VULCANIZING

—AS APPLIED TO—

DENTISTRY.

—BY—

GEORGE B. SNOW, D. D. S.

BUFFALO, N. Y.

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Press of

E. H. Hutchinson & Co.

Buffalo, N. Y.

THE VULCANIZER.

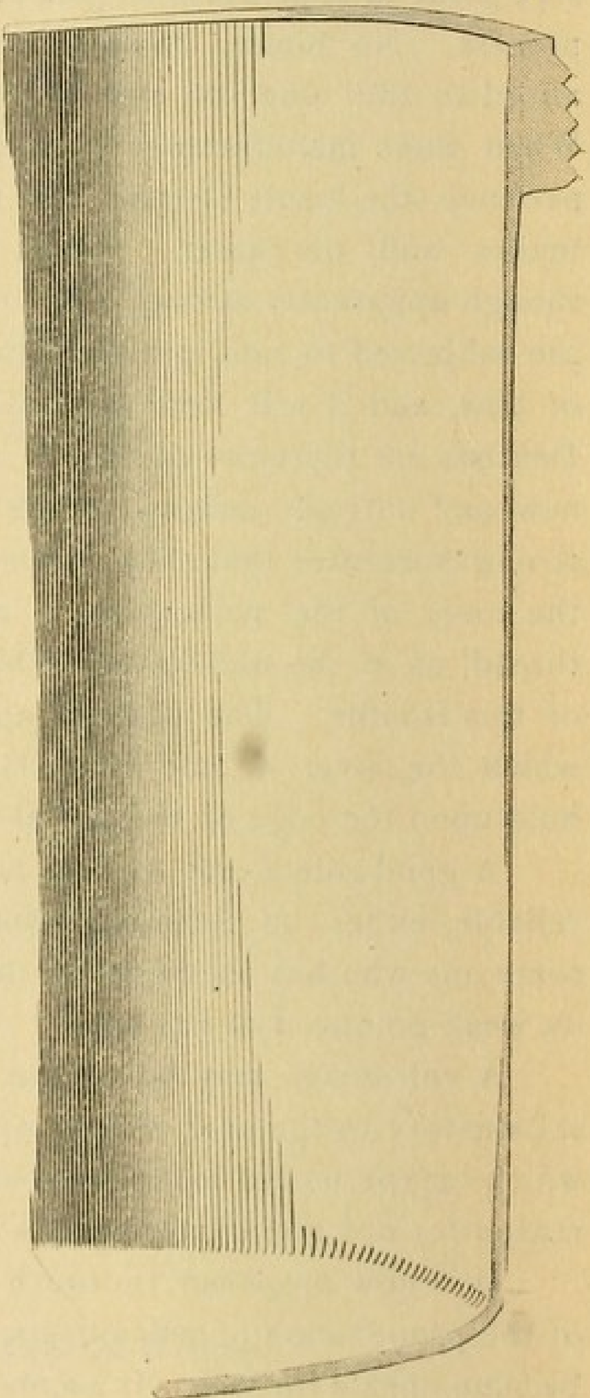
VULCANIZERS, if made by manufacturers of experience, may be depended upon to be strong enough to withstand a pressure three or four times as great as that incident to the vulcanizing process. No house, having any regard for its reputation, can afford to offer one for sale unless it is of undoubted strength. When their manufacture is undertaken by those having no experience, the result is very apt to be unsatisfactory, both to the maker and purchaser. Some of the patterns in the market, though apparently strong, will yield gradually to the strains they are subjected to, and in a short time the packing joint will get out of true, and it will then be difficult to keep them steam-tight. Dentists are therefore cautioned against purchasing vulcanizers of new and untried designs, unless the maker will give a full and strong warrantee that they will not get out of true by use. When the cover of the vulcanizer is attached to the pot by a screw thread, as in the well-known Whitney pattern, there is no danger of this trouble. The caution applies more especially to those in which the cover is held by a clamping device, which only has a hold upon the edge of the pot at intervals.

A good rule is not to buy any make unless it is known to be reliable, either by personal experience, or by the testimony of some one who has used one of the kind long enough to develope its weak points, if it has any.

A vulcanizer may be of the proper design, and still be unsatisfactory to the user if it is not well fitted. This is a point in which inexperienced makers are apt to fail, and constitutes a good reason for not giving their goods a trial.

It is now proposed to touch upon a few points in the matter of the proper care of vulcanizers, and to show how and when they become unsafe for use. It seems to be the opinion of some dentists, that a vulcanizer should remain good indefinitely; but it is often the case that one returned to the maker for supposed trivial repairs, is found to be in such condition as to warrant its condemnation. They are provided with ample safeguards, by which they will be relieved from over-pressure, if it should occur. But no such appliance can be made which cannot be, either ignorantly or designedly, put out of order; neither can a vulcanizer be made so strong that it will be safe under any attainable pressure. It must be carefully and intelligently managed to insure safety.

Vulcanizers are gradually weakened and eventually destroyed by corrosion. To illustrate the manner in which it takes place, the accompanying engraving, representing a section from a condemned vulcanizer, is presented. The original thickness of the metal is fully preserved at the bottom of the pot, and there is but a slight deficiency at the mouth. The action has been wholly upon the sides, and at the middle the metal has wasted away until it is scarcely thicker than paper. It will be seen to have been the greatest at the water line; showing that it is, in all probability, the joint effect of air and moisture.



Instances have been known of the use of vulcanizers without accident until the sides have been actually eaten through so as to leak. This shows how little strength is really required to withstand the pressure due to the vulcanizing process, if care is taken that it be not exceeded.

