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Selections

USES AND LIMITATIONS OF FORMALDEHYD IN DENTISTRY.*

By Dr. F. W. Low, Buffalo, N.Y.

Twenty years after its discovery formaldehyd was still *almost* an unknown quantity to the average pharmacist. Truth-hunters for truth's sake, reporting their findings at infrequent intervals, averred its undoubted and surpassing virtue, until at length sufficient interest was finally awakened to challenge a general investigation. Then, all at once, the unthinking many began to herald numerous doubtful and ofttimes most manifestly impossible achievements.

Such unwarranted hue and cry of the faddists and empiricists resulted shortly in the usual "black eye" being administered to the new-found remedy.

What wonder that "doubting Thomases" should logically have their innings when "Through a stone floor," "To the centre of mattresses," "Penetrating innumerable thicknesses of pillow-slips and blankets," are but fairly average samples of the bill-board announcements indiscriminately published in many of the more reckless so-called scientific journals.

"Innocuous to man, but sure death to 'bugs.' Hail! to formaldehyd, the new germ-destroyer."

Following in contrast is the gospel the anti-formaldehydists preach:

"At best formaldehyd is but a surface disinfectant, and not always sure at that."

"A pure atmosphere of it will invariably kill a cat."

"It is innocuous to man only because *he* cannot abide in it long enough to die decently."

* Read before the Annual Convention of the Seventh and Eighth District Dental Societies of the State of New York, October 25th, 1899.

"It almost puts one's eye out just to get the merest whiff of it."

Now who shall decide for us when doctors so disagree?

Perhaps we'll go least far astray by accepting the consensus of up-to-date *conservative* opinion. This I attempt to summarize before discussing uses and limitations in dental practice. I shall not detain you with numerous quotations, however, choosing rather to cite a few comparisons from authorities undoubted,—those which after careful reading and proper investigation I have elected to esteem the highest.

Concerning Penetration.—On the subject of house disinfection Williams, in his most recent publication,* sums up as follows: "Instead of formaldehyd, sulphur dioxid may be used for room disinfection, but in the light of recent knowledge the formaldehyd method is superior."

This opinion of Dr. Williams—who is professor of pathology and bacteriology, Medical Department, University of Buffalo—is that also, to my knowledge, of Professor Roswell Park, director of the New York State Pathological Laboratory for the investigation of cancer; of Dr. Ernest Wende, health commissioner of our city, and of Drs. Bissell and Carpenter, who are respectively chief and assistant bacteriologists in the Buffalo Bureau of Health.

Concerning the Tendency of Albuminous Matters to Retard Antiseptic Action.—"As compared with other disinfectants, such as corrosive sublimate, carbolic acid, lysol, etc., formaldehyd solutions have the advantage of *not being retarded*" (italics mine).—A. E. DeSchweinitz, Ph.D. (Dr. DeSchweinitz is chief of the government bacteriological laboratory at Washington.)

Concerning Certainty of Disinfection.—"Formaldehyd has extraordinary powers as a surface disinfectant, greater than that of any other known substance."—Charles Harrington, M.D., Harvard Medical School, Boston, Mass.

Concerning its Poisonous Effects on Higher Forms of Life in a Concentrated Atmosphere.—"It is *not* poisonous in the sense of easily destroying the higher forms of life, but the human subject suffers great discomfort upon being long exposed to it."

Concerning Certainty of Action.—"Of one thing there is no doubt, when formaldehyd in certain quantity comes in contact with the bacilli of infectious diseases, they are surely killed."

"A comforting fact also is that infectious material from a patient is more easily sterilized than artificial cultures."

* "A Manual of Bacteriology," by HERBERT U. WILLIAMS, M.D., Professor of Pathology and Bacteriology, Medical Department, University of Buffalo. Philadelphia: Blakiston's Sons & Co.

"There is some further comfort for those who have begun to use formaldehyd in the fact that its only alternative is sulfurous acid, which will not destroy diphtheria infections or others as resistant."

These latter quotations are from the report of the Committee of Publication which edited the *Journal of the American Public Health Association*, 1898. Franklin C. Robinson, Prof. of Chemistry in Bowdoin College, Maine, was chairman of this committee.

I might multiply proof indefinitely perhaps without making stronger evidence concerning the efficacy of formaldehyd as a general surface disinfectant.

Uses and Limitations.—To us as experts in the proper use of it, formaldehyd comes in one of three following guises:

In aqueous solution, sometimes with, sometimes without, the addition of other antiseptics.

As a paraform lozenge, or else we are presented with a miniature factory over which we are expected to exercise a superintendency.

Formaldehyd in aqueous solution is useful in various dilutions as a *wash*, both for persons and for things. 1 to 2500 with one hour's contact has been found by a contributor to the *Pharmaceutical Journal* as adequate to destroy any and all micro-organisms,—even the most resistant. 1 to 500 is recommended by this writer as a mouth-wash, and 1 to 250 as a general disinfectant for washing hands, instruments, etc., in surgery, and for spraying departments as a deodorant.

Parke, Davis & Co., in their latest pamphlet, quote the *University Medical Magazine* as authority for the statement that a four per cent. solution will almost immediately deodorize feces. Acting on this suggestion, I have found that a four per cent. solution will completely deodorize that most distressing odor which sometimes persists in clinging to my fingers after the tedious treatment of a putrescent pulp-canal.

In regard to washing dental instruments in solutions of formaldehyd, my experience coincides with the findings of the Committee on Publication of the *Journal of the American Public Health Association:* "The dry gas seems without action upon polished metallic surfaces, but in the presence of water bright steel is quickly attacked; hence its water solution is unfit for sterilizing instruments."

For all office cuspidors as a deodorant, formaldehyd solutions cannot be too highly recommended. It must be borne in mind, however, that nickel-plated ones will be attacked and tarnished by its use; 1 to 250 is the proper strength solution.

There is but one further use for aqueous solutions of formaldehyd in dentistry that I am aware of. I refer to its employment in supplanting the older antiseptics in treatment designed to render aseptic the putrescent pulp-canal. If solutions have proven tolerable for the purpose of irrigation in or about the deeper pockets of pyorrhea or for syringing out a freshly-opened abscess, I should be glad to know. I have been thus far afraid to try, fearing unduly painful consequences. Two experiences which I have had resulting from its employment in pulp-canals have made me cautious to the point almost of abandonment. In both cases the solution used was 1 to 250.

The Paraform Lozenge.—Schering & Glatz, New York Agents for a German company, have extensively advertised the advantages to be derived from the employment of the paraform lozenge in generating formaldehyd. There are limitations to this method compared to others: first, because the cost of maintenance in commission is very considerably greater, and, second, because in order to generate the gas from lozenges in sufficient quantities to be really effective, a fresh lozenge must be placed in the heating receptacle for dissipation as often as every fifteen or twenty minutes. I believe these manufacturers make the claim, however, that one lozenge is sufficient to sterilize dental instruments in an oven which they furnish with their lamp for that purpose.

Lamps that Generate the Gas Formaldehyd from Methyl Alcohol.—Of this type of generators there are quite a number of manufacturers. The lamps, while differing very considerably in *manner* of construction, all depend in fact upon the same general principle — namely, the action by its presence merely, without entering into chemical combination, of glowing hot platinum upon the fumes of methyl alcohol.

The only use which a lamp of this construction can have in dentistry is to sterilize our instruments, or, better still, the whole instrument-containing cabinet, with its contents, including napkins, forceps, ligatures, dams, and whatever other appliances are likely to be used in or about the mouth, by means of turning in upon them while the case is closed the dry formaldehyd gas.

I have recently been conducting a series of experiments with apparatus here exhibited, in anticipation that results might be deemed of interest by this section of the National Dental Association. My findings are submitted with no little trepidation, principally because I am not competent either as microscopist or bacteriologist.

Experiments which are reported I could not have conducted but for the active co-operation of my friend Dr. Thomas B.

Carpenter, assistant bacteriologist to the health department of the city of Buffalo, to whom I desire thus publicly to make most grateful acknowledgments.

EXPERIMENTS, SERIES NO. 1.

Made to determine, if possible, with dry gas formaldehyd fumigation in close confinement, what might be the shortest effective exposure for purposes of "scaling-instrument" sterilization.

In this series, measures were also incidentally taken to determine whether a flow of fresh gas from lamp over instruments was more effective than to completely shut off all ventilation.

