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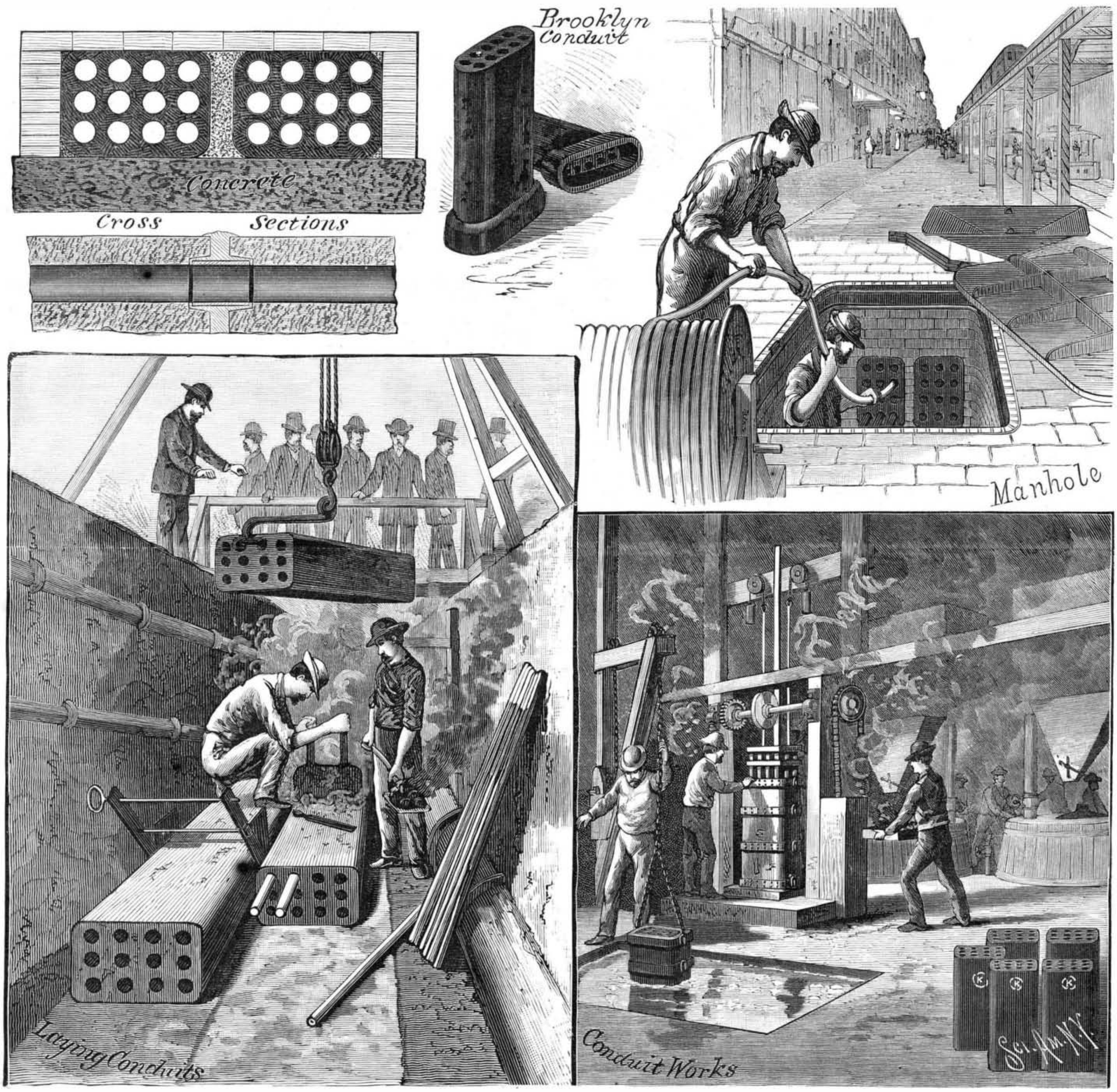
THE ELECTRIC SUBWAY CONDUIT IN NEW YORK.

Nearly a year and a half have passed since the subway commissioners were appointed, under a special act of the Legislature, to supervise the burying of the telegraph lines in this city. To do this work intelligently, a special study of the subject was required, together with a comparison of the different methods proposed by inventors. As the telegraph companies had done nothing to further the objects of the commission, a subway company was formed. This company, receiving its franchise from the commissioners, is now engaged in laying the conduit.