When the sides of the vulcanizer are weakened by corrosion, the fact is easily ascertained by tapping them lightly with a small hammer. One weighing one or two ounces is suitable for the purpose. If the metal is thick and strong, the hammer will rebound from a light blow. When the metal is quite thin, the sensation will be as though the blow were delivered upon lead. There will be little, if any rebound, and the metal will be dented and driven in very easily.

Sometimes, though happily very seldom, corrosion has been known to attack the brazing in the seams of the pot. This usually takes place locally, so that due warning is given by the occurrence of a leak. No instance is known of a dangerous accident resulting from this cause.

Occasionally, a crack runs around the bottom of the pot at the corner, and unless it is noticed in time, the bottom is blown out. This will not occur unless the juncture of the bottom and sides is brought to an angle. They should be joined by an easy curve; and in purchasing, this fact should be kept in mind.

As corrosion is the effect of the combined influences of air and moisture, the durability of the vulcanizer will be prolonged by expelling the air before vulcanizing, and by keeping it dry and clean when not in use.

When a screw fastening, like that of the Whitney vulcanizer, is employed, mischief is often the result of the inordinate use of black lead or soapstone powder upon the packing joint, and incidentally upon the screw. The particles of which either of these powders is composed are quite hard, and will wear away metal if placed between two rubbing surfaces. The screw threads of vulcanizers are sometimes so badly worn by their action that they have not sufficient hold upon each other to retain the cover.

The reason for applying either of these powders to the surface of the packing is often misapprehended. Their only office is to prevent the packing from sticking to the edge of the pot. Only a small quantity is necessary for this purpose, and it will need renewal but seldom. If it is applied too liberally or too often, it will form a porous coating on the surface of the packing, through which the steam will leak. If the coating attains much thickness, it will scale off in patches, and the leakage, which may have been almost imperceptible before, will be increased so as to be annoying. Possibly the dentist does not detect the cause of the trouble, and thinking that the vulcanizer "works hard," applies oil to the thread. This becomes gummy and dry by the heat of vulcanizing, and the cover is virtually cemented to the pot. It is now removed only with great difficulty. As a rule, when the packing of a vulcanizer is in good order and steam-tight, the less that is done to it, the better.

Sufficient steam room should always be left in the vulcanizer when it is closed. If it is filled with water, and room is not allowed for its expansion when heated, a pressure will be developed much greater than that due to the production of steam. The safety disk may be blown out in this instance when the thermometer only indicates 280° or 300°; or if the safety apparatus be put out of order, the vulcanizer pot may be bulged and stretched out of shape, or a rupture may result. Water is inelastic, and when it is closely confined, its expansion when heated will generate a force which is practically irresistible. It is an easy matter, if a vulcanizer is completely filled with water, to obtain a pressure of even a thousand pounds to the inch without heating it to the boiling point, if it should be able to withstand the strain without yielding.

The management of the vulcanizer is a matter which should be thoroughly understood. If it is intrusted to a careless boy who has had no proper instruction, there is a strong probability of an accident occurring, sooner or later.

THE THERMOMETER.

ALTHOUGH the thermometer is almost universally employed for indicating the temperature of the vulcanizer, the peculiarities of its action as so applied have been but little studied. Dentists put the utmost faith in its indications, when, in fact, it is only under certain conditions that it shows the exact temperature of the vulcanizer and, as will be seen, these conditions do not usually obtain.

When thermometers were first used with vulcanizers, they were so mounted that their bulbs projected into the interior of the vulcanizer, and were in direct contact with the steam. The transmission of heat was thus direct, and the true temperature of the interior of the vulcanizer was registered, provided the air was expelled therefrom; a matter which will be explained later on.

It was soon found that the steam exerted a solvent action upon the glass, and that the bulb became opaque; fine cracks appearing upon its surface, which finally extended through the thickness of the glass, causing the destruction of the instrument.

To obviate this objection, and to increase the durability of the thermometer, it was set in a mercury bath, an invention of the late Dr. Geo. E. Hayes. A cupped nipple, threaded on its exterior, was formed upon the top of the vulcanizer, upon which the thermometer case was screwed; the bulb dipping into the cup, which contained a little mercury. Perfect metallic connection was thus made between the vulcanizer and thermometer, and heat was promptly transmitted from the one to the other; while, as the thermometer was no longer subjected to the destructive action of the steam, there was nothing to destroy it but accident or bad usage. The employment of the mercury bath with dental vulcanizers has therefore become almost universal.

The mercury bath was first employed upon a style of vulcanizer now obsolete, known as the Hayes Oven, which had a petticoat jacket, which carried the escaping heat from the lamp over the top of the vulcanizer, and threw a current of hot air against the bottom of the thermometer case. This counteracted the effects of radiation so perfectly that experiment showed the indication of the mercury bath thermometer to be identical with that of one projecting into the steam space. When the mercury bath was first applied to vulcanizers of the ordinary pattern, the difference in the conditions was not noticed, and it was assumed that the indications of the thermometer were correct.

When Gas Regulators came into use, it was noticed that there was a variation at times, either in the action of the regulator or of the thermometer used in connection with it. When the regulator was tested with a steam gauge, however, the two agreed; showing that the thermometer was at fault. To ascertain, if possible, where the trouble really lay, a vulcanizer was prepared, and mounted with three thermometers, which had been tested as to their accuracy. One, (No. 1, see diagram,) was of extra length, and extended into the vulcanizer so far that its bulb was below the water line. No. 2 was set in the old way as a "steam" thermometer; its bulb projecting into the steam space. The third was set in a mercury bath, in the ordinary manner. A gas regulator, steam-gauge, and blow-off valve were also attached to the vulcanizer.

