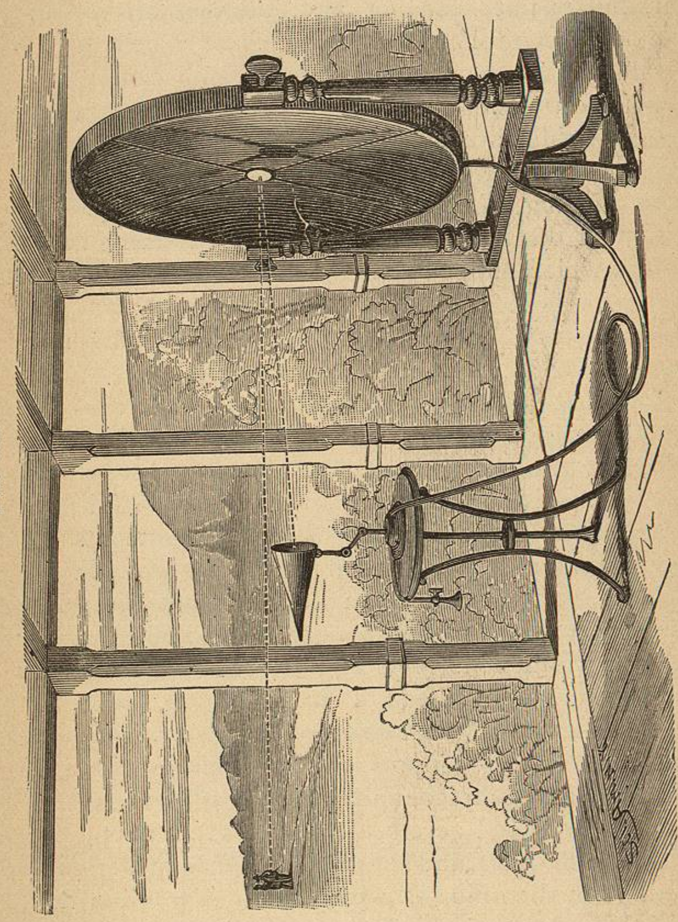
trumpet toward the small plane mirror, and moving the sound reflector until the source of sound is seen in the mirror. The reflector is then focused by exhausting the air from behind the flexible head until the required degree of

Fig. 162.

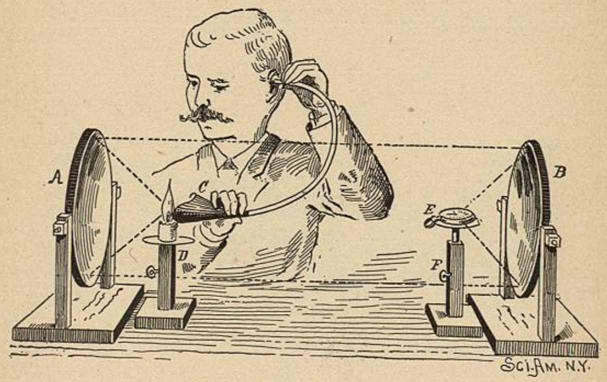


Adjustable Sound Reflector.

concavity is reached, which will be when sounds are distinctly heard in the ear trumpet. The air is readily exhausted from the reflector by applying the mouth to the mouthpiece. The details of the construction of the apparatus are shown in the engraving.

Of course, the operation of the instrument may be reversed—that is, sounds made at the focus of the reflector may be projected in parallel lines over long distances, but in practice a speaking trumpet is found to be better for this purpose. The engraving shows but one of the applications of the reflector. It would be a simple matter to provide for a deaf person an instrument on this principle. It could hang on the walls of the parlor unnoticed, as it might take the form of a richly framed picture, and would concentrate a great volume of sound at a single point. The same device

Fig. 163.



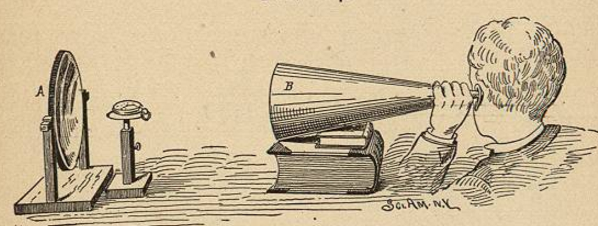
Reflection of Light and Sound.

may also be applied to an auditorium to project the voice of the speaker in any required direction.