The material of which it is composed is a mixture of three to four parts of coal-tar pitch to one of sand. This is moulded into prismoidal blocks, three feet long, each block containing twelve longitudinal apertures, 2½ inches in diameter. Each of these apertures can accommodate a cable containing one hundred telephone wires. Their manufacture is thus conducted: Sand is received at the factory and screened carefully. As fast as screened it is introduced into a long inclined cylinder, through which the products of combustion from a furnace pass on their way to the chimney. This cylinder, about eighteen inches in diameter and fourteen feet long, contains projecting pieces running lengthwise along its inner surface. These pieces are four inches wide and eighteen inches long, and, as the cylinder revolves, pick up and drop the sand, which emerges at its lower end quite hot and perfectly dry. Thence, by a chain and hopper elevator, it is carried up to a second floor, where it is placed in receptacles provided with steam coils, by which it is again heated. It is fed as fast as needed through spouts into mixing tanks on the lower floor. Melted pitch is fed in the same general way into the same vats, and the mixture is thoroughly stirred by rotary blades within them. The peculiarity of the process up to this point consists in the use of hot sand. About thirty per cent is present in the completed mixture. The blocks are formed in moulds from the hot material by ramming.

In addition to top and bottom plates, each mould consists of two parts, which are secured by lugs. When these two parts are joined, they form an open-ended prismoid. This is set up on end within the ramming apparatus, as shown in the cut. Twelve iron mandrels have first been projected upward from the base through the bottom plate, and are well oiled by swabs applied by hand. The mixture is introduced by boxes of the same outline as the blocks, and provided with removable bottoms. The filled box is placed over the open end, and its botton withdrawn, its contents falling into the mould. After six or eight inches have been filled, the rammer is set to work, and a rapid succession of

(*Continued on page* 228.)



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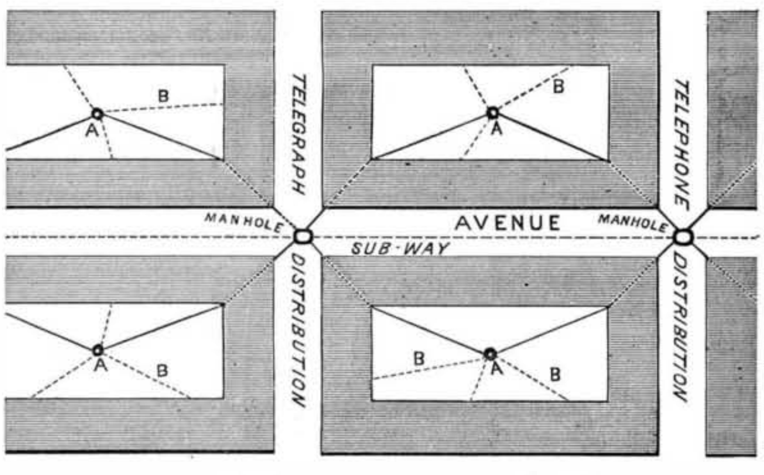
(*Continued from first page.*)

blows produced, until the sound shows that the mass is compact. Then more mixture is introduced, and more ramming given it, until the mould is filled. Owing to the ramming, it is very hard and compact. The mould and block, after being cooled by the application of water from a hose, is swung away and cooled completely in a tank of water, the outer casing is removed, and a finished block is the result. They are inspected by the commissioners' inspector, and, if approved, are stenciled.

Besides the blocks, short paper tubes, that fit into enlargements in the ends of the apertures, are supplied. They are used to complete the conduit at the joints. They are dipped into melted pitch before delivery. Their use is shown most distinctly in the longitudinal section of the conduit, where also the enlarged ends of the holes can also be seen.



A, Central Distributing Point. B, Distributing Lines.

PLAN OF DISTRIBUTION.

The conduit is laid in sections, every one of which is one block in length. Each section must be rigorously aligned, both as regards the vertical and horizontal planes. The grade must be perfectly uniform and true for this distance. It may vary from block to block, as may also the level. A trench is opened, and on its bottom a six inch bed of concrete is laid. This is made to conform accurately to the level or grade of the section, and by theodolite a straight line is drawn along its center. After it is sufficiently hard, the blocks are laid upon it in two longitudinal rows, breaking joints with each other. They are kept accurately in line, and are spaced apart by a template. Each block is laid thus: It is lowered into the trench, and placed in position about one inch from the preceding one. A hot plate of iron is held between the end faces of the two blocks until the ends are thoroughly hot. The paper tubes are next put into their seats, and long wooden mandrels are pushed through them and into the next block from the open end of the block that is being laid. The two segments are then pushed together until the paper tubes are seated. This brings them within an inch of each other, which interval is spanned by the twelve tubes and mandrels within them. Side or cheek pieces of iron are clamped on each side of the joint, and hot asphalt mixture is introduced, and worked in around the interstices by hot iron bars. The mandrels are withdrawn, and when the whole is perfectly filled and smoothed off, it is left to cool, the clamps not being removed for some time. When all is cold, the clamps are removed, and the longitudinal interval between the rows is filled with cement mortar, and a course of brick is laid over and around the two lines. Each block contains twelve holes, in three rows. In some sections the blocks are placed on their narrow edge; in others they are laid flat.