When heat was supplied, it was found that no two of the thermometers registered alike, nor did either of them agree with the published tables of steam pressures and temperatures and the readings of the steam gauge. After opening the blow-off, and expelling the air which was included in the vulcanizer, the two thermometers which projected into the interior of the vulcanizer agreed with the guage and table of pressures, but the mercury bath thermometer was still in error.

TABLE OF STEAM PRESSURES AND TEMPERATURES.

Temp.	Lbs. Pres.	Temp.	Lbs. Pres.	Temp.	Lbs. Pres.
212	0	310	62	410	264
220	2	320	75	420	295
230	6	330	88	430	329
240	10	340	103	440	366
250	15	350	120	450	406
260	21	360	139	460	449
270	27	370	160	470	496
280	34	380	183	480	547
290	42	390	208	490	602
300	51	400	235	500	661

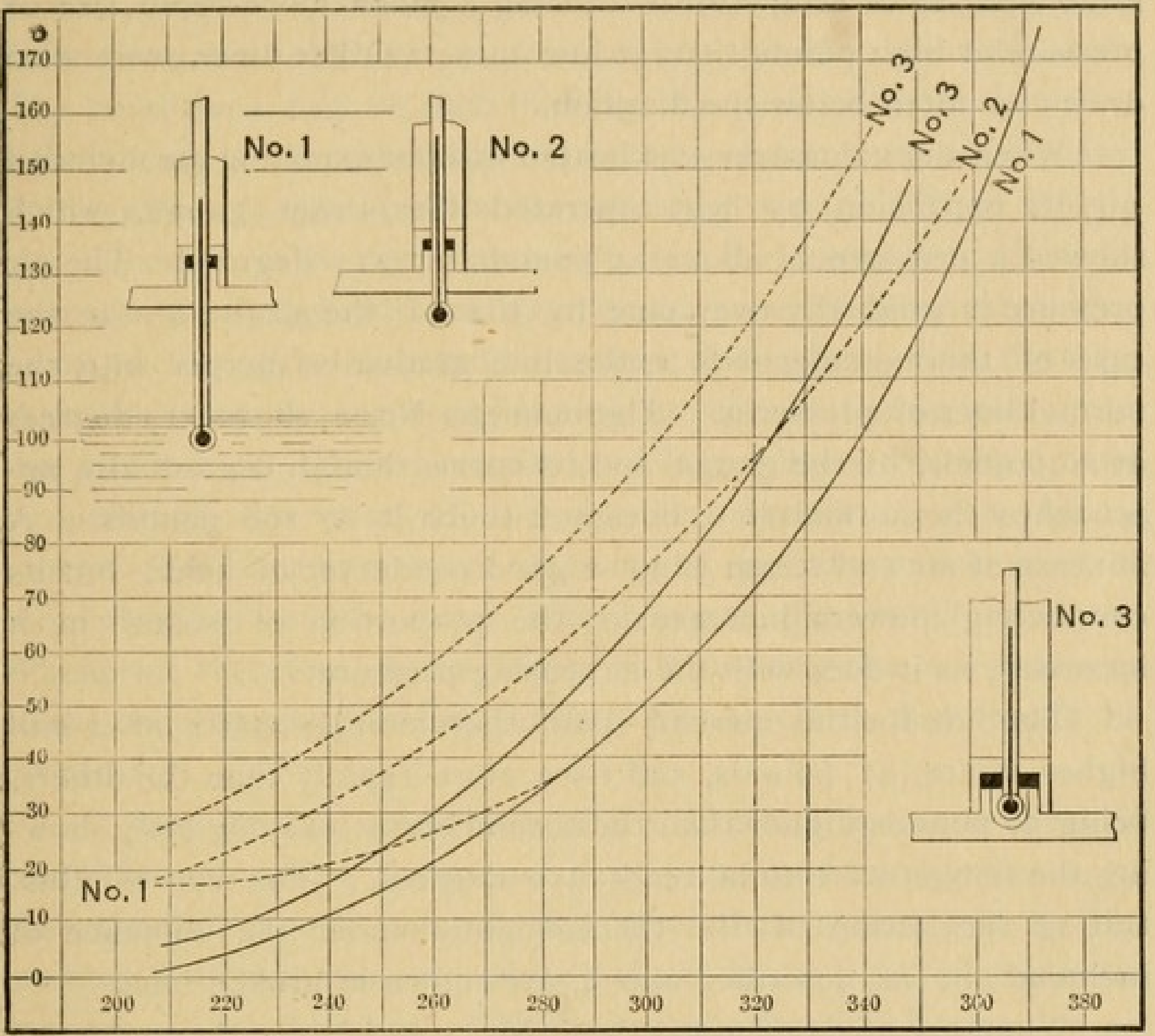


Diagram of steam pressures and temperatures as indicated by a thermometer immersed in the water of a vulcanizer, (No. 1,) one exposed in the steam space, (No. 2,) and a mercury bath thermometer, (No. 3.) Each curve is numbered in accordance with the thermometer from whose indications it is made. Those made with the air included in the vulcanizer are formed of broken lines; with the air expelled, of continuous lines. Nos. 1 and 2 are identical under the latter condition, and agree with the table of the elastic force of steam, given above.

The results obtained are most easily compared and studied if represented graphically, and the above diagram has accordingly been prepared. A series of horizontal lines have been drawn, each representing a rise in pressure of ten pounds, as compared with the line below. Another series, of perpendicular lines, cross the first; each representing a rise in temperature of ten degrees, as compared with the line to its left. On these was first laid off a line, No. 1, to correspond with the table of temperatures and pressures. It forms a curve, and it will be noticed at once how much more quickly it rises as the temperature and pressure increase, the same increase of temperature causing a much more rapid rise of pressure at high points than at low ones. Other lines were also drawn as noted below the diagram.

