RE-ENFORCEMENT OF SOUND.

BY GEO. M. HOPKINS.

The re-enforcement of sounds by the vibration of confined masses of air may be readily investigated without apparatus, that is, such apparatus as is commonly employed in acoustical experiments. A very simple experiment illustrating the fact that a sound

Fig. 1.—RE-ENFORCEMENT OF VOCAL SOUNDS.

may be strengthened by a confined body of air is illustrated in Fig. 1. The only requisite for this experiment is a paper tube 16 or 18 inches long and about 3 inches in diameter, or, in the absence of such a tube, a sheet of thick paper rolled into a tube will answer. This tube should be held with one end near the mouth, the opposite end being closed by the palm of the hand. By making a sound continuously with the voice, gradually rising in pitch, for example by singing O, with the voice rising from the lowest note it is capable of making, toward the highest note, a

Fig. 2.—SELECTIVE POWER OF A RESONANT VESSEL.

point will be found where the sound is largely increased. This increase of sound will occur at the same point in the scale each time the experiment is tried with the same tube, thus showing that the dimensions of the tube are in some way related to the re-enforced note, and to that note only. It will also be noticed that the vibrations of the air in the resonant tube not only affect the auditory apparatus, but also have sufficient power to be plainly perceptible to the sense of touch, the vibrations being felt by the hand.

Another very simple experiment showing the same phenomenon in a different way is illustrated in Fig. 2. In this case the resonant vessel consists of a vase. Any vessel of substantially the same form may be used. The size is not very material, but by making several trials of different vessels a particular one will be found which will yield better results than others on account of being of the correct dimensions. The experiment consists in holding the vase obliquely in close proximity to the ear, then running the chromatic scale upon any instrument having sufficient range, preferably upon a piano or organ. Some note of the scale will sound much louder than any of the others. By tilting the vase slightly in one direction or the other, so as to cause the ear to partly close the mouth of the vase, the resonant qualities may possibly be improved, as the movement of the vase in this manner amounts to tuning the resonator.

In Fig. 3 is represented an experiment in which the mouth is employed as a resonator, and an ordinary tea bell as the source of sound. The tuning is effected by moving the tongue back and forth, also by opening or closing the lips. By a few trials a position of the mouth will be found which will cause it to respond to the sound of the bell and act as an efficient resonator.

The familiar instrument shown in Fig. 4 is used in connection with the mouth as a resonator. In this example the reed of the Jew's harp is made to yield a variety of tones, dependent upon the adjustment of the mouth and the force of the breath. The fundamental note of the reed is the clearest and best, and always distinctly heard. The forced overtones are less satisfactory, but suffice for playing tunes that are recognizable.

The experiment with the bell, represented in Fig. 5, is very striking, and is easily performed. The bell is simply an old fashioned clock bell or gong fastened on the end of a small wooden handle by a common wood screw. The resonator is a paper tube of about two-thirds the diameter of the bell, provided with a movable portion or diaphragm, as shown at A. Although the bell may be set in vibration by rapping it with the knuckles or striking it with a large sized rubber eraser, it may be more satisfactorily sounded by drawing a well resined bow over its edge. The bell is held over the mouth of the paper tube, and the diaphragm is moved up or down in the tube until a position is reached in which the bell will yield a full tone, which is much louder than it is capable of giving when used without the resonator. The diaphragm is then fastened by means of sealing wax or glue.

To re-enforce one of the overtones of the bell, the opposite end of the tube is gradually shortened by paring off narrow strips from its edge until it responds to the high tone which the bell is capable of giving out when bowed in a particular way. Now, by causing the bell to vibrate strongly and placing it near opposite ends of the resonator in alternation, it will be found that the deeper cavity will respond only to the grave note of the bell, while the shallower cavity will re-enforce only the overtone to which it is tuned. In this experiment it will be found a little more convenient to have separate resonators for the different tones.

In Fig. 6 is shown an experiment which is substantially the same as that just described in connection with the bell. In this case two tuning forks, A and C, are used as sound producers, and to each fork is adapted a resonator consisting of a paper tube about ⅝ inch in diameter and 8 or 10 inches long. Each tube is tuned to the fork in connection with which it is to be used by inserting a cork and moving it until the length of the inclosed air column is such as to respond to the fork. It will be found that the A resonator will respond only to the A fork, and the C resonator will re-enforce only the sound of the C fork.