To concentrate and project light, heat, and sound by means of concave mirrors is generally supposed to necessitate the use of expensive parabolic mirrors, articles practically out of the reach of amateur experimenters, and not to be found in every institution of learning. To perform most of the experiments possible with concave mirrors, the spun metal reflectors used in large lamps answer exceedingly well. The projection of images and the accurate determination of the foci are the only experiments impossible with such reflectors. The largest size to be found ready made is 10 inches in diameter, with a principal focus of about 8 or 9 inches. The price is $1.50 per pair. To prepare them for use, two common wood screws are secured to them at diametrically opposite points, the heads of the screws being soldered to the edges of the mirrors, so that the screws project radially. Each mirror is provided with a stand formed of a base and two uprights. The wood screws project through the uprights, and are provided with wooden nuts.

To facilitate the experiments to be performed with the concave mirrors, two or three small stands are required. It is desirable that these stands be made adjustable. If nothing is at hand that will answer the purpose, a very good adjustable stand may be made by soldering a disk of tin to the head of a 4 inch wood screw, and inserting the screw in

FIG. 164.



Reflection and Concentration of Sound.

a short column, as shown in the engraving. A paper trumpet, 8 inches in diameter at the larger end and 2 feet in length, is useful, and a rubber tube having a small funnel at one end and an ear piece at the other end is necessary.

To show the concentrating power of one of these common reflectors, place it so that its concave surface faces the sun. Then place a piece of dark-colored cloth in the focus. It is at once ignited.

Place two reflectors, A B, 4 or 5 feet apart, with their concave surfaces facing each other, as shown in Fig. 163. Place a short candle on the stand, D, so as to reflect a parallel beam that will cover the reflector, B, as nearly as possible. Then place a watch, E, in the focus of the reflector, B, upon the stand, F. Now hold the funnel, C, with its mouth facing the reflector, A, and immediately behind the candle, or,

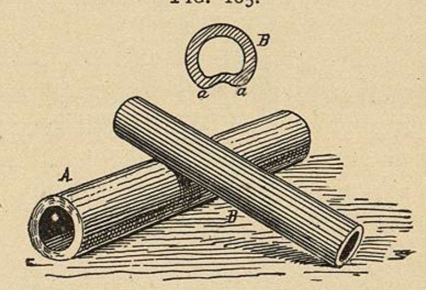
better, remove the candle and place the funnel in the position formerly occupied by the candle flame. With the funnel at this point the ticking of the watch will be distinctly heard, but a slight movement of the funnel in either direction will render the ticking inaudible. This experiment shows that the laws governing the reflection of light and sound are the same.

In Fig. 164 the use of the trumpet in connection with a concave reflector is illustrated. The reflector, A, is adjusted to the trumpet, B, by means of the light of a candle placed on the stand in the focus of the reflector. Afterward the candle is replaced by the watch. With this arrangement the watch may be heard twenty or thirty feet away.

TREVELYAN ROCKER.

This apparatus consists of a short piece, A, of lead pipe, about an inch in diameter, and a piece, B, of thick brass tubing, about $\frac{3}{4}$ inch outside diameter and five or six inches long. The lead pipe is flattened a little to keep it from rolling, and the surface along the side which is to be upper-

FIG. 165.



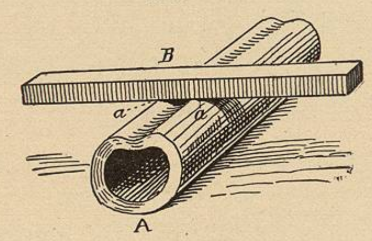
Trevelyan Rocker.

most is scraped and smoothed. The brass tubing, B, is filed thin, upon one side, near one end, and the thin part is driven in with the pein of a hammer or a punch so as to leave the longitudinal ridges, *a a*, as shown in the end view in Fig. 165.