When the vulcanizer was heated without expelling the included air, its expansion by heat operated the steam gauge, which showed a pressure of about 14 pounds, at 212 degrees. The air pressure is gradually overcome by that of the steam, and in the case of thermometer No. 1, the line gradually merges into the normal lines of pressures. Thermometer No. 2 shows 212 degrees at 20 pounds, by the gauge, and its curve, though it gradually approaches the normal line, does not touch it at 160 pounds. A mixture of air and steam is not a good conductor of heat; but its conducting powers increase as the proportion of steam in it increases, as it does with the increasing pressure.

The line for the mercury bath thermometer starts at a still higher figure, 27 pounds, and rises more rapidly than the others, being 50 pounds higher than the normal line at 320 degrees; showing the temperature to be really 350 degrees. The curves illustrating the action of the thermometers under the influence of included air, as described above, are shown in broken lines.

When the air is expelled, both No. 1 and No. 2 thermometers reach the 212 point before the gauge indicates pressure, and follow the normal line, No. 1, closely as the temperature rises. The mercury bath thermometer reaches the 212 point when the gauge indicates 7 pounds, and its line diverges from the normal line as it rises; so that at the 320 point the pressure is 98 pounds, instead of 75, as in the normal line; showing that it fails to indicate the true temperature by about 15 degrees. Therefore, if the air is expelled from the vulcanizer, the temperature is really 320 degrees when the thermometer indicates 305 degrees. When we consider the greater rapidity with which heat is abstracted from the exterior of the vulcanizer at high temperatures, by the greater amount of radiation and by convection by air currents, we see why the error of the mercury bath thermometer increases with the temperature. The amount of this error differs slightly with different vulcanizers, according to their construction.

The reason for the apparent variations of the gas regulator is now made plain. The regulator is operated by pressure, and turns down the gas when a certain pressure is attained in the vulcanizer. The conditions may be such that the thermometer fails to receive and indicate the temperature due to the pressure; in which case, the regulator is right and the thermometer wrong. When using a gas regulator, it is not unusual to see the mercury in the thermometer steal upwards ten degrees or more while vulcanizing is going on; for as the included air escapes through the leak, the thermometer comes nearer to registering the correct temperature. As the presence of a leak necessitates a larger flame to keep up the temperature, the valve of the regulator cannot close as far as though the vulcanizer were steam-tight, and the temperature of the vulcanizer will be lower, acccording to the size of the leak. Whenever, therefore, the regulator fails to bring the vulcanizer up to the usual temperature, a leak may be suspected, and should be looked for.

It may be laid down as a rule, that when the air is expelled from the vulcanizer, the actual temperature of its interior is, at the vulcanizing point, some 15 deg. more than is indicated by the mercury bath thermometer, while if the air is not expelled, it may be as much as 35 deg. higher. Vulcanizing may therefore be done at 355 when the dentist has no idea that 320 has been exceeded. Bearing this fact in mind, the reason for occasional mysterious appearances of spongy rubber is obvious, and the remedy apparent. The difficulty can be avoided by attention to the condition of the vulcanizer, and possibly, lowering the temperature.

Experience will show beyond question that the best work is done by the use of a low temperature and longer time.

Steam gauges have been recommended as substitute for the thermometer. Like the gas regulator, the steam gauge operates by pressure, and the pressure due to even the slightest increment of heat is immediately felt throughout the interior of the vulcanizer, while the temperature is, as we have seen, subject to delays in its passage upwards to the thermometer. The steam gauge is therefore the more sensitive instrument, but it is also more expensive, more complicated, and more likely to get out of order than the thermometer, which from its low cost, simplicity and durability, has enjoyed and will continue to enjoy the preference as a means for ascertaining the temperature of the vulcanizer.

The gas regulator has been described as operating by steam pressure. It is possible to make an instrument of the kind which will operate by expansion of a metal by heat, and such instruments have been made.

When the subject is properly understood, however, it will be obvious that preference is to be given to those operated by steam pressure, on account of their greater sensitiveness as the temperature increases, if for no other reason; there being, moreover, no saving as regards simplicity of construction in the one pattern of instrument over the other.

THE PHILOSOPHY OF THE
VULCANIZATION OF RUBBER,

AS APPLIED TO DENTAL PLATES.

A MIXTURE of india rubber and sulphur in certain proportions, will, when subjected to heat and pressure, undergo a molecular change which is known as vulcanization. The nature of this change is not clearly understood, but it is known to be accompanied by;

1. An increase in the hardness of the mass; which, from being soft and plastic, becomes hard and horny in texture.

2. An increase in specific gravity; the mass becoming smaller in proportion to its weight.

3. A decrease in susceptibility to atmospheric influences, and the action of solvents; there being but few substances which will affect vulcanized rubber, while there are many which will attack the unvulcanized gum.

The second condition mentioned above has not received the attention it should from dentists, for it is responsible for some very grave annoyances experienced both by the dentist and his patient.

The specific gravity of a piece of unvulcanized rubber compound, (black) was found to be 1.1333. The same piece, vulcanized, had a specific gravity of 1.1974. This would show a diminution of bulk by vulcanizing of about five per cent. Different samples will vary to some extent in their specific gravity, and possibly in their behavior in vulcanizing; but it is a well-established fact that ALL RUBBERS SHRINK IN VULCANIZING; the purer the sample the greater being the shrinkage. Those rubbers which are colored by the admixture of pigments, e. g., vermillion, oxide of zinc etc., shrink less just in proportion to the amount of foreign matter which they contain. The shrinkage is less, but it unfortunately happens that this benefit is accompanied by a loss of tenacity. Rubbers which are loaded with earthy or coloring matters are not so strong as those which are not so treated.

