tubes that connects the two pumps, the Geissler tube, and the lamp bulbs. The connecting tube, *g*, extends over the scale, *f*, parallel to and near the gauge tube, *f′*.

To produce a vacuum in the bulbs, G, the pinch-cock on the rubber pipe, *a*, is opened so as to permit a rapid succession of drops, or a full stream of mercury to flow down the internal tube of the Sprengel pump, B. This stream of mercury, falling through the space between the internal tube and the lower end of the bulb, enters the long tube of the pump, and carries with it a certain quantity of air, which is discharged together with the mercury into the cup at the bottom. As this process is too slow for creating a vacuum from the beginning, while the Sprengel pump is still working, the Geissler pump, A, is brought into use for removing the greater portion of the air. To operate this pump, the stopcock, *c*, is first closed, the reservoir of mercury—connected with the pump by a rubber tube—is raised by the attendant, as represented in the cut, until mercury flows up the long pump tube, and filling the bulb, drives out the air before it through the discharge tube, and finally overflows through the tube, *d*, into the cup at the lower end of the tube. The mercury reservoir is then lowered until the two vertical columns of mercury break in the bend of the discharge tube, and the mercury in the pump is below the stopcock, *c*, the latter is then opened, and the mercury reservoir is lowered until the mercury in the pump will sink no farther. The stopcock, *c*, is then closed and the operation is repeated two or three times. The Sprengel pump, which has been in operation meanwhile, is now permitted to finish the work. As the vacuum becomes more and more perfect the mercury rises in the pump, and when the drops strike the mercury column, a sharp metallic clink is heard, indicating that the atmospheric resistance to the falling metal is little or nothing. As fast as the mercury accumulates in sufficient quantities in the reservoir below, it is poured into the reservoir above.

Electric sparks from an induction coil are continually

Fig. 2.

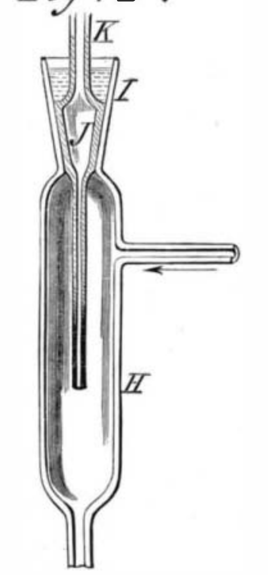

Fig. 3.

passed through the Geissler tube, D, as long as the vacuum is low enough to admit of it. Mr. Edison says that when a 9 inch spark fails to pass the ⅛ inch space between the electrodes in the tube the vacuum is still coarse.

The McLeod gauge is relied on mainly for testing the perfection of the vacuum. This gauge is operated by simply raising the mercury reservoir connected with it until the gauge bulb is sealed off from the other parts of the apparatus, the mercury, as it rises, closing the connecting tube, *g*. The mercury reservoir is then raised still further, until the mercury will go no higher in the gauge tube, *f′*. Should the mercury rise to the end of the gauge tube it would indicate a perfect vacuum, but this is never attained. The quantity of air contained in the tube, *f′*, indicates exactly the proportion of the air in the apparatus to the capacity of the apparatus or air at its normal density. Another method of calculating the value of the vacuum is based upon the difference in the level of mercury in the two tubes in front of the scale, *f*.

Mr. Edison informs us that the vacuum in his lamps is so nearly perfect that only a millionth of the original volume of air remains.

It is obvious that the Sprengel and Geissler pumps must be longer than a barometer, to obtain the full effect of the falling column of mercury. All of the rigid parts of this apparatus are made of glass; and wherever there is a joint or a stop cock, it is sealed with mercury. Figure 2 shows the upper portion of the Sprengel pump in detail, and also gives a good idea of the manner of sealing the joints. The bulb, H, has a conical mouth, I, into which is fitted and ground the enlarged portion, J, of the mercury tube, K. The space in the mouth, I, above the enlarged part of the tube, K, is filled with mercury.