When the brass tube is heated and placed across the lead pipe, as shown in Fig. 165, with the ridges, *a a*, in contact with the lead pipe, the brass tube begins to rock, invisibly, of course, but with sufficient energy to give forth a clear musical note. If it does not start of itself, a little jarring will set it going, and it will continue to give forth its sound for some time.

The accepted explanation of this phenomenon is that the contact of the hot brass with the lead causes the lead to suddenly expand and project a microscopic distance upward. These upward projections of the lead alternate between the

Fig. 166.



Rocking Bar.

two points of contact, and thus cause the tube to rock with great rapidity and regularity.

In Fig. 166 is shown a modification of the experiment, in which the lead is indented to form the two contact surfaces, *a a*, and the heated bar, B, is made to rock at a comparatively slow rate, giving forth a grave note. By careful manipulation, the bar may be made to rock both longitudinally and laterally, thus giving forth a rhythmic combination of the two sounds.

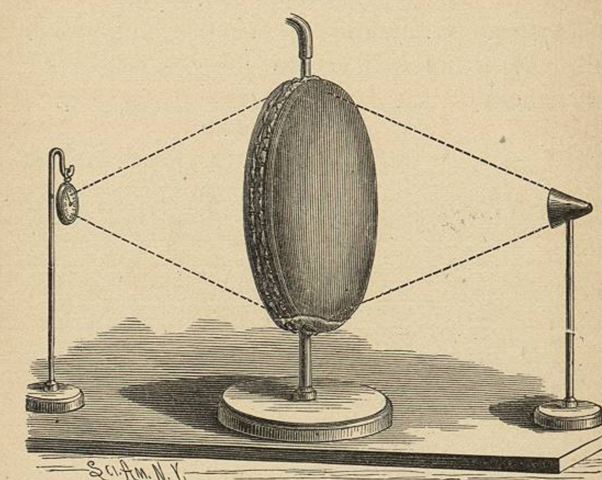
REFRACTION OF SOUND.

In Figs. 167 and 168 is illustrated an adjustable lens for showing the refraction of sound. The frame of the lens consists of three 12 inch rings of large wire, soldered together so as to form a single wide ring with two circumferential grooves. In the central part of the ring, at the bottom, is inserted a standard, and in the top is inserted a short metal tube. Over the edges of the ring are stretched disks of the thinnest elastic rubber, which are secured by a stout

thread wound around the edges of the rubber, clamping them in the grooves of the ring.

By inflating the lens through the tube with carbonic acid

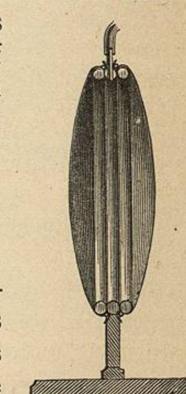
Fig. 167.



Sound Lens.

gas, it may be focused as desired. A watch placed at the focus upon one side of the lens can be distinctly heard at the focal point on the opposite side of the lens, when it can be heard only faintly or not at all at points only slightly removed from the focus, thus showing that the sound of the ticking of the watch has been refracted by the lens in much the same manner as light is refracted by a glass lens.

Fig. 168.

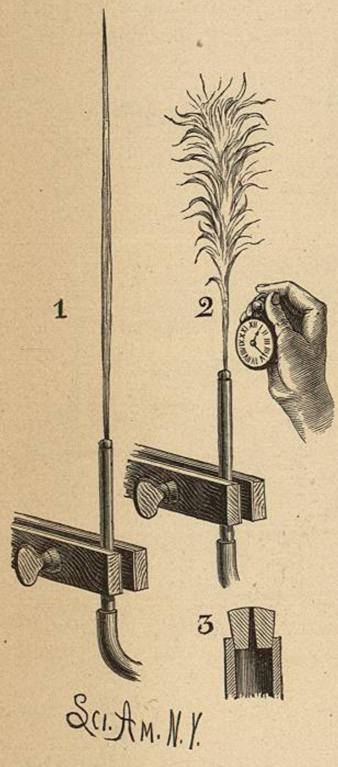


Section of Sound Lens.