At each cross street is a large bricked manhole, in which one section ends and the next one commences. A double iron cover, one protective and the other arranged to lock fast, secure it when not in use. The cables are to be laid by means of these openings, being fed through by a machine, after they are started. The entire length of the openings, for a block at a time, is previously to be well oiled to reduce friction.

The impediments in the way of the engineers have been very great. Three separate gas companies have a number of mains lying in close proximity to the trench. The water mains and sewer culverts also impede operation greatly.

This much refers to the New York system. In Brooklyn the same material is employed, but the blocks have ten apertures only, of less diameter than in the New York conduit, and each block is provided with a bell or hub. These are laid like water or gas pipes, the paper tubes being dispensed with.

This much disposes of the question of the disposal of transit lines. The next problem is that of distribution to different houses and offices. The proposed method is shown in the accompanying plan. Each second manhole is to be devoted to the distribution of telephone lines, and the alternate ones to telegraph line connections. A main branch is tobe carried from the manhole to the interior of each block of houses. As near the center as may be is to be established either a single pole or a manhole. From this point individual lines are to be carried under or over ground to the different houses requiring them.

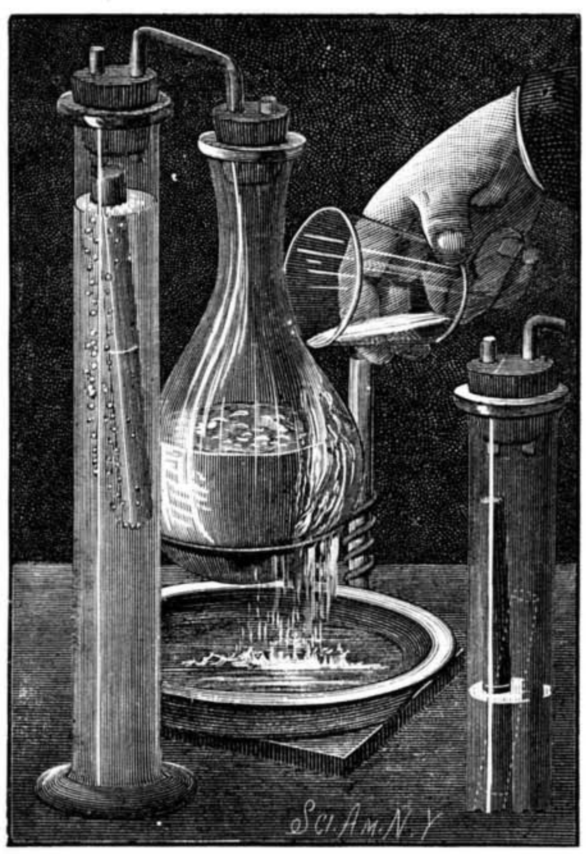
Such is the system now being introduced. Its principal characteristic is the absence of metal. Even the short joint tubes are of paper. While cheapness of construction is thus consulted, many good effects of metal are lost. The interior of the holes can hardly be as smooth as a good metallic pipe, and they will be more subject to deformation. A slow change of shape, such as sealing wax often will undergo, is among the possibilities. This, it is assumed, will be prevented by the large proportion of sand that is worked into the mixture. The anti-inductive effect of metal is lost. This will be provided for in each individual cable, it is to be presumed, in its lead casing. The objection made to metal pipes that they will decay cannot be regarded as well founded. A good cast iron pipe will last for a number of years as yet undetermined.

EXPERIMENTS IN PNEUMATICS WITH A STEAM VACUUM.

T. O'CONOR SLOANE, PH.D.

We have already shown how several representative air pump experiments can be performed with steam vacua. The interest attaching to this method of working in pneumatics is not confined to the mere simplification of apparatus, but each experiment serves still further to show how steam is really an invisible gas, returning to the liquid state on reduction of temperature. In engineering, this method of producing vacua sometimes operates disastrously. Boilers on vessels that have sunk suddenly have been known to collapse under its effects. Where a large space is to be exhausted, this method can often be adopted. In creosoting wood, the logs are run into large cylinders and treated with steam. If the steam is allowed to condense, a vacuum is formed, and any air contained in the pores of the wood is expelled. Then, on admitting the creosoting solution, it is eagerly imbibed by the wood, the capillary action being seconded by the atmospheric pressure. The experiment shown in the cut is an illustration of such a process. In practice on the industrial scale air pumps are often employed, but it is quite possible to dispense with them.

