## VESSELS MADE FROM QUARTZ AND SOME OF THEIR USES.

BY PROF. JOHN TROWBRIDGE.

For many years silk fibers were used to suspend tiny collections of magnets in various forms of galvanometers. At one time this method of suspension had great practical importance, for galvanometers provided with such magnets, placed on minute mirrors, were universally employed in transmitting and receiving messages on submarine cables.

All testing work in laboratories also depended on this use of silk fibers, for the cobweb-like filament permitted the slightest movement of the magnet of the galvanometers. There was, however, always the difficulty of the torsion of the fiber, which resisted the free motion of the magnet while it was under the action of the electrical impulse, and also led to a permanent set or deviation of the magnet from the true position of rest after the electrical action had ceased.

Prof. Boys was the first to suggest the use of quartz fibers for delicate suspensions in the place of cobwebs or silk fibers. This suggestion has led to a remarkable improvement in electrical testing apparatus; and in all forms of physical instruments in which suspensions free from torsion are necessary. The method employed by Prof. Boys, and followed by others, is to fuse pieces of quartz in an oxyhydrogen blowpipe until a fairly large piece of amorphous silica is obtained. An arrow or dart is then made. One end of the dart is provided with a sharp iron point; this is the head of the arrow. A piece of elastic is attached to a board, the ends about three feet apart. A piece of the fused silica is tied to the blunt end of the arrow; another piece of this silica remains upon the operating table. The arrow is drawn back from the board a suitable distance. The two pieces of quartz are fused together in the blowpipe and the arrow is discharged, carrying with it an extremely fine thread of the fused silica.

These threads can be twisted many hundred times without showing torsion, and magnets suspended by them return absolutely to their position of rest. This amorphous silica has also another still more remarkable property, and the method of preparation has made it resemble a metal.

Some remarkable advances have been made lately in the employment of quartz for vessels capable of withstanding very high temperatures without cracking. It is well known that glass vessels must be annealed with the utmost care in order to resist sudden changes of temperature. A glass blower cannot put aside a piece of glass which he has heated without first tempering it in a smoky flame. Now vessels are made of quartz which can be heated to a white heat and while in this condition can be plunged into cold water without suffering the slightest injury.

The discovery of the new manipulation of quartz is due largely to Prof. Shenstone, of Bristol, England, and the method he employs is as follows:

Pebbles of Brazilian quartz are heated to a red heat or even higher in a muffle furnace. They are then thrown into a vessel containing distilled water. The cleanest and purest pieces are selected and welded by means of the oxyhydrogen blowpipe into long pieces like knitting needles. The quartz has now completely lost its crystalline character, and is not quartz, but amorphous silica. It has acquired the remarkable property of resisting extremely sudden changes of temperature, and vessels of any shape or size can be made from it. Time and money are the only considerations. Fig. 1 shows vessels of different sizes and shapes which I have obtained by this process. The photograph represents them half the original size. The needle-like pieces are also shown. The tubes are built up from these. In the test tube, for instance, which is represented in the photograph, a white-hot coal can be dropped without breaking it; it also can be heated to a white heat and then filled with cold water without cracking.

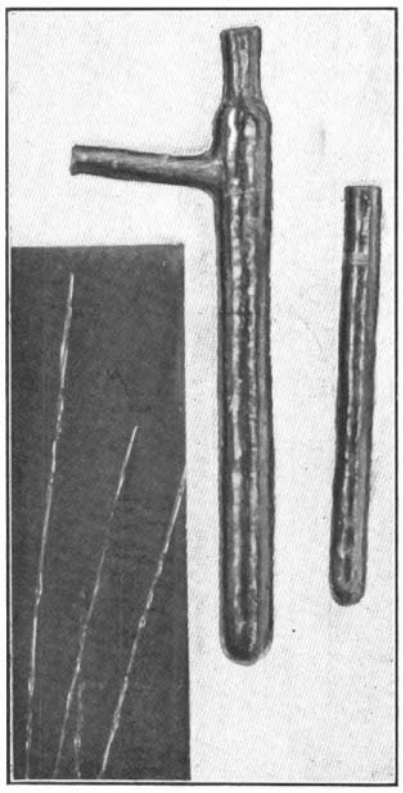


Fig. 1.—NEEDLE-LIKE PIECES OF AMORPHOUS SILICA, AND THE TUBES BUILT UP FROM THEM.