Since I had no hand personally in this series of experiments, it will suffice that I submit Dr. Carpenter's report without comment, further than merely to show you how the instruments were confined, how ventilation was accomplished, and the manner of conveying the gas from the lamp onto the contaminated instruments.

[Dr. Low here exhibited lamp and tray for holding the instruments while being disinfected.]

BUFFALO, N. Y., July 14, 1899.

DR. FRANK W. LOW, Buffalo, N. Y.

Dear Doctor,—I herewith present report of experimental work performed upon your disinfecting tray for dental instruments.

Experiment 1.—Six dental instruments used in a case of pyorrhea alveolaris were submitted. Nos. 1, 2, and 3 were used for control. Nos. 4, 5, and 6 were placed in the tray and subjected to the action of formaldehyd generated from the Low lamp, using porcelain combustion cone. All vents in the tray were wide open. The time of exposure was ten minutes. Ammonia gas was then passed through the tray, for about half a minute, in order to break up any possible combination between the disinfectant and the micro-organisms. All of the instruments were dipped into sterile bouillon to soften the adherent material, then inoculations were made into Loffler serum, and all placed in incubator. After twenty-four hours, results were as follows:

Control	1.	Luxuriant growth.
	2.	" "
	3.	" "
	4.	No growth.
	5.	" "
	6.	" "

After forty-eight hours:

4. No growth.
5. Doubtful.
6. Doubtful.

Mounts were made from all tubes, stained with Loffler methylen blue, and examined. The following results were obtained:

1. Staphylococci, streptococci, and a short bacillus.
2. " " " "
3. " " " "
4. No growth.
5. Few staphylococci.
6. " "

The above results demonstrate the restraining power of the disinfectant under the conditions of test.

Experiment 2.—Six platinum needles, mounted in glass rods, were sterilized and touched to an agar culture of the Staphylococcus pyogenes aureus and dried. Nos. 1, 2, and 3 were reserved for control. Nos. 4, 5, and 6 were treated in the same manner as the instruments in Experiment 1. After twenty-four hours' incubation, results were observed as follows:

Control {
1. Abundant characteristic growth.
2. " " "
3. " " "
}
4. No growth.
5. " "
6. " "

After forty-eight hours:

4. Doubtful.
5. "
6. "

Mounts were made from all tubes and examined with the following results:

Control {
1. Characteristic staphylococci.
2. " "
3. " "
}
4. Few staphylococci, taking stain poorly.
5. " " " " "
6. " " " " "

This experiment demonstrates the restraining power of the disinfectant. It is evident, however, that under the conditions of the experiment, ten minutes' exposure to the gas with open vents in the tray, the action is not sufficient to destroy the organism.

Experiment 3.—Four platinum wires were prepared as in Experiment 2. Nos. 1 and 2 were reserved for control. Nos. 3 and 4 were subjected to the action of the gas for fifteen minutes with the top vent of the tray closed. After inoculation on serum and incubation for twenty-four hours, results were observed as follows:

Control { 1. Abundant characteristic growth.
{ 2. " " "
3. No growth.
4. Slight growth.

Mounts were made from all tubes, confirming the presence or absence of growth and absence of contamination.

Wire No. 3 had a large amount of culture attached to it. No. 4 had a small but very apparent amount attached.

It seems evident from the above experiments that the gas, in the time allowed, and under the conditions of the test, will not penetrate and kill through a deep layer of organisms.

Experiment 4.—Four wires were inoculated with the Bacillus pyocyaneus (by dipping into a bouillon culture of the organism) and dried. Nos. 1 and 2 were reserved for control. Nos. 3 and 4 were placed in the tray, with all vents closed, and subjected to the action of the gas for fifteen minutes. Inoculations into bouillon from all wires and incubated forty-eight hours, gave results as follows:

Control { 1. Characteristic growth.
{ 2. " "
3. No growth.
4. " "

This experiment shows that under the conditions of the test, closed vents and exposure of this layer of organisms, the Bacillus pyocyaneus is destroyed by fifteen minutes' exposure.

Experiment 5.—This experiment differed from Experiment 4 only in time of exposure, ten minutes being given instead of fifteen minutes.

The results after forty-eight hours' incubation were as follows:

Control { 1. Characteristic growth.
{ 2. " "
3. No growth.
4. " "

The above series of experiments were repeated twice in all cases, and in many cases three times. The results were uniform. I am therefore of the opinion that this apparatus can be relied upon, after an exposure of from ten to fifteen minutes, to destroy thin layers of the commoner, non-sporulating, pathogenic organisms. Very truly yours,

THOS. B. CARPENTER.

EXPERIMENTS, SERIES NO. 2.

This series was primarily conducted with a view to ascertain if school clothing of children or a suit worn by nurse or doctor into the presence of contagion might be thoroughly sterilized by placing them in a wardrobe and leaving them exposed over night to the fumigation of this little lamp.

Satisfactory results reported by Dr. Carpenter suggested the possibility of the Low disinfector being installed for purposes of instrument, ligature, and napkin fumigation without removal from their various receptacles in the modern dental instrument cabinet.

On this series Dr. Carpenter reports:

BUFFALO, N. Y., July 15, 1899.

DR. F. W. LOW, Buffalo, N. Y.

Dear Doctor.—I herewith report results of experimental work upon the Low formaldehyd lamp.

The material used in each experiment consisted of cotton threads thoroughly soaked in bouillon cultures of the following organisms: Staphylococcus pyogenes aureus, Bacillus pyocyaneus, Bacillus diphtheriæ, Bacillus typhi abdominalis, and Bacillus anthracis (sporulating). The threads were thoroughly dried before exposure to the action of the lamp. The disinfecting chamber consisted of an ordinary tight closet, with a capacity of 15.8 cubic feet. In all tests the lamp was placed upon the floor of the closet and allowed to burn for twelve hours. A wire combustion cone was used. After removal of the lamp, ammonia gas was generated in the closet and the threads were allowed to remain for fifteen minutes in the atmosphere. This was done to destroy any possible chemical combination between the organisms and the formaldehyd gas. Four impregnated threads of each organism were used in each test, only two of which were exposed to the gas. The other two were used for control. The test threads were exposed in open Petri dishes. In each case the growths were examined to determine the presence of the test organism.

Experiment 1.—The dishes were placed on the floor of the closet near the lamp. Control threads—characteristic growths. Test threads—no growth after forty-eight hours' incubation.

Experiment 2.—Dishes placed one foot above lamp. Control threads—characteristic growth. Test threads—no growth after forty-eight hours' incubation.

Experiment 3.—Dishes placed two feet above lamp. Control threads—characteristic growth. Test threads—no growth after forty-eight hours' incubation.

Experiment 4.—Dishes placed three feet above lamp. Control threads—characteristic growth. Test threads—no growth after forty-eight hours' incubation.

Experiment 5.—Dishes placed four feet above lamp. Control threads—characteristic growth. Test threads—no growth after forty-eight hours' incubation.

It is evident, therefore, that twelve hours' exposure to the action of this lamp, in a closet of 15.8 cubic feet capacity, is sufficient for effective surface disinfection, the most resistant pathogenic bacteria being destroyed. Truly yours,

THOS. B. CARPENTER.

EXPERIMENTS, SERIES NO. 3.

These were conducted in some instances by myself, at other times by various of my *confreres* in Buffalo, the object being to determine if methods usually in vogue for the care of our scaling instruments were adequate.

Recently the promulgation of the locally pathogenic origin of pyorrhea has made this inquiry doubly pertinent.

Test tubes corked with sterile cotton containing sterile beef tea were taken about to different offices, where at the dentist's operating case they were opened after having been burned over in Bunsen flame, both plug and mouth of tube thus doubly treated.

When opened, instruments, as indicated by subjoined reports, were carefully projected into the tubes and their points immersed in culture-media, when they were as carefully withdrawn and the tube at once re-plugged. The tubes so treated were then submitted to Dr. Carpenter for incubation and subsequent observation and report.

It would be manifestly wrong to mention the names of the gentlemen who submitted their instruments to this examination. I may, however, be permitted to say that I purposely avoided tests being made upon instruments of any practitioner where I harbored doubt about the most cleanly practices in the care of them.

TUBE No. 1.—Inoculation with fifteen scalers from my own instrument case. My method of sterilization was to wash in very hot soapsuds, after which instruments were dipped in hot formaldehyd solution, 1 to 250, wiped dry, and put away.

Test Report of Dr. Carpenter.—I append results of examination of bouillon culture in test tube No. 1, submitted by you. There was found a luxuriant orange-colored growth. Microscopical examination shows it to be a sarcina, evidently the Sarcina aurantia.