Experiments have developed the fact that samples of rubber vulcanized at high temperatures, and consequently under high steam-pressure, have a greater specific gravity than those vulcanized at a low temperature and pressure.

The amount of shrinkage which rubber experiences in vulcanizing therefore varies to some extent, and depends upon the temperature of the vulcanizer as well as the time of vulcanization.

Rubber solidifies more rapidly in the early part of the vulcanizing process; the change in density and specific gravity being nearly completed during the first two-thirds of the time required to properly harden the mass.

Rubber expands by heat more rapidly than any other solid body. Its rate of expansion at ordinary temperatures, from 70 to 90 Fahr. is over six times that of iron, about five times that of brass, and nearly four times that of zinc, which is the most susceptible to expansion by heat of any of the metals. Its rate of expansion is known to increase as the temperature rises, but it has not been definitely ascertained.

When it is desired to construct a dental plate of rubber, a mould is prepared, separable into two halves, of which the teeth and a model of the mouth form component parts. Gateways, to allow of the escape of any excess of rubber, are cut in the parting surfaces of the mould, which is then packed with rubber compoud. The two halves of the mould are then brought together by means of bolts; heat being applied to soften the rubber, which yielding gradually to the pressure of the bolts, flows into and obliterates the vacancies left by careless packing, any excess escaping into the gateways. When the flask is completely closed, it is placed in the vulcanizer.

As the temperature rises, the rubber expands, and until the vulcanizing point is reached, there is a constant flow of rubber into the gateways. When the desired heat is attained, and the temperature becomes stationary, the mass begins to solidify. It now gains in specific gravity and shrinks, and in a few moments it is no longer capable of filling the mould. As the rubber coheres to the plaster more strongly than it does to porcelain, it is usually the case that no defects from shrinkage are apparent on the surface of the plates, but if teeth are removed, vacancies will be found under them, and the platinum pins will be found loose in the rubber.

Sometimes, though not often, the effects of shrinkage are seen as small depressions, like the impression of a split pea, occurring indifferently on the lingual or palatal sides of the plate. More often, nothing is noticed until it becomes necessary to remove some of the teeth from the plates; though when plain teeth are used, spaces are sometimes found under the shoulders of the molars and bicuspids. If a tooth stands alone, as in a partial plate, it will sometimes be found to be loose, shaking perceptibly when an attempt is made to move it.

The fact that the teeth and pins are loosely held in the rubber can be ascertained by rattling the plate on a table or counter, as a coin is tested. It will be found to give out a sound as though it were cracked.

The vulcanizing process being concluded, the plate cools down to the temperature of the room, and in doing so contracts. As will be explained later on, this contraction is a fruitful source of warping and misfits. For the present we have to consider

SHRINKAGE, AND HOW TO OVERCOME IT.

A careful inspection of old plates when breaking them up, will show it to be the rule, rather than the exception, for the pins to be more or less loose in the rubber; and when section teeth have been used, and set at a distance from the model so as to allow of a considerable thickness of rubber between the teeth and the plate, spaces will be found under the teeth, which, if the plate has been worn for any length of time, will be filled with a magma of putrefying food. This is the cause of the disgusting odor which taints the breath of the wearer of the plate to his annoyance and that of all who have occasion to come near him.

To overcome this defect, enough material must be retained in the mould to insure its being perfectly filled at the conclusion of the vulcanizing process. This may be accomplished by interposing thin slips of metal, (e. g., heavy tin foil), between the two halves of the flask, so that it will not be fully closed. Then, after the plate is about half vulcanized, the flask should be removed from the vulcanizer, the strips of metal removed, and pressure applied to complete the closing of the flask. The rubber will be too hard to yield to the pressure of bolts as usually applied, and it is necessary to use spring pressure, which can be continued after the flask is replaced in the vulcanizer, the rubber being still soft enough at the vulcanizing temperature to flow and accommodate itself to the mould. The second heating must immediately follow the first, as the plaster soon disintegrates and softens and will not then bear the pressure required to re-mould the rubber.

Some judgment is required as to the thickness of the interposed slips, and the amount of spring pressure to be applied. For an upper plate with, say a sixteenth of an inch of rubber between the teeth and model, slips of about the thickness of No. 30 plate will answer; for very light cases, even thinner ones may be used; for heavy lower plates slips as thick as No. 24 may be necessary.

In gating the flask, remove all the surface of the plaster except a very narrow margin immediately around the mould by a cut gradually deepening as it passes outwards. Cut no notches from this channel into the mould itself, as the springs will yield to the pressure of the rubber as it expands, and allow the two halves of the flask to open sufficiently to allow the surplus to escape.

The springs supplied with the flasks of the New Model Whitney Vulcanizer require a force of from 180 to 200 lbs. to fully close them. They are therefore capable of putting a pressure of from 540 to 600 lbs. upon the flask. This amount is not necessary or advisable except when a large surface of rubber is exposed, and if the plate is small the springs should be only partially compressed.

As the teeth are sometimes cracked by over-pressure, care should be taken not to bring the coils of the springs into absolute contact, and throw them out of action.

It appears that the expansion of the rubber compound in heating from 212 degs. to the vulcanizing point is about equal to its shrinkage in vulcanizing. It is possible, therefore, to dispense with the interposition of the thin slips between the halves of the flask, by simply relieving all pressure thereupon during the first part of the time of vulcanizing and allowing the flask to open as the rubber expands. Spring pressure must then be applied, after shrinkage is practically completed, to close the flask as before.