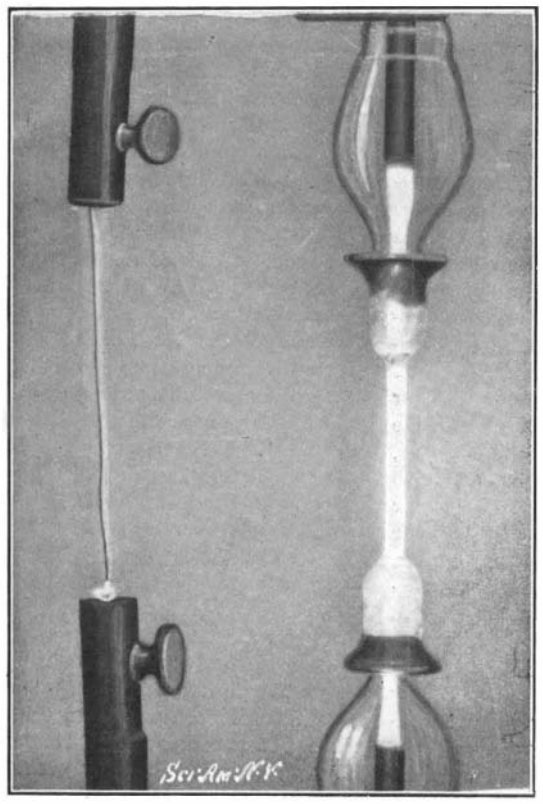


Fig. 2.—SPECTRUM TUBES MADE FROM AMORPHOUS SILICA.

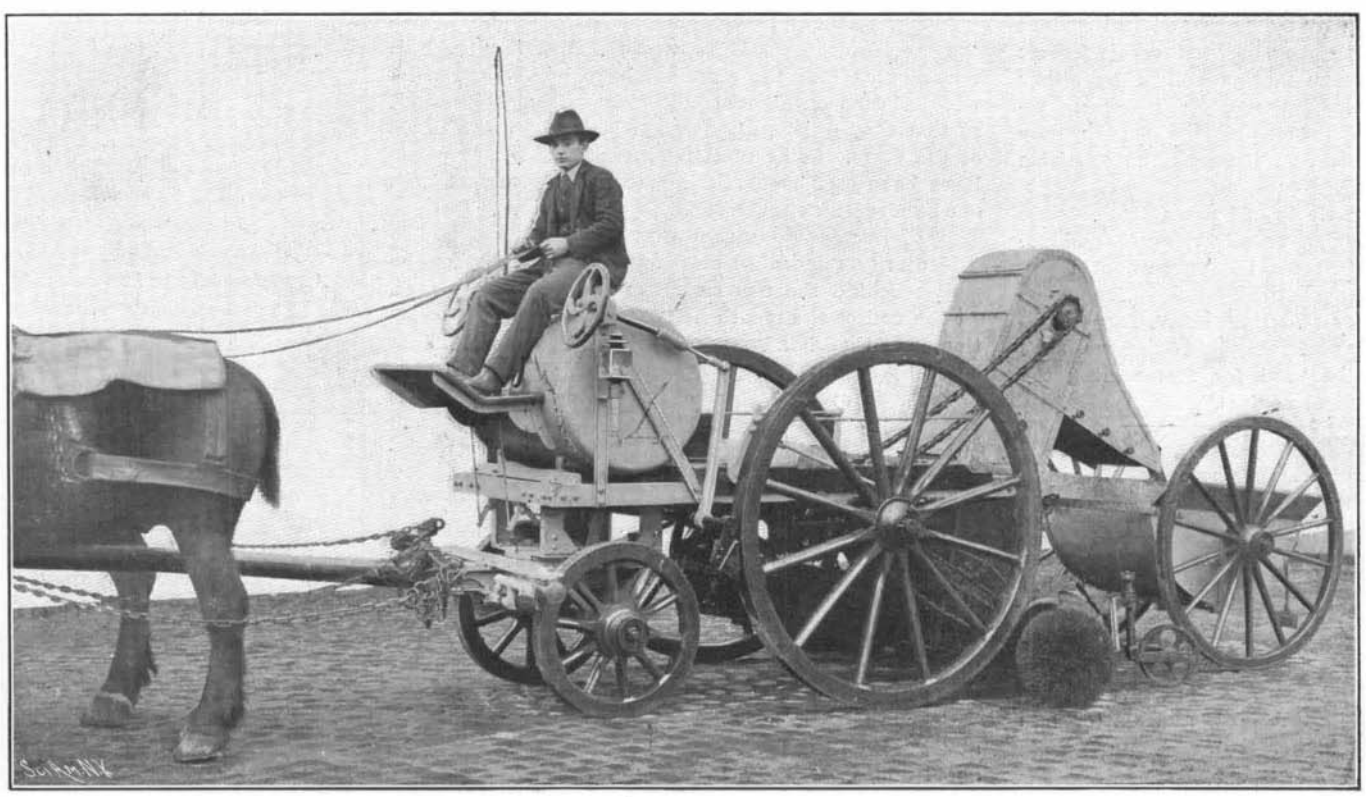
Fig. 2 shows spectrum tubes made for me from this amorphous silica. This tube was filled with hydrogen; a piece of iron wire No. 36 gage was placed in the same electric circuit. The quartz tube is illuminated by its own light, which is the most powerful artificial light which has ever been obtained. The duration of this light, in this case, was only one hundred-thousandth of a second. The iron wire is shown intact, although no trace of it could be found after the discharge. It took a comparatively long time to melt the wire, and this was accomplished when the light had entirely died out from the tube. These quartz tubes have proved of great importance in my work on hydrogen gas submitted to very high temperatures. Glass spectrum tubes speedily cracked or disintegrated under the powerful electrical discharges, but the quartz tubes withstood this high temperature without the slightest corrosion of the inner surfaces. By their use I have discovered new gaseous spectra which seem to me to be of great importance in regard to various speculations in regard to the changes going on in the sun and other heavenly bodies. When glass spectrum tubes are employed, various lines appear which some have attributed to the impurities coming from the glass. Most glass, for instance, contains the metal calcium; and two very strong calcium lines fall on the two most marked lines of the solar spectrum—the so-called great HH lines. When hydrogen is submitted to strong electrical discharges in glass tubes, two strong lines appear, which are also coincident with these great solar lines; and they have been therefore attributed to the calcium coming from the glass. The use of quartz tubes, however, shows that these lines are gaseous and that the gas is also contained in the earth's atmosphere. The lines may be due to hydrogen or to an unsuspected gas. I am now investigating this question.