TUBE No. 2.—Inoculated with sixteen scalers from operating case of Dr. A. His method of sterilization is to wash in hot soapsuds only, except upon occasions when specific infection is feared. In such case an antiseptic, usually three per cent. pyrozone, is used.

Test Report of Dr. Carpenter.—Found fair yellow-colored growth. No odor. Zooglear masses. A very small coccus. Evidently not a pus coccus.

TUBE No. 3.—Inoculated with set of five scalers from operating case of Dr. B. Method employed in cleansing not stated.

Test Report of Dr. Carpenter.—Found luxuriant white growth. No odor. Green mould on top. Microscope shows mixture of large cocci, both staphylococci and streptococci. No pus organisms.

TUBE No. 4.—Inoculated with twenty scalers from operating case of Dr. C. His method of sterilizing is to wash in hot soapsuds unless specific infection is suspected; in such cases with pyrozone.

Test Report of Dr. Carpenter.—Found good growth. Foul odor. Contains the B. proteus and a large coccus, not a pus coccus.

TUBE No. 5.—Inoculated with seven scalers from operating case of Dr. D. His method of sterilization is to dip points into three per cent. Oakland Chemical Co.'s peroxid. Then into four per cent. formalin solution. Wipe dry.

Test Report of Dr. Carpenter.—Found slight growth containing staphylococci and streptococci. Not characteristic of pus organisms.

TUBE No. 6.—Inoculated with five scalers from operating case of Dr. E. Method of cleansing not stated.

Test Report of Dr. Carpenter.—Found green mould on top. Luxuriant white growth without odor. Contains a large streptococcus and an actively motile bacillus. Evidently not pathogenic organisms.

Tube No. 7.—Inoculated with six scalers from operating case of Dr. F. His method of sterilization is to dip in from two to five per cent. Merck's formaldehyd.

Test Report of Dr. Carpenter.—Found heavy white growth, without odor. Microscopic examination shows it to be a pure culture of some form of Leptotricheæ.

Tube No. 8.—Inoculated with three instruments from operating case of Dr. G. His method of sterilization is to wash in hot water and wipe dry, except in cases where specific infection is suspected.

Test Report of Dr. Carpenter.—Found heavy white growth. No odor. Contains a large coccus and a non-motile bacillus, not pathogenic.

Tube No. 9.—Inoculated with instruments, number not stated, from operating case of Dr. H. Method of cleansing instruments: Scrub with brush in cold soap and water.

Test Report of Dr. Carpenter.—Found a uniformly turbid culture without odor. Green mold on top. Contains a large non-motile bacillus, not a pathogene.

Tube No. 10.—Inoculated with instruments, number not stated, from operating case of Dr. I. His method of sterilization is to wash thoroughly with cold water, then with dioxid of hydrogen, three per cent. (Oakland).

Test Report of Dr. Carpenter.—Found a uniformly turbid culture without odor. Green mold on top. Contains a large coccus, not a pathogene.

Tube No. 11.—Broken. No report.

Tube No. 12.—Inoculated with four scalers from operating case of Dr. J. Method of cleansing: Give them a good scrubbing in soap and water.

Test Report of Dr. Carpenter.—Found heavy white growth. No odor. Large coccus, not a pus organism.

Tube No. 13.—Accidentally broken. No report.

Tube No. 14.—Inoculated with six scalers from the operating case of Dr. K. Method of cleansing: Wash in tepid water, dip points in three per cent. pyrozone.

Test Report of Dr. Carpenter.—Found green mold. Nothing else.

Tube No. 15.—Inoculated with instruments, number not stated, from operating case of Dr. L. His method of cleansing is to wash in boiling water.

Test Report of Dr. Carpenter.—Found heavy yellow growth without odor. Examination shows it to be a sarcina, evidently the Sarcina lutea.

TUBE NO. 16.—Inoculated with seven instruments from cabinet operating tray of Dr. M. His method of sterilizing is to boil in bicarb. soda water. Polish with emery-cloth, dip three per cent. (Oakland).

Test Report of Dr. Carpenter.—Found white mold on top. Small coccus in gelatinous zooglæ. A form of myxomycete.

TUBE NO. 17.—Inoculated by myself with single broach which had been immersed in a supposedly pyorrhea pus. It was then immediately dipped in a three per cent. peroxid, where it was held a moment, after which it was immersed in culture tube to learn if short time exposure to three per cent. peroxid is sufficient to destroy germs.

Test Report of Dr. Carpenter.—Found luxuriant growth in heavy masses. A very large streptococcus, not a pathogene.

TUBE NO. 18.—Inoculated by myself with nine miscellaneous instruments taken from the operating case of my neighbor, Dr. Barrows. When last used they were washed in cold soapsuds, then placed in compartment of case that smelled strongly of formalin from fumigation of previous forty-eight hours. This test was made to determine if case had continued sterile from previous fumigation.

Test Report of Dr. Carpenter.—Found white mold on top. Small coccus in gelatinous zooglæ. A form of myxomycete, same as tube No. 16.

TUBE NO. 19.—Inoculated with twenty miscellaneous instruments which had been kept over night in a Harvard scroll-front cabinet instrument case, in which a Low disinfector was in constant operation.

Test Report of Dr. Carpenter.—Found sterile.

TUBES NOS. 20 and 21 were not used.

TUBE NO. 22.—A single broach was inoculated from a supposedly pyorrhea pocket. Mode of inoculation was to burn probe before inserting into pocket. It was then transposed to culture tube at once.

Test Report of Dr. Carpenter.—Found fairly good growth Examination shows it to be a myxomycete.

In concluding his report of this entire series of test-tube cultures, Dr. Carpenter says that "the organisms found are all derived from the air and from damp, moldy surroundings. The finding of so many molds leptothrix and myxomycetes is very unusual in any series of cultures." This leads him to believe that the source given (damp mold) is correct.

It must be remembered that the instruments were cleaned and put away the night before. They were taken direct from their respective places in the dental cabinet the following morning, care being taken that they came in contact with nothing to contaminate, and that whatever cultures were obtained from them had been communicated either from the air or picked up from contact with the lining of the drawer or tray in which they rested. With this borne in mind, the series appeals to me altogether most interesting and instructive.

Does it prove that methods in vogue for the care of our scaling instruments are inadequate.

Every set *except the one where the whole case was fumigated* over night produced some cultures, but not one set developed a culture of pathogenic organisms.

The interesting question *now* becomes, Does the possibility of inoculation seem great enough to demand the fumigation of scalers just previous to their using, or would it be preferable in future to provide for cabinet fumigation, or can we feel warranted in going on "in the same old way?"

Of one thing my investigations have made me confident: Of all known methods for sterilizing instruments, fumigation with *dry formaldehyd* gas is most easy of accomplishment and altogether certain.

Dr. Barrows reports the following case of the use of formalin cataphorically:

This was a case of "blind" abscess, the most difficult to treat, perhaps, of all the various pathological conditions coming under the dentist's care. The tooth presenting was the left upper first molar, and was under treatment by the usual methods for about four months—that is, intermittently—and every time that an attempt was made to fill roots and seal up cavity, all the symptoms of previous trouble returned. In desperation I decided to try formaldehyd cataphorically.

I first adjusted rubber dam and thoroughly dried root-canals by hot air. Then I wound a few strands of cotton around a probe electrode, dipped it in formalin—full strength—inserted in one of the root-canals and turned on the current for five minutes. I treated remaining canals same way and filled the cavity. This was done in February last, and everything has been quiet since.

Since the report of Dr. Barrows came I have made some experiments to show the effect of the cataphoric current upon litmus after it had been saturated with formalin. I had previously tested many other combinations of drugs and chemicals, and had invariably found that marked decomposition was the outcome.

The electro-positive elements of every other medicament had divorced themselves from the electro-negative, the electro-positive seeking the negative pole, while the electro-negative sought the positive pole.

With formalin so treated no such phenomena obtain, but the formaldehyd seems rather to be given off equally from the whole length of the litmus strip in its original form of gas. This would seem to indicate that it is the penetration of the eliminated gas which did the business for Dr. Barrows so effectually.

The topic which I chose as the title of this essay is by no means yet exhausted, but the essay is already overlong. In conclusion, permit me to thank you for your very patient and courteous solution.—*Dental Cosmos.*

THE STORAGE BATTERY IN THE DENTAL OFFICE.*

By G. E. Lob, M.E., Chicago, Ill.