The disadvantage of this method is that as the pressure upon the rubber is entirely relieved, it will not flow and obliterate the small imperfections which sometimes occur in packing the mould. If it is to be employed, then the rubber compound must be thoroughly softened, and especial care taken to pack it so that there shall be no faults, employing something of the same degree of care that would be exercised in filling a tooth. Spring pressure is then to be applied to close the flask, it being boiled in a dish of water until its closure is complete. The nuts are then slackened to relieve all pressure upon the springs, and the flask placed in the vulcanizer.

The processes of vulcanizing above described form the subject of Letters Patent, granted to the undersigned on June 16, 1891. Office rights to use the same can be obtained by application to

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SPONGY RUBBER.

WHEN thick pieces of Rubber are vulcanized, it is sometimes the case that if they are cut into, they will be found not to be hardened entirely through; the interior being soft, spongy, and fetid.

This occurs more frequently when black rubber is used, and less so with those containing much foreign matter, the scale running from black, whalebone, red, light red, to pink and white; the latter seldom, if ever, becoming spongy under ordinary treatment. The purer the rubber, then, the more apt it is to become spongy, and the more it is adulterated, the thicker the mass of it which can be safely vulcanized.

Sponginess is more liable to occur as the vulcanizing temperature is raised; and as this may happen by some derangement of the thermometer, this instrument should be carefully looked to if there is any trouble of the kind. Thick pieces cannot be cured at as high a heat as thinner ones; and when it becomes necessary to vulcanize one, especial care must be taken that the heat does not run too high. When sponginess does occur, unless the piece is unusually thick, it may be at once assumed that the heat has been too great; and in subsequent operations it should be lowered without any regard to what the indication of the thermometer may be, the time of vulcanizing being accordingly increased.

When it becomes necessary to vulcanize an unusually thick piece, its interior may be packed with pink, or some other heavily "loaded" rubber; or pieces of old plates, cut into convenient sizes and filed all over, so as to present clean surfaces, may be mixed with the fresh rubber. The latter plan is preferable if the piece is very thick, as it also diminishes the amount of shrinkage in vulcanizing. If the pieces are clean, with fresh surfaces, they will unite perfectly with the new material, and there will be no lack of strength in the work when finished. The more old rubber used, the less shrinkage there will be; as it, being already vulcanized, has shrunk nearly all it is capable of doing.

As there will be a difference of color between the new and the old rubber, the latter should not be allowed to come to the surface, if it can be prevented.

Sponginess may occur as an accident, from a sudden relief of pressure; as, for instance, from the blowing out of a safety disk. It is particularly apt to happen, if the disk is blown out during the first half hour of the time of vulcanizing; the rubber being then soft, and changing in consistency more rapidly than thereafter. The fact of the failure of the disk, is a pretty sure indication that the temperature has been inordinately high, and sponginess might occur from this cause alone, without any relief of pressure. But it will take place if the blow-off valve is opened during the first stages of the vulcanizing process, if the piece is at all thick and enough steam is allowed to escape to lower the pressure to any great extent.

When a disk blows out, the escape of steam can be stopped by driving a plug of soft pine into the hole from which it escapes. It is well to keep one or two plugs ready prepared, as the lowering of pressure in the vulcanizer consequent upon a few moments' delay may cause the rubber to become spongy and ruin the plate.

WARPING OF PLATES.

ALTHOUGH rubber plates are moulded and hardened upon the models of the mouths they are to fit, they often fail to fit as they should. The trouble may arise from a faulty impression, or from carelessness in running the model. There are some who are ignorant of the fact that the model may be warped by delay in pouring the plaster into the impression. If a little is poured in, then the remainder is stirred before pouring it, and this is repeated until the impression is finally filled, the model will arch up so that its palatine portion will leave the impression, and a space will be clearly seen between the two. The plaster should always be mixed thin enough to run freely, and the impression filled as speedily as possible.

It has been heretofore noted that rubber is probably the most sensitive to fluctuations of temperature of any solid body. As the difference between the vulcanizing temperature, at which plates are moulded, and that of the mouths in which they are worn, amounts to considerably over two hundred degrees, the contraction of the plate is quite perceptible; still it does not interfere with the fit unless gum teeth are used. Porcelain, of which the teeth are made, changes but little with fluctuations of temperature; and when an arch of it is formed by lateral contact of the section teeth, it renders more apparent the contraction of the rubber. If careful measurements be taken across the condyles of a plate mounted with section teeth before and after vulcanizing, the second measurement will be found to be considerably shorter than the first; the condyles having been brought together by the contraction of the rubber in cooling. As a consequence, the thin, palatal portion of the plate is forced upwards, and when it is tried in the mouth it will be found to rock. If this defect should not be noticed, a sore spot upon the hard palate will usually be developed after a few days wear.

If the plate is a new one, the defect can be usually remedied by warming the palatal edge of the plate sufficiently to soften the rubber, and bending it downwards enough to relieve the pressure, it being seldom the case that there will be any bad effect from the narrowing at the condyles. But when an old plate is re-vulcanized, its contraction is thereby doubled; and it often happens that there will be a serious impairment of the fit.

To restore the fit of the plate, it should be spread or widened at the condyles to compensate for its previous contraction. Put a small mark upon each condyle and measure the distance between them. This can be most easily done with a pair of dividers. Then direct light puffs of a blow-pipe flame upon the plate, directly back of the central incisors until it is softened throughout its thickness for a space about as large as the thumb nail. Seize it by the condyles with both hands, pull them forcibly apart, and at the same time dip the plate into water to cool it. The dividers will show the amount of alteration produced; if it should be too much, a slight re-softening of the plate, as before, will allow it to partially regain its former shape.