SENSITIVE FLAMES.

The sensitive flame, first observed by Dr. Le Conte and afterward developed by Tyndall and Barrett, exhibits some of the curious effects of sound. For its production it is necessary that the gas be under a pressure equal to that of a column of water six or eight inches high. The common method of securing the required pressure is to take the gas from a cylinder of compressed illuminating gas, such as is used for calcium lights. Another method is to take the gas from a weighted gas bag, and still another is to fill a sheet metal tank with gas and displace it with water in the manner illustrated in Fig. 170. The burner is shown at 1, 2, and 3, Fig. 169. It consists of a small tip inserted in the end of a suitable tube. The tip in the present case is made of brass, but those commonly used for this purpose are of steatite. They are superior to the metal ones, but require careful selection.

Fig. 169.



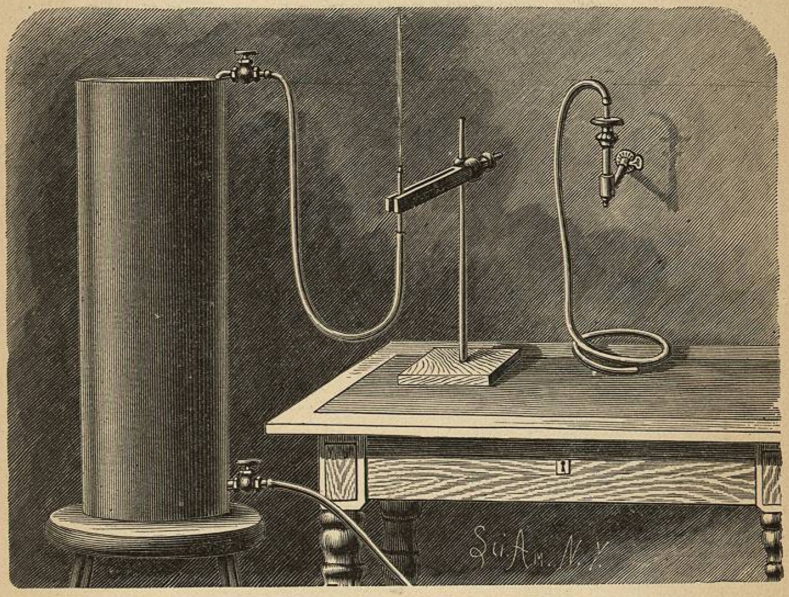
Burner for Sensitive Flame.

It has been found that some of the lava pinhole burner tips used in certain kinds of gas stoves answer admirably for this purpose, and cost very little. A tip with a round, smooth hole is to be selected. The bore of the tip is here shown tapering. Its smaller diameter is 0·035 inch. The burner is supported in the manner shown at 1 and 2, or in any other convenient manner, and gas under a suitable pressure flows through and is ignited. The flame will be tall and slender, as shown at 1. By regulating the gas pressure carefully, an adjustment will be reached at which the flame will be on the verge of flaring. A very slight increase of pressure beyond this point will cause the flame to shorten and roar. When the flame is at the point of flaring, it is extremely sensitive to certain sounds, particularly those of high pitch. A shrill whistle or a hiss will cause it to flare. The rattle of a bunch of keys will produce the

same result. It will respond to every tick of a watch held near it.

Tyndall says that when the gas pressure is increased beyond a certain limit, vibrations are set up in the gas jet by the friction of the gas in the orifice of the burner. These vibrations cause the flame to quiver and shorten. When the flame burns steadily, any sound to which the gas jet will respond will throw it into sympathetic vibration. Experi-

Fig. 170.



Apparatus for producing Gas Pressure for the Sensitive Flame.

ment has demonstrated that the seat of sensitiveness of the flame is at the base of the flame, at the orifice of the burner.

The method of producing the required gas pressure illustrated in Fig. 170 is available when gas bags or cylinders of compressed gas are not to be had. A tin cylinder of about 15 gallons capacity is provided at the top and bottom with valves. The lower valve is connected with a hydrant, and the cylinder is filled with water, while the upper valve is left open to allow of the escape of air. When the cylin-