The storage battery! A doubting smile will cross a good many dentists' faces when they hear any one advocating the use of such cells after the disappointment it has caused to many of them. Leaking jars, burned carpets, broken plates and lack of current just at the instant when it is mostly needed, have at times exasperated even the best natured operator and made him go back to his old foot-engine, because it is always ready for work and will not give out at the most inopportune moment. Nevertheless, since electricity has become such an important factor in the dental office and its use being bound to spread more and more, so that even the practitioner in the small country town, where no light or power circuit is available, wants to use it, the storage battery should deserve some attention, especially since its form has been improved and, through better knowledge, ways have been devised to simplify its handling.

Naturally, men handling electric machines and apparatus should want to understand the construction of the different appa-

*Read before the Chicago Dental Society.

ratus and the principles of their working—the "how and why." Having this knowledge, success depends upon watching and doing, or, more simply, "know how" and "do it."

Therefore, a brief description of the construction of the storage cell, or accumulator, and the principle upon which it works, will be in order. Electric cells, or when combined in any number so as to form a single source called electric batteries, are divided in two great classes:

I. Primary batteries. II. Secondary, or storage batteries.

Primary batteries are generators of electricity through the chemical action which takes place between certain different substances when brought into contact with each other, and independently from any outside electric current. To make this plainer, take the simplest form of a primary cell, a glass beaker filled with water, to which has been added a certain quantity of sulphuric acid, into which a strip of copper and one of zinc has been set, and connect these two metal strips by a copper wire. Immediately a strong chemical action will take place, showing an electric current flowing from the copper strip to the zinc through the conducting wire. The chemical action is as follows: The water is decomposed into hydrogen and oxygen. The hydrogen collecting on the surface of the copper and the oxygen combining with the zinc, forming oxide of zinc, which then combines with the sulphuric acid, forming sulphate of zinc. The principal seat of chemical reaction is at the surface of the zinc, which is consumed by oxidation, while the copper acts as a conductor and is not consumed. Hence, since electric movement is from higher to lower potential, and the same law applies to the energy of chemical reaction, in common with other forms of physical energy, and since the electrical energy of the cell is found to be strictly proportionate to its chemical reaction, it is assumed that the electric current originates at the surface of the zinc and flows through the fluid to the copper.

In the absence of external connection between the metal strips it is evident that the difference of electric potential would immediately become equalized and the current cease, but when they are connected by a conductor the current finds an outlet through the copper and flows back to the zinc through the external circuit; chemical action is thus sustained and the current becomes continuous. The law of the conservation of energy requires the expenditure of energy in one form as a condition of the production of the same amount in another form. Hence, as chemical energy is the only energy expended in the battery, the natural conclusion is that it is the source of the electric energy or current generated.

Secondary or storage batteries are not generators of electricity itself, but, as their name indicates, only receptacles of electric energy, which is carried to them from an outside generator and stored in the cells in the same way as we store up solids or liquids in cans or bottles. Thus electricity is stored in a manner which is impossible with any other power. While stored, the energy is dormant, and can be retained for long periods with very little loss.

A storage cell consists of three principal parts—the plates, the electrolyte or liquid, and the containing jar or box. The plates are divided into two kinds, positive and negative, and a set or group of these is commonly known as an element. The element is placed in a containing jar or box, which is then filled with a solution or electrolyte. The storage of energy in electric accumulators is accomplished by means of chemical action, produced in this case by the passage of an electric current through the element and electrolyte. The lead plates which form the element must be so constructed as to present a large surface upon which the chemical action may take place, as the amount of energy which can be stored in a cell depends upon the capability of the plates to take up the chemical action. This is termed the capacity of a cell.

The positive plates consist of lead upon which a coating or covering of peroxide of lead has been formed, while the negative plate is pure lead, the surface of which is of porous or spongy formation. The peroxide of lead and the spongy lead, respectively, are the portions of the plates which are subjected to the chemical action, and are consequently called the active material. The electrolyte used with all storage batteries is sulphuric acid diluted with water in the proportion of one part of acid to from five to ten parts of water, according to the type of cell.

The positive and negative plates of each cell are arranged alternately in a group, all the plates of like denomination being connected together in multiple. Insulating pieces or separators are provided to keep the plates apart, so that when they are connected respectively to the positive and negative poles of a source of electricity, the current can only pass from one to the other by flowing through the electrolyte.

As to the chemical reaction that takes place in a storage cell many different theories have been advanced, which would be too long to enumerate here. Joseph Appleton, in his "Storage Battery Engineering Practice" explains it in the most concise and simple form by saying: "The chemical condition of the plates and electrolyte differs when charged and discharged. When the cell is fully charged the positive plates have a coating of peroxide of lead, the negative being porous or spongy lead, as described before, and the electrolyte is of its full strength or specific gravity. During discharge, that is, when the positive and negative poles of a cell are connected through an external circuit, an E. M. F. is set up in the cell, a current flowing into the circuit from the positive plate.

The chemical action which takes place during discharge is as follows: The sulphur radical in the electrolyte enters into combination with the active material on both plates forming sulphate of lead, the specific gravity of the electrolyte being correspondingly reduced. When all the active material has been acted upon in this manner the cell is discharged, for an equilibrium has been created between the two plates and the electromotive force has fallen to zero.

When a cell is being charged, the chemical action is reversed. The current enters the cell at the positive plate, passing through the electrolyte to the negative. The passage of the current through the electrolyte decomposes it, oxygen and hydrogen gas being given off. The oxygen is given off at the positive plate and converts the sulphate of lead into peroxide of lead again, the sulphur going back into the electrolyte; the hydrogen which is given off at the negative plate enters into combination with the sulphate of lead, reducing it to pure lead, the sulphur returning to the electrolyte and increasing its specific gravity. This action restores both plates and electrolyte to the original condition of full charge. If the charging current is continued after the cell is fully charged, that is when all the active material has been converted to peroxide of lead and spongy lead respectively, no further effect will be produced except to decompose the water, the resulting gases pass off through the water, giving it a milky appearance. This indicates that the cell is fully charged. Continuing the charging current beyond this point, that is, overcharging the cells at the proper rate, does no harm to the plates, but the energy represented by the current is wasted.

When the cell has been properly charged, the positive plate is of a brown or deep red color, while the negative is a slaty gray. Naturally the chemical action can take place only at a certain rate, depending on the amount of active material and the construction of the plates. If it is attempted to give or to take from a cell too much current, the efficiency and durability are affected.

Generally speaking, there are two distinct methods of preparing the active material of storage battery plates. One of these consists in applying mechanically some material to the surface or exterior of a lead conducting plate or grid, which is either active itself or can be converted into active material by a process of electrical or chemical formation; the second method consists in treating or forming electrically or chemically the surface of a lead plate, which has been designed to present a large area to the electrolyte, whereby the surface is converted into active material.

The first method is commonly known as the pasted type of cell, although the active material is not always supplied in the form of paste. The second method is known as the Plante type, so-called because Gustave Plante, a French electrician, was the first to utilize practically the electrical method of forming the plates without the use of applied material.

The larger proportion of storage cells now in use are of the lead accumulator type mentioned so far, but there is a second class of storage cells made, which are called bimetallic accumulators, and whose elements consist of two different metals, the electrolyte being a salt of one of the metals. The principle upon which they work is the same as in the lead cells.

Naturally, lead accumulators are very heavy, and this being a great objection to their use in certain instances, a combination of elements of less weight was sought for, and the bimetallic cells were produced, but they never have been used to any great extent. The electro-motive force in them is somewhat higher than that of the lead accumulator, but owing to the danger of local action on open circuit, they will not retain their charge for more than a few days, while a lead accumulator will scarcely lose twenty-five per cent. of its charge in as many months; besides, the tendency of reducing the weight of these cells must necessarily weaken their construction, and on this account their life will be much shorter. About two years ago a small battery of this class was shown at the different dental meetings in connection with a small mouth lamp, and special stress was laid upon its high electro-motive force and its small weight. The battery has disappeared from the market, and those who invested money in buying it have probably found out by this time that the whole appliance was a failure.

It will be seen from the aforegiven description that the storage of electrical energy is entirely different from the storage of any other form of energy. A quantity of electricity cannot be stored or accumulated in a vessel or reservoir, because it does not exist in a tangible form. We are able, however, to make the electric current perform work in shape of chemical action and afterward, by setting up certain reactions, can reproduce the current stored. As long as the materials used are free from impurities and the chemical action is continued until completed, there is practically no limit to the time which may elapse between the storage of electricity with its contingent chemical action and the reaction, which, practically speaking, sets free again the electrical current.