When a plate is to be re-vulcanized, it will be well to treat it in this manner before putting it in the vulcanizer; widening it at the condyles nearly a sixteenth of an inch, thus compensating for the former shrinkage and warping as well as the one from the intended vulcanizing.

CRACKING OF BLOCKS.

THE Dentist is sometimes dismayed by finding an otherwise satisfactory piece of plate work marred by the appearance of cracks in the teeth. The plate may have appeared to be perfect when first taken from the vulcanizer, and the cracks may not be noticed until it is nearly or quite finished. As it oftentimes necessitates making a new plate, the causes which lead to this very annoying accident are deserving of careful study. They may be divided into three classes, viz.:

1. Excessive pressure upon the teeth in packing the mould; which may be caused by:

a. The presence of a large excess of rubber; filling and clogging the gateways.

b. Attempting to close the flask before the included rubber is thoroughly warmed and softened.

c. Using undue force in closing the flask, and not allowing the rubber time to flow.

2. The effects of contraction of the rubber in cooling.

3. Carelessness in handling the plate after it is taken from the vulcanizer.

Rubber compound, even when warmed, is very viscid; and while it is quite capable of intruding into places where it is not wanted, as, for instance, the joints between section teeth, it offers considerable resistance to any suddenly applied force. The operator should, therefore, never be in a hurry in closing his flasks; but apply the pressure gradually, and allow plenty of time for the rubber to flow. No attempt should be made to close the flask until after it has been thoroughly warmed, and plenty of time given for the heat to penetrate and soften the rubber.

Over-packing the mould, by obstruction of the gateways by the inordinate amount of surplus, may lead to the application of too much force in closing the flasks; and, as a consequence, section teeth may be cracked.

If the gateways are insufficient, or are clogged by the escaping surplus, and the flask, when closed, is held rigidly by bolts, the expansion of the rubber under the rise of temperature to the vulcanizing point may exert a force quite sufficient to do damage to the teeth. If the flask is held under spring pressure, it will be able to yield to the expansive force, and allow the escape of the surplus; then, if the flask should remain a trifle open, the springs will continue their pressure and close it when the shrinkage of the rubber in vulcanizing relieves the internal pressure. Indeed, the flask and its contents may be safely trusted to the springs, even though it be not fully closed, if there is a certainty that the gateways are free. The gateway may, in this case, be only a deep, wide groove, with a narrow margin of plaster left between it and the mould; no "runners," or passages leading outward from the mould being necessary. This method of gating the flask was advocated by Dr. W. S. How in an article in the "Dental Cosmos," for July, 1889, and has advantages which should lead to its adoption.

It has been before noted that rubber is the most sensitive to the changes of temperature of any solid body. Its contraction in cooling from the vulcanizing point to ordinary temperatures is sufficient in amount to cause considerable warping of the plate when section teeth are used; and, in some instances, the pull of the rubber upon the sections is strong enough to cause vertical checks to appear in the centers of the front sections. It is also the case that, although the plate may safely bear the reduction of temperature to, say, 60 or 70 degrees, the temperature of the office, it will not bear a further reduction to the freezing point or below. If, therefore, the laboratory is left without a fire at times in cold weather, the dentist may be disagreeably surprised to find the piece of work which he left in a perfect condition Saturday night, with the front teeth checked, when he examines it on the ensuing Monday. Patients should be cautioned against leaving unused plates where they will be exposed to extreme cold, or dipping their plates into very cold water. Though no harm may result, there is a risk of damage from such practices which it is better to avoid

Improper grinding of the teeth, taken in conjunction with the shrinkage of the rubber, is a fruitful source of annoyance from cracking and chipping. If the ends of the sections are ground away too much at the rear, so that only a narrow surface is left for contact immediately at the gum surface, the pressure on the same from contraction is often sufficient to chip the edges of the joint. Though a bearing over the whole end of the block is unnecessary, it should be of an appreciable width.

If the rim of the plate is thick, and the edges of the gums are left so that they are held by it, its contraction will sometimes exert force enough upon the gums to crack them. In this case, the cracks will proceed horizontally along the gums, just above the bases of the teeth, and will be clean; no rubber being injected into them. This state of affairs is sometimes brought about by grinding the gums thin in fitting the teeth to the model, when there was no necessity for so doing.

The rubber is drawn away from the rear of the gums by its contraction, and affords them no support. The edges of the gums should therefore be ground so that the rubber will have no hold upon them. They should be ground to a square edge, or if either corner of the edge is left sharp, it should be the front, rather than the rear one. In waxing up, especial care should always be taken that the wax does not overhang the gums. It should be scraped off so as to be exactly flush with the gum: the necessary surplus for filing and finishing being secured by scraping off a little plaster from the proper locality after the case is flasked, and before packing.

In the matter of careless handling of the plate, there is but little to be said. Damage may be done in getting them out of the flask, or by grasping them too hard when finishing them. They should never be pinched, so as to force the condyles together, as this intensifies the strain the plate is already under from contraction of the rubber.

THE CONTOUR OF THE LINGUAL SURFACE OF THE DENTAL PLATE.

THE best results in art come to him who makes the closest study of nature. One instance of the truth of this saying is evinced by the marvelous advance made in the appearance of artificial teeth, and their adaptation to the mouth. It is sometimes the case, though, that after the dentist has selected teeth of the correct shade, shape, and size, and has mounted them upon a satisfactorily fitting plate, the wearer still loses something of the comfort and satisfaction he might have, by reason of improper contouring of the plate on its lingual surface.