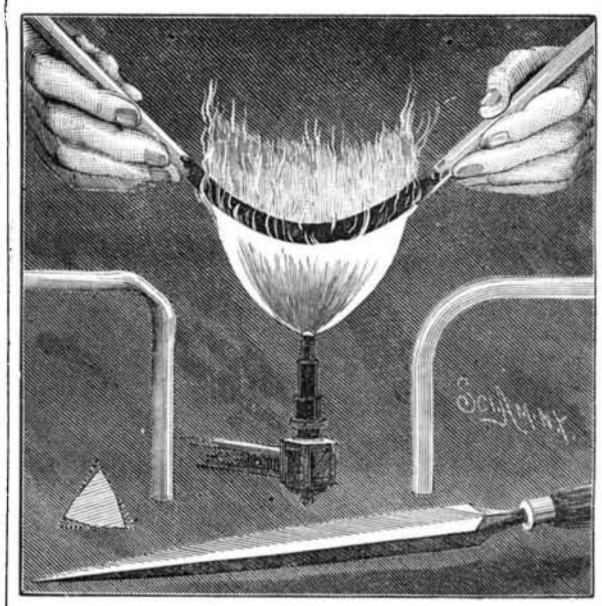
The boiling flask is arranged in connection with a tall vessel. Any bottle will answer, but such a cylinder as shown is convenient. A piece of wood is floated in it when it is partially filled with water, and the line to which it sinks is marked upon it. The cylinder is then filled as full as possible, corked, and the steam



AIR IN PORES OF WOOD.

vacuum produced as before described. After the flask has boiled some minutes and the plug has been replaced, it may be cooled by having water poured over it as shown. The air contained in the pores of the wood immediately begins to expand, and escapes in innumerable bubbles. This continues for a long time. The amount that can be thus withdrawn seems to have no limit. It must be remembered in this connection that the bubbles afford no real measurement of the air given off, referred to ordinary conditions, as the low pressure expands the air to ten or fifteen times its volume. If we imagine, therefore, that fifteen of the bubbles are compressed into one, we shall have some idea of the actual volume of air expelled, if measured at atmospheric temperatures.

After five or ten minutes have elapsed the plug may be withdrawn, when the sudden cessation of the effervescence and the shrinking out of sight of the bubbles will be quite striking. The cylinder is uncorked, some of the water poured out, and the floating of the stick is observed. It will be found to sink deeper in the water, perhaps half an inch below the original line. This is shown to one side of the cut, the stick as it floats after the process being indicated by dotted lines.



MANIPULATION OF GLASS TUBES.

In performing a series of these experiments, it will be found very tiresome to hold the flask over the lamp. An extemporized ring stand is shown that will save this labor. A piece of strong wire is bent at one end into a ring of size adapted to receive the flask, and at the other end it is wound into an even spiral. A piece of board, about six inches square, has a hole bored in one of its corners or near the center of one of its sides. This receives an upright piece that the spiral fits closely around. By pushing the wire up or down on the upright standard the level can be adjusted. Even if the spiral fits loosely, the weight of the flask will tend to make it bind upon the upright rod. The best plan would be, after its level is adjusted, to secure it by a tack. The mode of connection by a bent tube with no rubber joints is far the best to use in these experiments.

A word on the manipulation of glass tubing will not be out of place here. To cut it into short pieces, a file is as good as anything. Glass knives, made of Wootz steel, are also very efficient. These are so brittle that the edge keeps flaking off, thus keeping always in cutting condition. To cut a tube, a small scratch is given it across one side of it at right angles to its axis. No deep notch is required. Then it is taken in the hands, one on each side of the scratch, with the thumbs underneath the glass, and about an inch from each other. Both hands are now drawn apart, and at the same time a slight bending stress produced, the ends of the tube being drawn against the thumbs and toward the body. The tube thus treated breaks off square where the file has scratched it. The point is not to attempt to break the tube as if it were a piece of wood, but to combine a strong pull with a slight transverse strain.

By the file, or by holding the end in an alcohol lamp flame, the sharp cutting edge can be removed.

A file soon becomes dull when thus used, but it can, by sharpening, be made to last a long time. The sharpening is done on a grindstone on each edge on one side only. Thus each corner is smooth on one side and has file cuts on the other. The process is illustrated in the cut, a file that has been thus treated being shown in section and in general view.

A convenient way of bending tubes is also shown. The tube is held in an ordinary gas flame, near its upper part, its length coinciding with the long axis of the flame. The tube is continually rotated. The flame soon coats it with lamp black. After a few minutes it begins to soften. As soon as it yields easily it can be slowly bent as desired, without being removed from the flame, the outer and inner sides of the bend being alternately exposed to the flame. On the right of the cut a good bend is shown, on the left a bad one, such as should be always rejected.

In pushing glass tubes through corks, care must be exercised to avoid injury. The pressure should always bear upon a straight part of the tube. If any force is required, the tube should be surrounded by a towel. Sometimes the hand is badly injured by tubes breaking and lacerating it while being pushed through corks.