The quartz tubes also allow the study of the invisible violet portion of the spectrum of hydrogen, for quartz permits the passage of rays which glass completely intercepts. A new region of gaseous lines is thus opened which has never before been brought to light. Under strong electrical discharges hydrogen shows dark lines as well as bright lines. These dark lines are due to a reversal on the photographic plate, and the phenomenon is of great importance in speculations on the nature of the changes which are occurring on the sun and in the variable stars.

## A MECHANICAL STREET CLEANER.

The disadvantages of all those methods of road cleaning which involve the direct removal of dry dust and refuse are so obvious that it is scarcely necessary to point to them. Of the innumerable microbes which are set floating through the air by the brush drawn over dry ground, quite an alarming number must be carried into the respiratory organs of animals and man, not to mention the multitude which in one way or another reach vulnerable points of the system, after being whirled into the air with the dust.

Various ways of avoiding these evils have been proposed and put to the test. One machine designed to effect this and also to clean the road, was exhibited in the Public Health section of the recent Düsseldorf exhibition. The plan adopted is to sprinkle the road before the brush is sent over it, and to collect automatically the mud gathered by the brush. We reproduce a view of this machine, which will help to make clear its construction. The machine, which is called the "Salus" street cleaner, is mounted upon two pairs of large wheels and a pair of small wheels in the front truck. Above this latter is lodged a water tank of about 200 gallons capacity, and on this again is fixed the driver's seat. Within easy reach of the driver is a tap which controls the flow of water to the sprinkler, and a wheel, by turning which he can at will raise or lower the broom. This latter consists of two stiff portions at the sides, connected in the middle of a flexible piece, which is kept curved, with its convexity toward the back. A combination of gear wheels and sprocket chains transmits the rotation of the axle of the center pair of carriage wheels to the broom. Owing to the curved form of the broom the mud is driven in toward the middle, collecting there upon a platform, which grazes the ground just in front of the brush, until it is forced along by a scraper. The action of this scraper is such as to rake the mud periodically upon the platform toward a bucket chain, which is also driven from the middle carriage axle. This chain lifts the mud and



AN HYGIENIC STREET-SWEEPING MACHINE.