Figure 3 represents a mercury-sealed stop cock, L being the stop cock, entirely surrounded by mercury contained in the cup, M.

The lamp bulbs, G, are connected with the apparatus by a joint similar to that represented in figure 2. From time to time, while the air is being exhausted from the lamps, they are tested by connection with wires from the electrical generator. When the vacuum is practically complete, the tubes connecting the lamps with the vacuum apparatus are heated by a spirit lamp, sealed and separated from each other and from the apparatus.

LABORATORY APPARATUS.

The laboratory apparatus designed and patented by Thomas Fletcher, F.C.S., of Warrington, England, has been long and favorably known in Europe, and has recently been largely introduced in this country by the Buffalo Dental Manufacturing Company, of 307 and 309 Main street, Buffalo, N. Y., who have made arrangements with Mr. Fletcher to manufacture all of his specialties.

The apparatus, consisting of hot and cold blast blowpipes, blowing apparatus, gas furnaces with and without blast, ingot moulds, and a great variety of other articles, is designed for colleges, academies, schools, chemists, assayists, manufacturing jewelers, dentists, artisans, and experimenters.

We have chosen a few of the leading articles for illustration and description.

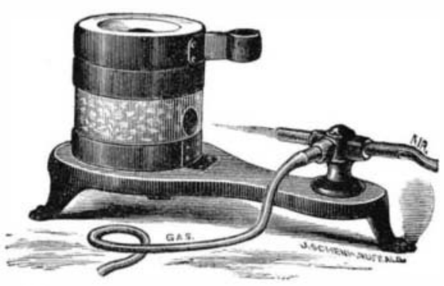

Fig. 1.—FLETCHER'S NEW CRUCIBLE FURNACE.

Fig. 1 shows a new crucible furnace, consisting of a simple pot—for holding the crucible—with a lid, and a blowpipe, all mounted on a suitable cast iron base. As compared with the ordinary gas furnace it appears almost a toy, owing to its great simplicity.

The casing, which consists of a new material discovered by Mr. Fletcher, holds the heat so perfectly that the most refractory substances can be fused with ease, using a common foot blower. Half a pound of cast iron requires from seven to twelve minutes for perfect fusion, the time depending on the gas supply and pressure of air from the blower.

The power which can be obtained is far beyond what is required for most purposes, and is limited only by the fusibility of the crucible and casing. A suitable crucible will hold about ten ounces of gold.

An ordinary gas supply pipe, five sixteenths or three eighths will work it efficiently. It is said to require a smaller supply of gas than any other furnace known. About ten cubic feet per hour is sufficient for most purposes.

Any common blowpipe bellows will work the furnace satisfactorily except for very high temperatures (fusion of steel, etc.), for which a heavy pressure of air is necessary.

The furnace shown in Fig. 2 will take crucibles up to four by three and a half inches, and with half inch gas pipe, giving a supply of about thirty feet per hour, will melt three or four pounds of brass in about twenty-five minutes, and the same quantity of cast iron in about fifty minutes from the time the gas is first lighted, without the slightest trouble or attention. It will melt a crucible full of silver or gold in twenty-five minutes. The crucible will hold and melt about six pounds when quite full. It is made in a very substantial manner, and is recommended

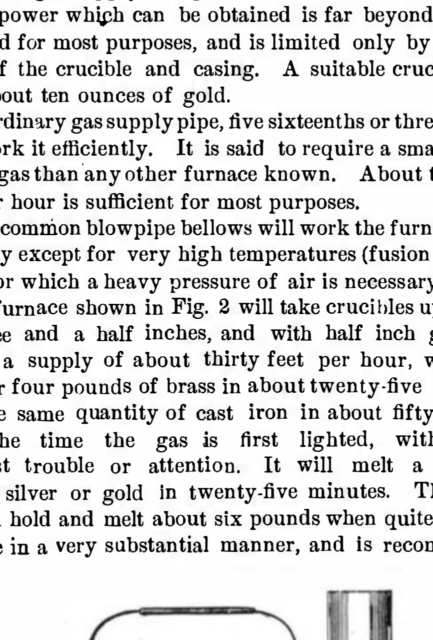

Fig. 2.—LARGE CRUCIBLE FURNACE.

as a first-rate furnace for manufacturing jewelers, reducing photo. waste, etc. In using this pattern of furnace, the narrow end of the plumbago cylinder which surrounds the crucible is always put downward. The use of this cylinder is to keep the flame in contact with the crucible up to the top. The flame is then deflected by striking against the lid, and, turning downward, leaves the furnace by the chimney, at the lower side.