Having considered the principles upon which the storage of electrical energy depends and noted the various elements which are necessary to make up the complete cell or storage battery, we will examine its application with special reference to dental practice.

The first and most common application of the storage cell in dental offices is to furnish the necessary power to run the dental motor, where no other current or no day current can be obtained. In order to keep the number of cells necessary to produce a certain amount of power, required for this kind of work, as low as possible, special wound motors must be used, which will work under a very small pressure. The unit of power in all electrical problems is the watt, which is equal to the voltage of electromotive force multiplied by the amperes or intensity of current. 746 watts represent an electrical horse-power. To produce such a horse-power, or any fraction of it, it will not make any difference if the voltage is high and the amperage low, or *vice versa*. 93.25 watts or 1-8 horse-power may be produced by a current of 110 volt pressure with only 0.85 amperes, or by 4 volts with 23.34 amperes, or any other combination giving the total of 93.25 watts, provided a motor can be constructed whose windings will be able to carry the current and in the same time offer sufficient resistance to the pressure, without being too clumsy in appearance.

Therefore, the resistance and carrying capacity of the wire on the motor are the main points to be considered. Necessarily, with a low voltage the wire must have a large cross sectional area in order to carry a current of high intensity without overheating the conductor, but as such a heavy wire has also a very low resistance and quite a large number of feet will be required even for the lowest voltage, practical reasons forbid to go in the construction of a battery motor beyond certain limits. Now the question arises, what power is actually needed to run a dental engine? I know, from everyday experience, that the large majority of dentists are laboring under a very wrong impression with regard to this point. Their judgment being based on the ratings and sizes of the ordinary motors coming under their eyes. most of them think that about one-fourth horse-power would be needed for a cord outfit and laboratory work, and perhaps one-eighth horse-power where the power is taken directly from the armature shaft. The reason for this is, that nearly all the small motors on the market are highly overrated, and when it comes to an actual test the power developed will produce only fifty per cent. or less of the indicated power. If the electrical motor is properly constructed, about one-sixteenth horse-power will be sufficient for cord outfits and the running of a lathe head, and one-fiftieth horse-power for a motor connected directly to the cable and handpiece. Of course the latter form will be the most preferred where a storage battery has to be used, as being the most economical on account of the smaller number of cells needed.

The next application of the storage battery in dentistry is to furnish light and heat, and in both cases more satisfactory results are obtained than from any other source of electricity.

The small mouth lamp or the somewhat larger mouth illuminator will give a steadier light and will last longer than when operated from an incandescent light circuit through a rheostat, or from primary cells, as the current is of absolute uniform flow, and no burning out of the lamps and going down of the light can occur through variation of pressure.

Heating instruments, such as root driers or hot air syringes where with a low voltage a current intensity of not over two or three amperes is required, may be as well operated from the incandescent light current through a rheostat as from the storage battery, but the electro-cautery where with the low pressure a current intensity of from eight to twenty or more amperes is needed no rheostat can perform this, and only a motor generator —a quite expensive machine—or the storage battery will answer the purpose.

Outside of the before mentioned apparatus and instruments the storage battery can be used for any other purpose where the electric current is wanted, provided its cost is not too high and the same result can be obtained in a cheaper way, as for instance in cataphoresis.

The efficiency of a storage battery depends to a great extent upon the proper selection of the cell best suited for the work required, its care and maintenance. In early days of storage battery work this was ignored, and many of the failures, which have been recorded are traceable to this account. The general practice was to consider a storage battery simply as a piece of apparatus to store up electrical energy for any purpose, irrespective of the character of the work, the classification being nothing more than good, bad or indifferent, with very little of the first. Modern practice has, however, changed this, and it is at last understood that there are many types of cells, and that a cell which can run a small motor need not of necessity be the one which should be used for heavy cautery work or to run a large motor.

In the dental office, the selection of the cell depends in a large measure upon the way it can be charged. Where a commercial current is available which can be brought right in the office and the charging can be done as often as desired, a cell of fifty ampere hour capacity will be sufficient for small motor work. If a larger lathe motor and heating instruments are used, larger cells of about double the ampere hour capacity will be needed. Usually portable batteries in covered wooden boxes are preferred on account of their neater appearance, but from a practical point of view the open glass jar is by far the better, because its contents are always open to inspection and the condition of the plates and electrolyte can be watched.

The cells should be placed in a dry, well ventilated place, not too near any heater and not too far—that is over twenty feet —from the apparatus operated by them and the conducting wires used must be as heavy as possible to reduce their resistance to the flow of current. This is a very important point to be observed, as many batteries which did not furnish sufficient current to give the motor its full speed, were found upon inspection to be placed in a distant cellar or laboratory connected to the motor with ordinary No. 16 or No. 18 lamp wire, while when this was replaced by No. 10 or No. 12 wire, the motor worked perfectly.

In dental practice the storage battery should always remain in its original place, and not be removed at all. The old method of sending out storage cells to be recharged at the electric light station or any other electric plant is impracticable, and in most cases disastrous to the jar and plates. If the expressman handling the cells does not break them on his way to the charging place, the local electrician, or as he prefers to be called, the expert electrician, in a large majority of cases, especially in small towns, has very little, if any, knowledge of the charging of storage cells and either by reversing the poles or by sending too strong a current through them, will destroy a battery that with proper care and attention probably would have done good service for several years.

For the above reason, storage batteries should be charged right in the place where they stand, and the charging current brought to them, so that it can be done without their removal.

This brings us to the question, Which current is suitable for charging storage cells and how it is to be done? Only a direct continuous current can be used for this purpose, such as furnished from a direct incandescent or arc light circuit, from a small dynamo, a primary battery or a thermo generator.

No charging can be done from alternating currents. In charging an accumulator only a small part of the E. M. F. required to force the current through the cell is expanded in overcoming the resistance of the plates and electrolyte; the remainder *is expended in overcoming the E. M. F. of the chemical action of* the cell. It follows, then, that if the applied E. M. F. be just equal to the E. M. F. of the cell no current will flow, so that the E. M. F. of the cell itself may be considered as a counter E. M. F. opposing that of the charging current—in other words, the E.M. F. of the charging current should be about twice as high as that of the cells to be charged. On the other hand, the amount of current charged per hour should not exceed what is called the normal charging rate, and which differs according to the size of cells. The normal rate of charge for small accumulators is about ten hours, and if the cell has a capacity of fifty ampere hours not more than five amperes should be charged, or ten amperes for a 100 ampere hour cell. Thus in using a direct incandescent light circuit it voltage must be cut down by interposing the proper resistance · order to bring the current to the normal rate. This can be done either by a rheostat or by a bank of incandescent lamps connected in parallel, in series with the main circuit. Every sixteen C. P. lamp will allow about one-half ampere of current to flow, and ten such lamps connected in parallel will furnish a charging current of five amperes. Of course, there is no harm in charging at a lower rate than the normal, if the great number of lamps should be any objection to the operator, or to use fewer lamps of higher candle power.

With the arc light circuit, where the arc lights are connected in series with the main line and only a fixed amount of current is flowing, no special resistance is needed, as the storage battery is simply connected in series with the line the same as all the arc lamps.

In case the current on such a line should be in excess of the normal charging rate, which would be damaging to the plates, the battery should be connected in multiple; that is, all its positive plates to one end of the line and all its negative plates to the other end. Thus the large current is divided through the battery and each cell, instead of receiving the full amount of current, will only receive its pro rata.

Very few dentists will ever use small dynamos to charge their storage cells with, as the first outlay for such an equipment is quite expensive and requires a good deal of attention.

To charge accumulators from primary cells, where no commercial current is available, is perhaps one of the simplest and also cheapest ways of doing. Only primary cells, which will be able to deliver a steady, continuous current for any length of time can be used for this purpose, and among them the so-called gravity cell in its different forms is the best. This cell will deliver a very steady current of a low intensity as long as the chemical action is kept going, and therefore it can be left connected permanently to the storage battery. All the attention needed is the replacing of the absorbed copper sulphate about once a month and of the zincs about every six or eight months, according to the type of cell used. When white salts begin to creep out on top of the cells, this is a sign that the solution is oversaturated with zinc sulphate and part of it should be taken out from the top of the cell, without disturbing the solution too much, and be replaced by clean water. If these points are carefully observed the primary battery will furnish a very satisfactory charging medium, which renders the dentist absolutely independent from the exactions of electric companies, especially in small towns.