In all these cases the resonant tube or cavity corresponds in depth to one-quarter of a wave length of the particular sound which it is adapted to re-enforce. The wave proceeding from the sounding body strikes the bottom of the resonant chamber, and is reflected back in time to proceed with the other half of the wave moving in the opposite direction, greatly augmenting its volume.

The combination of two series of sound waves may be made to produce silence if the relation of the two series be such that the air condensations of one series coincide with the rarefactions of the other series. This may be demonstrated by holding a tuning fork over its appropriate resonator and turning it until the plane of vibration of the fork is at an angle of 45° with the axis of the resonating tube. Then the sound of one arm of the fork will exactly neutralize that of the other arm.

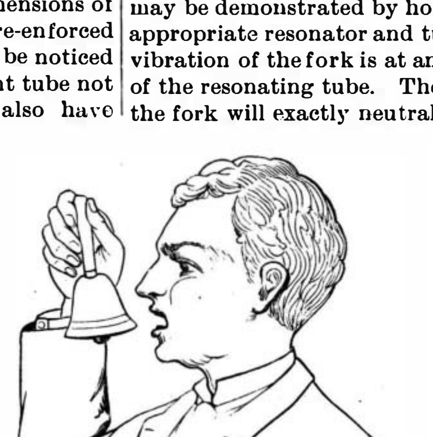

Fig. 3.—THE MOUTH USED AS A RESONATOR.

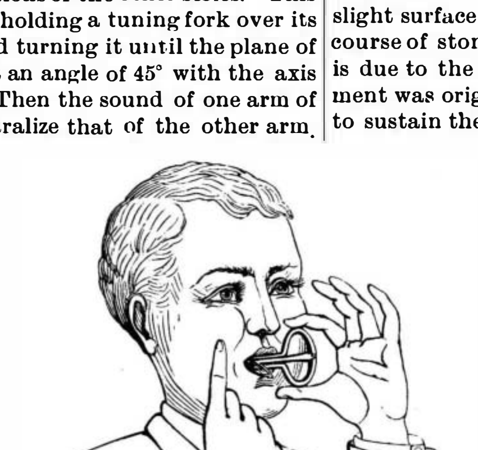

Fig. 4.—EXPERIMENT WITH THE JEW'S HARP.

Fig. 5.—BELL AND RESONATOR.

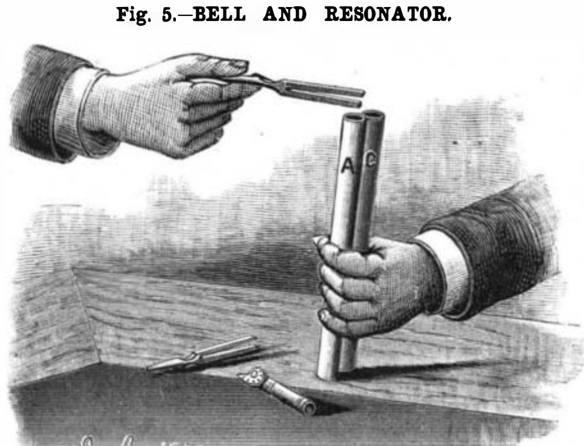

Fig. 6.—TUNING FORKS AND RESONANT TUBES.

Vegetable Glue.

Concentrated solution of gum arabic possesses the disagreeable property, when applied to printing and other paper not strongly sized, to penetrate them to transparency, and, in spite of this, not making them adhere to other paper. Paper cannot be attached to common pasteboard, nor wood to wood by it. Paper gummed with mucilage will not adhere to metallic surfaces, but soon falls off; and it is no use for glass, porcelain, or earthenware. All these disadvantages are remedied when an aqueous solution of sulphate of aluminum is added. For 250 grains of the concentrated gum solution (prepared with two parts of gum and five of water), two grains of cryst. aluminum sulphate will suffice. This salt is dissolved in ten times its quantity of water, and mixed directly with the mucilage, which in this condition may be termed *vegetable glue.* Solution of alum serves the same purpose, but far less efficiently.—*Pharm. Central.*

The Washington Monument.

It is said, by those who are in position to know all about the matter, that the statements going the rounds of the press, in reference to the disintegration of the Washington monument have no warrant in fact whatever.