An excellent object lesson, one that dentists unfortunately too seldom avail themselves of, may be had by a careful inspection and study of plaster casts of mouths containing perfect sets of natural teeth. If these casts are divided by a vertical section through the mesial line, the sectional curve, formed by the lingual surfaces of the incisors, the gum and the palate, is worthy of especial attention. As a contrast, a similar cast, taken from a "job" on rubber, similarly divided, may also be studied. To one whose attention has never been directed to the matter, the difference between the curves of the mouth and the plate will be a source of astonishment. In the mouth there is a gradual easy curve from the point of the incisor to the palate. In the plate the material is usually cut away behind the incisors, making two curves instead of one, and these joined by an abrupt angle at the rear of the lingual surfaces of the incisors.

What are the objections to this practice?

A considerable portion of the strength of the plate is sacrificed, and in some cases it splits through the middle, when worn, from no other cause than the manner in which it has been cut away just behind the incisors.

The proper enunciation of the "S" and "Sh" sounds is only to be secured by making the contour of the lingual surface of the plate to resemble that of the mouth. These sounds are formed between the tongue, the lingual surfaces of the incisors, and the gum and palate behind the incisors. The whistling or whirring S sound, by which it is so easy to detect the wearer of a dental plate, is directly attributable to the incorrect contour of the surface in question.

It is now proposed to describe the mechanism by which these sounds are produced, and to draw attention to the importance of giving due consideration to the shape of the lingual surface of the plate in order to secure for its wearer clearness and ease of articulation of the sounds referred to.

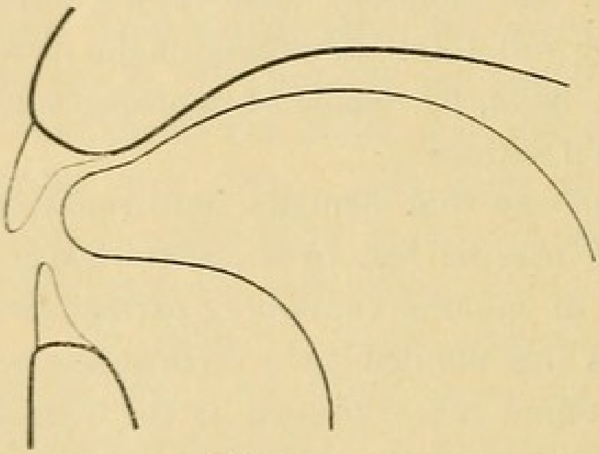

Fig. 1.

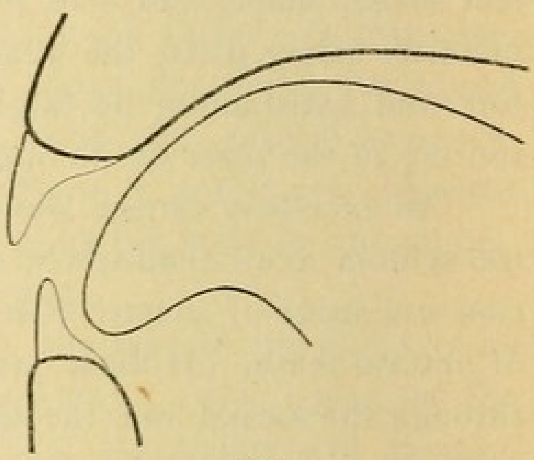

Fig. 2.

Figure 1 is a diagram illustrating the relative positions of the jaws and tongue in producing the "S" sound. The teeth are held slightly apart, the tip of the tongue rests against the gum behind the upper incisors, the edges impinging closely against the lingual surfaces of the bicuspids and molars at the junction with the alveolus. A narrow passage is thus formed over the center of the tongue, through which a current of air is impelled against the incisors.

In making the "Sh" sound (Fig. 2) the tongue is pushed a little farther forwards, and its tip is directed downwards. The passage over its center has a larger outlet, and the current of air is directed against the lower incisors.

Attention is drawn to the easy reversed curve formed by the teeth and gum, and to the manner in which, in connection with the tongue, a passage is produced which gradually narrows and then widens, and by which the sounds in question are readily and clearly produced.

Figure 3 represents a section of a fairly well made vulcanite plate. The lingual surface of the incisor here forms an angle with the palatal surface of the plate, and the re-

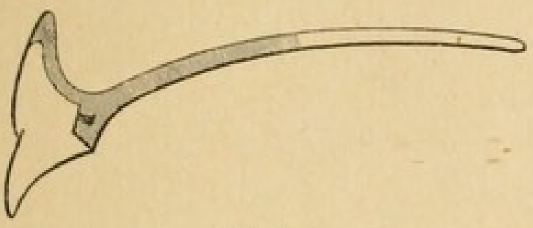

Fig. 3.

Fig. 4.

versed curve of Fig's. 1 and 2 is plainly out of the question. To obtain this, the plate should be filled in as shown in dotted lines in Fig. 4. If this were done, the enunciation of the wearer would be improved, and another substantial benefit would be secured; an increase of strength which would obviate any danger of the plate cracking through the center. This very annoying accident is very often the result of excessive cutting away of the thickness of the plate at the point in question. As the end of the gum section is plainly shown in either figure, it can be seen at a glance how little rubber there is behind it in the one case, and how much stronger it would be in the other for the change suggested.

At first thought, it appears to be the proper thing to "make the plate light", and the filling up which is necessary to restore the right contour looks bungling. A fair trial, in even a few cases, will convince anyone that the latter plan is the right one; i. e. to fill in behind the incisors in waxing up, so that the surface of the plate will form an easy "reversed curve," beginning with the lingual surfaces of the incisors, and extending backwards nearly or quite half an inch over the plate before the normal thickness of the plate is reached.