The gravity cells deliver a current of about three-eighths ampere, and when connected permanently to the storage battery will charge about nine ampere hours in twenty-four hours' time. If this should not be sufficient for the work to be done, another series of primary cells of the required voltage can be added, which will double the amount of current charged.

The use of thermo-generators in connection with the storage battery is comparatively new in this country, although they have been used quite successfully in Europe for this purpose for the last ten or twelve years. As the name indicates, in such apparatus the current is generated by heat, the instrument consisting of a large number of thermo-electrical pairs (strips of two metals of different coefficient of expansion and electric affinity), connected together in series in such a way as to expose the inside or half of all the joints to heat, while the other half or outside is kept cool. Thus by the difference of temperature between the two joints of each pair a small electro-motive force is generated, which will increase with the number of pairs or elements connected together. Owing to the very small E. M. F. generated at each joint and the high internal resistance, quite a large number of pairs will be required to produce pressure sufficiently strong to charge three or four storage cells. Naturally the cost of such thermo-generators will be high and their use limited to small batteries. On the other hand, the electric mallet, mouth lamp and even a small fan motor may be operated successfully direct from the apparatus, while the amount of current flowing will not be strong enough to drive a power motor direct, and the accumulation of current in the storage battery is needed.

In charging a battery the following points should be watched: Special care must be taken that the polarity of the charging current is right. The positive pole of the battery must always be connected with the positive pole of the charging source. The voltage required to charge should be at least fifty per cent. higher than the combined voltage of all the cells in the battery, assuming for each cell an E. M. F. of two volts.

The rate of charge should be preferably kept at normal or under, as continuous charging at a higher rate than the normal will damage the plates.

In dental practice discharging until complete exhaustion is not advisable. Repeated recharging only for a few hours every few days will keep the battery in much better condition and preserve the plates much longer than a complete discharge and then a recharge. Besides, the operator being liable to forget that his battery is exhausted, will let it stand so for a length of time and the plates will soon become seriously injured. A long series of tests has shown that the continuous discharging of storage cells below one and nine-tenths volts is liable to produce sulphating of the plates; and the nature of the chemical action being changed, it also leads to the distortion of the positive plate, which is known as "buckling."

As the plates are located very close together in the cells to reduce the internal resistance, buckling is liable to cause the plates to touch, thus short-circuiting the cell.

The plates should always be completely immersed in the electrolyte. Evaporation will cause the electrolyte to fall below the level of the plates; this is detrimental and must be compensated for by the addition of water, as it is only the water which evaporates, the acid remaining in the solution. When adding water to a cell to make up for this evaporation it should be put into the cell through a hose or funnel reaching to the bottom, otherwise, the water being lighter than the acid, will remain in a layer on the top.

With a good modern storage battery very few troubles are liable to occur, provided proper attention is given to keep the regulation of the charge and discharge within proper limits and if the cells are properly supplied with electrolyte. The only thing likely to happen and cause trouble is the formation of short circuit between the plates, causing the cell to discharge through itself. The short circuit may occur either in the cells through the scaling or peeling of the active material, the pieces which become detached lodging between the positive and negative plates, or in the apparatus operated from the battery.

As soon as it is noticed that the battery will not hold its charge it should be immediately examined for short circuits. The best way to do this is to probe between the plates with a thin piece of hard rubber, thus removing any material which may have formed a connection between the plates. If this will not stop the trouble and the electrolyte is covering the plates entirely, in most of the cases the short circuit will be found in the apparatus. One or two charges and discharges will soon bring the cells back to their original condition.

To sum up what has been said before, all there is needed to keep a storage battery in good condition, is a proper installation, a judicious charging with due consideration for the amount of the current taken out, and a careful maintenance of the cells.

The storage battery of to-day is a practical and mechanical piece of apparatus. Engineers have come to the assistance of the chemist, the result being a well-designed and constructed apparatus, free from the weak points which were inherent in all early types of cells and which necessitated the constant attention of a skilled doctor or nurse.—*Dental Review.*

SOME THOUGHTS ON ORTHODONTIA.—AN ANSWER.

By Dr. Thomas B. Mercer, Minneapolis, Minn.

To corrupt a line attributed to the " Bard of Avon " " That man that hath no opinion, I say is no man." A rational, conservative view on any topic, whether it be a deduction of his own mind or a reflection from another's, is always welcome, and must always invite a certain amount of respect; because he at once becomes sponsor for this opinion, and must expect to meet all would-be challengers.

As a challenger, then, exception is herewith taken to a few of the points brought out in " Some Thoughts on Orthodontia," December *Items of Interest.*

The article suggests to me a boundless faith in one particular authority; at least its influence is apparent in his methods of procedure.

On page 882 he says, " I feel constrained to believe that most of it (irregularity) is purely hereditary." The Egyptians and Jews are then quoted as examples whose " racial characteristics have remained almost unchanged through ages."

The mechanical influence is quite ignored.

Much of either egotism or bravery is necessary for one to stand up and take exception to so obscure a science as heredity in this direction; in fact, the tendency is toward taking refuge in its darkness. But I firmly believe that the more we investigate along this line the more we will find how misplaced has been the responsibility. To be sure, there are two sides to the question, but the element of speculation exists in both, so it is extremely difficult to disprove on the one hand or verify on the other. However, I have a few puny, perhaps trite, arguments in support of the theory that heredity as a factor in irregularity is an over-estimated and misconstrued quantity.

The most casual thinker will certainly admit that there is nothing in the organization of the Jewish or Egyptian child that would preclude the possibility of its becoming a mouth-breather, a thumb or tongue-sucker, a lip-biter, or a victim of abnormal lip-function, the same as other children, and be subject to the same natural consequences; nor does it seem probable that either race has at any time included many dentists of the ultra-conscientious type who would hesitate to extract because of its later evil influence. The vicious consequences of premature extraction in a child of pure blood would certainly be as apparent as in one of irregular lineage.

Any orthodontist will acknowledge that seven-eighths of the cases that come under his observation can be traced to, or show the mechanical influence of some one or more of the foregoing causes. Why, then, should the Egyptian or Jewish child escape?

If we accept the questionable hypothesis of the transmission of acquired faculties, how have the racial characteristics been maintained?

One of the most complex cases I have yet seen was that of a Jewess.

The result of advanced civilization is also cited. I would ask, then, if that portion of a race that yields to the influence of civilization will not necessarily become the very head and front of this people physically, morally, and mentally? On that theory they are also the most subject to malocclusion.

It would hardly seem, then, as though we could attach absolute faith to the result of measuring thousands of jaws of this people *generally* to verify the idea, because of the extreme likelihood that the material at hand will not represent the class most apt to be afflicted.

The law of the ultimate disposition of the fittest always has, and always will, hold good.

In this connection I wish to quote from one of the current text-books on orthodontia: "When one parent possesses a large frame, with full-sized teeth set in large jaws, and the other a small frame, with correspondingly small jaws and small teeth, the child may inherit the large teeth of one parent and the small jaws of the other."

After much investigation, I am unable to reconcile this view with the teachings of embryology or with heredity as set forth by Galton, Weissmann, or even Darwin; in fact, I am led to believe that such is not the case.

There certainly must be a consistent law of transmission, as, for example, paired structure. We don't have one brown eye and one blue. In further proof of this, outside of paired structure, we don't have the small feet of the female and the large hand of the male represented in the same normal being. The teeth and jaws are the product of the same embryonic layer, the mesoderm (except enamel, which obviously does not determine the size of the teeth); they are therefore very intimately related. If then, as it seems, there is a consistent law of transmission, does it seem probable to suppose that a tendency to inherit scant distribution of structure in the jaws would be transmitted from one side of the family and a tendency toward extravagant distribution in the teeth from the other?

There are also many heritages that come from one side of the family to the exclusion of the other; for instance, if one progenitor is dark-eyed, with a like family history, and the other is light-eyed, with a supporting family history, the tendency of the offspring is not toward intermediate or blended tints, but to take one or the other.

I believe that in structure so intimately related as the jaws and dentin this same tendency will hold good.

It has probably been noticed that reference to the immediate progenitors, without considering family influence, has been avoided, for this reason:* "It appears that there is no direct hereditary relation between the personal parents and the personal child, except perhaps through little-known channels of secondary importance; but that the main line of hereditary connection unites the sets of elements out of which the personal parents had been evolved with the set out of which the personal child was evolved."