The foundation of the statements may be traced to slight surface cracks, and some spalling in the outer course of stone of a portion of the old structure. This is due to the fact that when the building of the monument was originally begun, it was never contemplated to sustain the immense pressure of its present structure, and hence the outer course of stone of the first 150 feet was of smaller dimensions than it would have been had it been supposed that the monument would ever have reached its present great altitude. But it is only in about the first 40 feet of the outer course of stone of the old structure that the surface cracks and spalling appear; and it is thought that this state of affairs will gradually continue in the old structure until some repair to the outer course of the first 150 feet of the same shall become necessary. This repair, however, will be a very simple matter, involving only the services of stone masons, a good scaffolding, and the outlay of some money. But it is estimated that it will be probably fifty years yet before any repair will be necessary. The monument is considered a substantial and lasting engineering feat, and one that it will take a great convulsion of the earth to affect.

Artificial Rubies.*

BY GEO. F. KUNZ.

The subject of artificial gems is at the present moment of considerable interest. Early this summer the Syndicate des diaments et pierres precieuses was informed that certain stones which had been sold as rubies from a new locality were suspected to be of artificial origin. They were put upon the market by a Geneva firm; and it was surmised that they were obtained by the fusion of large numbers of small rubies, worth at the most a few dollars per carat, into one fine gem, worth from $1,000 to $2,500 per carat.

Some of these artificial stones were kindly procured by Messrs. Tiffany & Co. I was not, however, permitted to break them for analysis, to observe the cleavage, or to have them cut so as to observe the optical axes more correctly. It is possible, however, to detect the artificial nature of this production with a mere pocket lens, as the whole structure is that peculiar to fused masses. Examination elicited the following facts: The principal distinguishing characteristics between these and the genuine stones is the presence in them of large numbers of spherical bubbles, rarely pear shaped, sometimes containing stringy portions, showing how the bubbles had moved. These bubbles all have rounded ends, and present the same appearance as those seen in glass or in other fused mixtures. They are nearly always in wavy groups or cloudy masses. When examined individually they always seem to be filled with gas or air, and often form part of a cloud, the rest having the waviness of a fused mixture. Some few were observed inclosing inner bubbles, apparently a double cavity, but empty. In natural rubies the cavities are always angular or crystalline in outline, and are usually filled with some liquid, or, if they form part of a "feather," as it is called by the jewelers, they are often arranged with the lines of growth. Hence the difference in appearance between the cavities in the natural gem and those in the fused gem is very great, and can readily be detected by the pocket lens. I have failed to find in any of the artificial stones even a trace of anything like a crystalline or angular cavity. Another distinguishing characteristic is that in many genuine rubies we find a silky structure (called "silk" by the jewelers), which, if examined under the microscope, or under a four-tenths to eight-tenths inch objective, we find to be a series of cuneiform or acicular crystals, often iridescent, and arranged parallel with the hexagonal layers of the crystal. When in sufficient number, these acicular and arrow-shaped crystals produce the asteria or star effect, if the gem is cut *en cabochon* form with the center of the hexagonal prism on the top of the cabochon. I have failed to find any of them in the stones under consideration, or even any of the markings of the hexagonal crystal which can often be seen when a gem is held in a good light, and the light allowed to strike obliquely across the hexagonal prism. Dr. Isaac Lea has suggested† that these acicular crystals are rutile, and interesting facts and illustrations have been published by him.

From my own obervations on many specimens, I believe there is little doubt of the truth of this hypothesis. My explanation is that they were deposited from a solution, either heated or cold, while the corundum was crystallizing, and I doubt very much whether they will ever be found in any substance formed by fusion. The hardness of these stones was found to be about the same as that of the true ruby, 8·8, or a trifle less than 9, the only difference being that the artificial stones were a trifle more brittle. The testing point used was a Siamese green sapphire, and the scratch made by it was a little broader but no deeper than on a true ruby, as is usually the case with a brittle material. After several trials it was faintly scratched with chrysoberyl, which will also slightly mark the true ruby.

The specific gravity of these stones was found to be 3·93 and 3·95. The true ruby ranging from 3·93 to 4·01, it will be seen that the difference is very slight, and due doubtless to the presence of the included bubbles in the artificial stones, which would slightly decrease the density. As a test, this is too delicate for jewelers' use; for if a true ruby were not entirely clean, or a few of the bubbles that sometimes settle on gems in taking specific gravities were allowed to remain undisturbed, it would have about the same specific gravity as one of these artificial stones.

