made up.

The character of the union between the separate portions o gold united, as described, in the above experiments, may not, in the estimation of some persons, deserve the name of welding. The union of the particles may not be so intimate as that effected by bringing together two surfaces of iron while they are at a welding heat. But I scarcely think it can be disputed, that the union is so perfect that it differs very little from it. So far, indeed, as we are able to judge, the mass resulting from the union of a number of pieces of gold, in the manner indicated, possesses all the properties of a lump which has undergone fusion. One piece is as

malleable and ductile as the other; it will receive as high a polish; it presents, indeed, no visible difference. The specific gravities I have not compared, but I have no doubt that they will be found the same. So far from being deficient in this welding property, it would appear, from these results, that gold possesses it in a higher degree than any other metal. I shall, however, as I have intimated, subject it to every possible test.

The first experiment makes it apparent, that the pointed instruments, described, are not necessary to effect a union between the several portions of a filling, by driving one layer into another, as is necessary when unadhesive gold is employed. The whole object of the pointed instruments, of the second class, is to leave the condensed portion with a rough surface; pressure with a smooth instrument having the effect of burnishing the layer of gold with which it comes into contact, when there is no longer any adhesion until the surface is roughened.

Heating a leaf of gold, after it has been compressed, either by hammering or burnishing, restores its adhesiveness perfectly. The change effected in this way in the surface of the gold, as regards this property of adhesion, is quite interesting. Several explanations of the character of this change have suggested themselves, but I have not now time to offer them.

I HAVE thus attempted to describe, in such detail as I have thought important, a method of using gold foil for filling teeth, from which I have derived the greatest advantages. So far as I have had any light from my fellow practitioners, it is a new system. Methods of practice very similar, or, perhaps, identical, may have been for years pursued by others, but if so, it has not been communicated by them to the profession. If this is the case, and any gentlemen now desire to claim priority of invention, and to appropriate to themselves any credit which may attach to the discovery and promulgation of an improved method of practice, I shall enter into no contest with them. It is a legitimate source of satisfaction to receive commendation when it is justly bestowed, but it is of much greater importance that the community should be benefitted by improvements, than that the originators should obtain credit for having made them. I am much more anxious that the present improvement, to which I have so earnestly called attention, should be fully understood and appreciated, than I am to be considered the author of it; and if I can succeed in giving it that consideration, with the dental profession, it so well deserves, I shall be satisfied.

But it must never be forgotten, that if the system I have explained, really possesses all the advantages which I claim for it, and which I believe it does possess, it simply adds facility in the performance of one part of an

important operation. Dental surgery, slightly appreciated as it is, except by some of those who have made it the business of their lives, could not be successfully, or to any great extent, usefully practiced, if a material for filling teeth could be found as plastic as wax, and which, immediately after using, would become as hard and smooth as enamel, if the operator were possessed of no other knowledge than that necessary to enable him to use this material. There are many other considerations involved, well appreciated by every educated dentist, which demand thought and attention in a degree, of which the mere mechanical operator never dreams. It is not to be feared, therefore, as I have heard it suggested, that if the feature of our practice, upon which I have thought it of importance enough to prepare this little treatise, were so much simplified as to require no skill in its performance, our profession would fall into the hands of mere ignorant manipulators. If this were the case, dentistry would have no claim to such a position among the vocations of mankind, as that for which it has been, of late, so pertinaciously contending. But it is a calling, in the pursuit of which, it is necessary to treat diseases of parts which are affected, in accordance with laws of vitality not always clearly made out. If it is not pursued with an undeviating regard for these laws, so far as they are known, and with an earnest endeavor to develop and make plain everything having a bearing upon it not perfectly understood, it will continue to be what it is now, in the hands of so many, a system

of very gross empiricism. The addition of any means of lessening labor, or of securing better results, in the management of materials required in the manipulations incident to it, will, if in the study and practice of the profession its other important requirements are disregarded, be of value, simply so far as it will enable unskilful hands to render service to the community otherwise out of their power.

The author of the foregoing Treatise has been, for some time, engaged in the preparation of a work on the "Diseased Conditions of the Dental Pulp and Periosteum," which he expects to complete sometime before the close of the present year.