Suppose for a moment it be granted that irregularities may be caused by the transmission of the small jaw of one progenitor and the large teeth of the other, according to the foregoing standard authority, the immediate parents would have very little direct influence unless this same relative disparity had existed

*Galton.

before them. The union of two widely differing individuals physically can hardly with one fell swoop establish a type, because necessarily more or less of a process of evolution must be undergone. The ovary of the mother is as old as the mother herself; it was developed in her own embryonic state. The ova it contains in her adult life were actually or potentially present before she was born, or grew as she grew. There is more reason to look on them as collateral with the mother than as parts of the mother.

How, then, can a child have transmitted from its immediate progenitors the small jaw of one and large teeth of the other?

Again, suppose for argument that from this cause a child was delegated to acquire any irregularity, why should it be so vicious and unseemly as to wait over until the permanent teeth erupt and not manifest itself at all during the life of the deciduous teeth? (Cases of irregularity of the deciduous teeth being rare indeed.) It is true, of course, that the jaws are only partially developed at that time, but nevertheless much the same relative proportion exists.

Some small amount of correspondence with histologists, embryologists, and biologists on this point reveals a singular concurrence in the opinion that is best expressed in the following quotation from a letter of one of them: "I can see no reason why, if the child inherited teeth and jaws from different parents, the irregularity should not appear as much in one set of teeth as the other."

Are irregularities of the teeth transmitted?

A current text-book contains the following statement: "When the irregularity is known to have been acquired in the parent of the child, and thus to have been transmitted but once, the difficulties in the case are not so marked because the type has scarcely been confirmed."

The author assumes, it has been noticed, that acquired characters can be transmitted; then goes on to elucidate the case. This, to say the least, is unwarranted and misleading; the scientific world is and has been for years poised in doubt on this question.

Weissmann says, "The inheritance of acquired characters has never been proved either by means of direct observation or experiment."

Galton says, "I am unprepared to say more than a few words on this obscure, unsettled, and much discussed subject of the possibility of transmitting acquired faculties."

Darwin himself admits that his well-known hypothesis was provisional, but necessary to explain his development of species.

Professor Conklin, of the University of Pennsylvania, has an article in the *Philadelphia Medical Journal* (September 16, 1899), entitled "Phenomena and Mechanism of Inheritance," that touches upon this question in no uncertain manner. It is splendidly concise, and seems splendidly consistent. The last few lines are in the nature of a climax: "The inheritance of acquired characteristics is inconceivable, because the egg is a cell and not an adult organism; and in this case there is no sufficient evidence that the thing which is inconceivable really does happen."

As to the transmission of irregularity, the following little argument would also seem to have some force: "The temporary teeth are rarely found other than in their normal relation. On the best authority it seems that there is no difference in the process of formation in the two sets, and also that the permanent teeth are developed from an extension into the depth from the original connection between the enamel organ (temporary set) and the epithelium of the surface of the gum." If, as it appears, both sets come from the same source, how can one set be normal and the next abnormal unless it be brought about by external means?

But to return to the article in question. In the next paragraph the word extract is surprisingly frequent. Why extract at all except from dental cause? If the lateral incisors are erupting in lingual occlusion (inferior maxilla), why not with a piece of "G" wire inserted between the temporary cuspids, and pinched every few days, gently widen the arch with no inconvenience to the little patient? If extraction, however, is resorted to, all right; but with band and spur *preserve the space.*

On page 885 is the first of a series of engravings showing the progress and eventual completion of a case. The lower arch, I take it, the author deems a scant factor, for there is no consideration given it whatever in its relation to the upper; no disclosure as to the treatment accorded (for there certainly was a bunching and overlapping), nor is there a single engraving of it in the series. We are therefore deprived of any reliable means of diagnosis; but it has the appearance of coming under Class I (Angle), in which the relative position of the jaws mesio-distally is normal; the first molars also being in normal occlusion.

Fig. 4 shows that the upper right first bicuspid has been sacrificed, but he does not account for such action in any way. If the facial lines indicated such a move it was of course justifiable but there is no mention of facial lines except where he says the little girl has a "decidedly hatchet-faced appearance," and that certainly argues against the advisability of it. On the contrary, if the occlusion disclosed the fact that it came under the subdivision of Division 2, Class 2 (Angle)—viz., unilateral distal occlusion—extraction was perhaps necessary; but it would be interesting to know if the corresponding lower right first bicuspid was also sacrificed.

The appliances shown and the engraving following certainly indicate most efficient work, but it would seem as though photographic reproductions would be more satisfactory to all concerned, because of the surprising progeny of one Thomas by name and erstwhile doubter.

The question of retention, surely a vital issue, is not touched upon; but if the lower arch has been left uncorrected, as I am perhaps wrong in assuming, it is not exactly clear to one who accepts occlusion as a basic principle what means will be employed to permanently insure their position.

Perhaps the author assumes that the answers to many of my questions are self-evident, but to me a scientific article at its very best is always more or less obscure; and there can never be too much detail in the description of a mechanical operation.—*Dental Cosmos.*

AMALGAMS.

By J. Foster Flagg, D.D.S., Swarthmore, Pa.

That I should be writing an article upon amalgams may seem to others, as it does to me, peculiar, in that I have already written so much about them; but until my resignation from the Philadelphia Dental College, some four years since, I had such opportunity to *talk* them that further writing appeared unnecessary; but so much is being done with them now, so many papers about them and their workings are being contributed to our societies, and so much consequent discussion is being indulged in, that these, together with the extraordinary and questionable claims as to attributes, and more than usually curious lists of "testimonials" which are being presented to "the profession," are my warrant for this contribution.

In addition to this, I have already replied to many letters of inquiry, and am in receipt of so many more yet unanswered, but which evidence an encouraging interest, and in some cases misconceptions that seem too general, that I think I can make one reply more serviceable than many.

In regard to the making of amalgam alloys I have for twenty years demonstrated that it was a comparatively easy thing to do; that it needed but little in the way of apparatus and appliances, and have had the satisfaction of thus far helping many a student to such practical knowledge of that department of dentistry.

My experience of these many years has taught me, as I have taught, that several kinds of amalgam are essential to the proper utilization of that material; that, of all these, that line which has been called in "New Departure" nomenclature "sub-marines," and in laboratory parlance "bronze alloys," from the fact that alloys of copper and tin are utilized for the facile incorporation of the copper, are the most positively *useful,* because they had been proven capable of saving a class of teeth which *no other material has saved,* and that this *saving* seemed almost limitless, as dreadfully decayed and miserably structured teeth had been saved by the thousands for periods varying from ten to thirty, and even forty, years.

No one can say that no other amalgam can do this; but no other amalgams have done it.

The *peculiar attribute* of all "sub-marine" amalgams is their property of *sulfiding* when exigencies demand it, and apparently of doing this *in proportion* as this demand is made upon them; so that while in some dentures a given demand causes a brown discoloration of greater or less intensity, in others a greater demand causes an almost immediate discoloration to the blackness of jet.

These results are due to combinations of silver and copper; in most cases more or less controlled by tin, but in cases of absolute necessity of either copper alone or of silver and copper only. This leaves *copper* as the *distinctive* metal for "sub-marine" amalgam alloys, as *all* dental amalgam alloys contain silver.

A very gradual increase of copper now gives the formula for "sub-marine" alloy as silver, 60; tin, 33; copper, 7.

The next class of amalgam is "contour," or "usual," the alloys for which I compose of silver, tin, *gold* as their *distinctive* metal, and zinc, in the varying proportions of from 60 to 70 silver, from 25 to 35 tin, from 1 to 3 gold, and from 1 to 3 zinc.

This kind of amalgam has done most acceptable service for twenty-five years; its formulæ were "accepted" with much deliberation, and only after years of clinical trial of each modification. Its grain is good; it mixes easily with its mercury; it gives ample time for comfortable manipulation, and by "wafering" it is made to set with satisfactory celerity. Its maintenance of color is good when left with that "mat" finish which nearly approximates the color of a tooth, and if it discolors it is usually permanently restored by pumicing and burnishing. But its greatest merit is its reliability; upon that the testimony of years gives no discount.

The third class of amalgam is that known as "facing," or "white," a most desirable amalgam *for its purposes,* and which has zinc for its *distinguishing* metal.

Commencing twenty-five years ago with the formula: of tin, 50 odd; silver, 30 odd; gold, 5 to 7; zinc, 2 to 4; it was at first used either alone or in combination with "contour" as a means for increasing the maintenance of color, and thus giving a degree of beauty as well as utility to the then-growing frequency of amalgam filling; but as years passed the tin was increased to 55, the silver to 40; the gold was abandoned as non-compensating, and the zinc increased definitely to 5.