I found on examination by the dichroscope that the ordinary image was cardinal red, and the extraordinary image a salmon red, as in the true ruby of the same color. Under the polariscope, what I believe to be annular rings were observed. With the spectroscope the red ruby line, somewhat similar to that in the true gem, is distinguishable, although perhaps a little nearer the dark end of the spectrum. The color of all the stones examined was good, but not one was so brilliant as a very fine ruby. The cabochons were all duller than fine true stones, though better than poor ones. They did not differ much in color, however, and were evidently made by one exact process or at one time. Their dull appearance is evidently due in part to the bubbles.

The optical properties of these stones are such that they are evidently individual or parts of individual crystals, and not agglomerations of crystals or groups fused by heating. In my opinion these artificial rubies were produced by a process similar to that described by Fremy and Feil (*Comptes Rendus*, 1877, p. 1029), by fusing an aluminate of lead in connection with silica in a siliceous crucible, the silica uniting with the lead to form a lead glass and liberating the alumina, which crystallizes out in the form of corundum in hexagonal plates, with a specific gravity of 4·0 to 4·1, and the hardness and color of the natural ruby, the latter being produced by the addition of some chromium salt. By this method rubies were formed, which, like the true gem, were decolorized temporarily by heating.

It is not probable that these stones were formed by Gaudin's method (*Comptes Rendus*, xix., p. 1342), by exposing amorphous alumina to the flame of the oxyhydrogen blowpipe, and thus fusing it to a limpid fluid, which, when cooled, had the hardness of corundum, but only the specific gravity 3·45—much below that of these stones. Nor is it at all likely that they were produced by fusing a large number of natural rubies or corundum of small size, because by this process the specific gravity is lowered to that of Gaudin's product. The same also holds good of quartz, beryl, etc.

The French syndicate referred the matter to M. Friedel, of the Ecole des Mines, Paris, supplying him with samples of the stones for examination. He reported the presence of the round and pear-shaped bubbles, and determined the hardness and specific gravity to be about the same as of the true ruby. On analysis he found them to consist of alumina, with a trace of chromium for the coloring matter. The cleavage was not in all cases distinct, and the rough pieces given to him as examples of the gem in its native state had all been worked, so that nothing could be learned of their crystalline structure. When properly cut according to axes, they showed the annular rings. The extinction by parallel light was not always perfect, which he believed to be due to the presence of the bubbles. He states that he himself has obtained small red globules with these inclusions by fusing alumina by oxyhydrogen light; and, although having no positive evidence, he believes these stones to be artificially obtained by fusion.

On the receipt of M. Friedel's report the syndicate decided that all cabochon or cut stones of this kind shall be sold as *artificial*, and not precious gems. Unless consignments are so marked the sales will be considered fraudulent, and the misdemeanor punishable under the penal code. All sales effected thus far, amounting to some 600,000 or 800,000 francs, shall be canceled, and the money and stones returned to their respective owners.

The action taken by the syndicate has fully settled the position which this production will take among gem dealers, and there is little reason to fear that the ruby will ever lose the place it has occupied for so many centuries.

* Abstract from an article on precious stones, in "Mineral Resources of the U. S.," Department of Interior, U. S. Geological Survey.

† Proc. Philad. Acad. Sc., Feb. 16, 1869, and May, 1876.

The Wax Paper Process.

BY J. EDWARDS GOWER.

In all photographic operations on paper the first care should be the selection of a suitable quality, and for the wax paper process it should be thin, have an even texture, and be free from spots and blemishes of any kind.

Having cut it to the required size, the first operation will be waxing the paper. To do this quickly take, say, ten pieces and float three of them, one at a time, on melted spermaceti, or if that be not at hand, on bleached beeswax. Do not use more heat than is absolutely necessary to melt the wax, or you will run the risk of turning the paper black in places. Float the sheets quickly, and let any excess drop off while the wax is still hot. When cool, lay one unwaxed piece on a sheet of white blotting paper; on the top of this lay a waxed one, and then on that two unwaxed ones, and soon until all are used. Now place another piece of blotting paper on the top, and then well rub both sides with a hot iron until the wax is evenly distributed through all the papers. If any one sheet has a superfluity of wax, it must be ironed separately between blotting paper.