The lid never gets very hot, and can be lifted away by the handle across the top; it is now made of the patent non-conducting material, in one piece, with an opening in the center for convenience in examining work. This pattern of furnace requires no blast.

The furnace shown in Fig. 3 takes crucibles up to two and a half by two and a quarter inches outside. This pattern is more especially designed for gold, silver, copper, etc., and, as sent out, with four foot chimney and single lid, E, is amply powerful. If required for temperature up to the fusing point of cast iron, it requires a chimney six feet high.

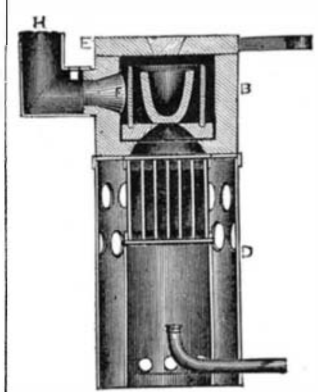

FIG. 3.—Small Crucible Furnace.

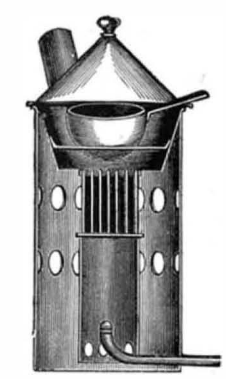

FIG. 4.—Ladle Furnace.

The ladle furnace represented in Fig. 4 takes ladles up to six and a half inches diameter, and will melt six or eight pounds of zinc in about fifteen minutes, or the same quantity lead, tin, etc., in half the time. It is a convenient and powerful arrangement for dentists, heating soldering irons, etc.

Fig. 5 shows a simple, compact, and powerful blower. The step for the foot is very low, and enables the blower to be used with ease whether the operator is standing or seated. The pressure is steady and equal. If the rubber disk is distended until forced against the net, the pressure can be increased to almost any extent desired. It will give, if required, a heavy and continuous blast through a pipe of one quarter inch clear bore.

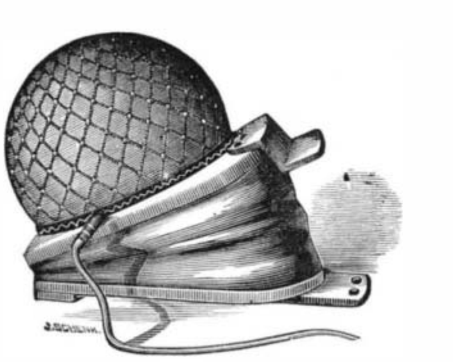

Fig. 5.—FOOT BLOWER.

These compact and well designed pieces of apparatus supply a want long felt by our artisans and experimenters, and will undoubtedly meet with the success they merit.

The Buffalo Dental Manufacturing Company supply an illustrated catalogue giving descriptions of many other pieces of apparatus of this character.

Starch Photo. Process.

In consequence of the remarkable results obtained by gelatine and silver bromide, experimentalists have been induced to try starch and gum emulsions, and the latest contribution to this branch of photography is a formula for a starch emulsion by Senors Pauli and Ferran, of Barcelona. Take four grammes of potato starch and mix to a creamy consistency with twenty grammes of water; then add slowly eighty c.c. of boiling water, and, while the fluid is still hot, 1·12 grammes of bromide of potassium and 1·62 grammes of silver nitrate dissolved in twenty c.c. of water. It is recommended to add a little gelatine to the starch, in order to lessen the solubility.