Meanwhile its value as a reliable covering to arsenical applications, when exigencies demanded such for long-continued periods; its adaptability for the filling of tap-holes, when such were regarded desirable in positions subject to attrition; its eminent appropriateness for amalgamating gold-coated porcelain inlays and for "cold-soldering" them to the cavity-filling, whether of gold, amalgam, or "combination" work, became so apparent that I do not now know how all these ends can be accomplished without this form of amalgam.

All these amalgams appear to be established as means for certain ends, and there remains but one other class of alloys for consideration. These are the "bastard" or "brass" alloys.

It has been noted that each class of alloys has its *distinctive* metal, used for a special purpose; and, with the exception of gold, this purpose positively assured. But it must also be noted that copper is used mainly for the assuring of discoloration (though incidentally for the control of expansion), while zinc is used for the prevention of discoloration and for the assurance of expansion. Thus copper, as copper, and zinc, as zinc, are diametrically antagonistic the one to the other, and for this reason I have never made such combination.

But by reference to page 50 in the first edition of "Plastics" (1883), it will be seen that as the result of "New Departure" metallurgic work I was early impressed with the alloys of copper and tin as productive of very white results; while in the edition of 1890, page 104, it will be seen that even then ten years of experiment had been given to the problem of a "front-tooth" alloy.

By this time I had reached the heavily gold and heavily zinc alloys, also had the experience that though they promised much the promise was not satisfactorily fulfilled; I had also worked up the alloying of copper with tin, and made some curious results which are given on page 104a. I next tried the "mechanical mix" of copper and zinc as distinct alloys, which work will be found on page 104b, and which gave the most acceptable results reached up to that time.

It was soon decided that even the amalgams obtained from these alloys were by no means such as were desired, but they had given the ideas for the "bastard" or "brass" alloys, in which work I have recognized the results as "bastard" because they can be neither sub-marine, contour, nor facing, and as "brass" because as with copper in the first, gold in the second, and zinc in the third, brass is the *distinctive* ingredient of this fourth class.

If the compounding of the alloys of silver, tin, and copper, or of silver, tin, and zinc, is peculiar and very interesting work, the compounding of alloys of copper and tin (bronze), or of copper and zinc (brass), are interesting even to fascination, and when these are in turn compounded with silver and tin, and possibly with gold, the results are *probabilities,* and the *possibilities* are determined only by experiment.

This work is done, not primarily for the purpose of a *tooth-saving* "contour," not for any substitute for the "sub-marine;" not, by any means, to subserve the most desirable purposes of the "facing," but to give an acceptable amalgam for the doing of that "combination" or "composite" work done by "lining" cavities with either zinc phosphate or oxychlorid cement and filling wth amalgam, of which we now have the record of *twenty years* as being the nearest perfection as a *tooth-saving* work, and only requiring such an amalgam as is yet not positively *known* to have been made to give it *perfect beauty.*

For such an amalgam we desire an acceptable grain, an ease of mixing, a deliberate though sufficiently prompt setting (that time may be given for careful manipulation and that the setting may admit of a reasonably quick finish), a good degree of resistance to both attrition and pressure; though this attribute is not now a question, for, so far as I have made them, I do not know of any "brass" amalgam that does not possess needless hardness, while some are so hard as to have been undesirably inflictive in their removal (even though softened with mercury in drill-holes) when such removal became necessary.

But beyond all these the *persistent* maintenance of color is *the* attribute without which all the others are of no avail, and this is what I believe is not yet *known* to have been accomplished.

For a long time I have had and taught amalgams which would retain their color—almost always—for several years, but time, "which tries all things," has usually proven too much for even the most promising.

I have, for long, established the rule to give dental experiments (from conservation of pulps to action of filling-material) not less than five years, and under the most possible varied conditions, before coming to even a preliminary, and by no means positive, opinion.

I have repeatedly noted the advantage of this deliberation, and it is this which I regret as likely to debar me from much further experimental research, a work which has been to me a source of great pleasure, and, largely, of comforting satisfaction. As I view it, the obtaining of an amalgam which would *permanently* maintain its white and tooth-like color would give dentistry for ordinary work (the usual filling of cavities of decay), a material which, while it might be better than gold, because of the markedly greater facility in its introduction, would nevertheless be but *relatively* only better than gold because of that very retaining of unattacked brightness.

As is well known, I have worked and taught for twenty-five years (a good, long experience) in the faith of the theory of Dr. S. B. Palmer, that "Failure in operations is *mainly* due to incompatibility of filling material with tooth-bone."

In no other way have I been able to explain the failures of my carefully introduced fillings of gold (and not mine alone, by any means!) and the success of my so much more comfortably introduced fillings of other materials, and I have never believed other than with my friend, Professor Henry Morton, when he said, "Now acid fluids do act chemically on bone, and the presence of a good conductor, *which is itself unattacked*, in contact, must, on general electrical principles, assist the electro-chemical action."

"Unattacked" means ability to maintain integrity, for so long as that condition exists the attacking force is a nothing to it, but just inversely the other element in the fray suffers, and *therefore*, "in proportion as a tooth *needs* saving," an amalgam which maintains its color would, *alone*, be the worst amalgam to fill it with.

But "life" is not everlasting, and even the permanent teeth are not intended to last a lifetime, as many do not erupt until from a sixth to a quarter of the average length of life is passed, so that it may be, according to the table of electrical conductivity, that a bright amalgam filling will save a tooth twice or thrice as long as a bright gold one; and if such is proven, by time, to be true, then surely we will have approximated the "ideal" filling-material, and those who think that filling with gold can alone keep dentistry up to its high standard of manipulative ability must look for other means, as they will find "Othello's occupation gone!"—*Dental Cosmos.*

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EDITOR:

W. GEORGE BEERS, L.D.S., D.D.S. - - - - MONTREAL, Que.

699 SHERBROOKE ST., COR. PARK AVE.

To whom all Editorial Matter, Exchanges, Books for Reviews, etc., must be addressed.

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THE PINS IN ARTIFICIAL TEETH.

Why do they pull out so easily? Twenty-five years ago the degeneracy in the manufacture of artificial teeth began. It was one of the coincidences of the curse of vulcanite. Anything was then thought good enough for a plastic. But the fact is, the rubber is not so much to blame as the tooth-material. The pins come out of the porcelain. Twenty-five years ago (See *Canada Journal of Dental Science*, Vol. iii., page 161) Dr. C. Brewster read a paper before the Montreal Dental Society on this subject, in which he described his experiments in pulling out the pins of American and English teeth, in which, in the former, the teeth went to pieces, and the pins came out whole and perfect, and in the latter the tooth could not be broken by the same strain, and the pin could not come out, but was broken off by sheer force close to the porcelain. It is well known that if we want to separate a gum-block, it can be divided with a pair of scissors easier than a caramel! The American artificial tooth-structure of thirty years ago was as much ahead of the modern in point of strength as a piece of steel is ahead of a piece of tin.

OLD-FASHIONED.

We suppose there are many enthusiastic practitioners who think that a man might better be out of the profession than out of the fashion. Most of us who have passed the meridian of practice can remember the hey-day of its beginning, when we started to set the St. Lawrence and Lake Ontario on fire, and with a loftiness of gall perfectly sublime looked down upon the old practitioner, whose experience we did not condescend to count. It would be almost a pity were it otherwise. We should lose so many refreshing illustrations of that happy daring, which carries better men than only the fools, to shove aside the timid angels. It is better for a young man to make an ass of himself as early as possible in his professional career than ape a modesty which is only pride, and write himself down a donkey when his friends felt sure he had passed the *Pons Asinorum*.

SCHOOL TEACHERS.

Ontario Province has the best system of common school education in the world. One of the results has been that the professions have had a special attraction for the well-educated sons of farmers and country merchants, and many of these boys have risen to distinction in every profession, as well as in the political arena. Dentistry has been peculiarly favored by the large number of former school teachers who have entered its ranks. No class could be more desirable, and we look to them as prominent in every phase of educational and ethical progress.

THE Ontario Board of Directors do not examine, but appoint examiners, and do not appoint themselves. Nor, as a rule, do they appoint members of the teaching staff. In the case of Technique and Comparative Dental Anatomy they have appointed the teachers, as there are no others so familiar with the course as given in the college. In appointing examiners, the Board selects graduates who were well up in their subject when they passed, and have since had some years' experience in practice.