The next operation is iodizing the paper. Make the following solution:

Potassium bromide	16 grs.
" iodide	60 "
Distilled water	5 ozs.

into which place the waxed sheets to soak for say two or even three hours. During that time they should now and again be separated and turned over, to remove air bubbles, etc. After being taken out and dried, they will keep any length of time, and can be sensitized, when required, on the following bath:

Silver nitrate	175 grs.
Glacial acetic acid	2 drs.
Distilled water	5 ozs.

Immerse the sheets one at a time, and when all are in, remove any air bubbles that may have formed, with a strip of glass. Keep the sheets moving during the immersion, in order that the sensitizing may be even. An easy method of doing this is to move the bottom sheet to the top about every minute, using a pair of non-metallic forceps. The time of immersion should be from five to ten minutes. The sensitized sheets must now be taken out, drained, and washed in several changes of water; after which they can be dried by gentle artificial heat, or between blotting paper, and are then ready for use. In a dry place they will keep well, but it is all the better to use them as soon as is convenient after sensitizing. As exposures run now, these papers will be voted awfully slow, and indeed they are almost useless for ordinary work. However, on a bright, still day, a landscape may be managed, and also architectural subjects, but, of course, portraiture is out of the question. There is, however, another use to which they may be put and with more chances of success, and that is printing from negatives by artificial light. To say what exposure will be required for this process is difficult, as density of negative, quality of light, and other things have to be considered. But given a negative of medium density, and holding the printing frame about 6 inches from a gas burner, the time of exposure should be about three or four minutes. When required, the frame may be held further from the source of light and a longer exposure given. This circumstance renders it more easy to practice the various "dodges" which are ofttimes necessary for successful printing. The next operation will be the development, and for this we require—

Saturated solution gallic acid	5 oz.
Acetic acid	2 drs.

Pour as much of the solution as is required into the developing dish, and add a few drops of a weak solution of silver nitrate. Two or three pictures may be developed at the same time, and the amateur must exercise his patience, as they take much longer to "come up" than a gelatine plate does. If the image is very slow in making its appearance, or refuses to appear at all, a few drops more silver solution may be added. The density can be easily judged of on account of the transparency of the waxed paper. When development is completed, the prints must be washed and then fixed in hypo. of the usual strength. After this comes the final washing, which must be thorough. If there has been any loss of transparency, it may be restored by passing the hot iron over the prints. These pictures backed with white paper or mounted on white cardboard possess a soft transparency peculiarly their own, and which is certainly not objectionable. If, however, the paper is only wanted for printing, the waxing may be omitted, and in that case the best writing paper may be used, the glaze of which prevents the image sinking too much into the body of the paper, which would result in a general fall off of quality in the finished picture. When using plain paper, the sheets will only require to be floated, and not immersed in the various solutions, as is necessary when it is waxed.

I think that experiments might be made with this process, with a view to seeing if the color of the prints can be varied by any of the toning baths now in general use, as it gives much more promise of producing permanent results than does albumenized paper. Amateurs may also pass pleasantly some of the long winter evenings by printing from some of their negatives by this process, and I think they will find the results quite presentable.

All the operations from sensitizing to fixing must be carried on by the light of a candle placed behind a screen of yellow or orange paper, which gives plenty of light, pleasant to work with.—*Amateur Photographer.*

Electrified Balsam.

Mr. C. V. Boys has described an interesting experiment he has made with some electrified gums and balsams. If sealing wax or any such sticky material is melted in a cup and put on the conductor of an electrical machine, it throws out threads and fibers which break into beads. The cup containing the gum should be inclined from the operator and the electrical machine before the latter is worked, else both will be covered by an invisible sticky web. Burnt India-rubber also sent out the filament; but Canada balsam appears to show the phenomenon best. When a candle flame is held near a cup throwing out such filaments, they shoot to the flame, and sometimes cover the candle, and sometimes discharge into the flame and turn back into the cup. In a few minutes a large quantity of these sticky threads can be made, and as they break into beads, Mr. Boys points out that this plan can be used to pulverize these substances, which are not easily pulverized in the ordinary way.

Fifty Millions' Worth of Diamonds.

The editor of the *Jewelers' Journal* asked a Maiden Lane dealer the other day to estimate the value of diamonds in New York City. In answer to the inquiry, the dealer answered, more than $50,000,000 worth. He stated further that "there are $15,000,000 to $20,000,000 worth constantly on sale by importers. Two of the largest firms are reputed to keep a stock of $1,500,000 each, and there are eight or nine other dealers with half that quantity, besides all the smaller concerns and the jewelers.