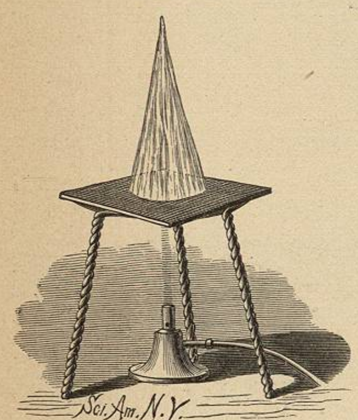
der is filled with water, the supply is shut off and a tube from a gas burner is connected with the upper valve and the gas is turned on. Then the water is allowed to escape from the cylinder, thereby drawing in the gas. When the cylinder is filled with gas, the valves are closed and the lower one is again connected with the hydrant, while the upper one is connected with the pinhole burner. The valves on the cylinder are again opened and water is admitted at the rate required to produce the desired gas pressure. Only two precautions are necessary in this experiment; one is to avoid a mixture of air and gas in the cylinder by driving out all the air, the other is to avoid the straining of the cylinder by water pressure.

Fig. 171.

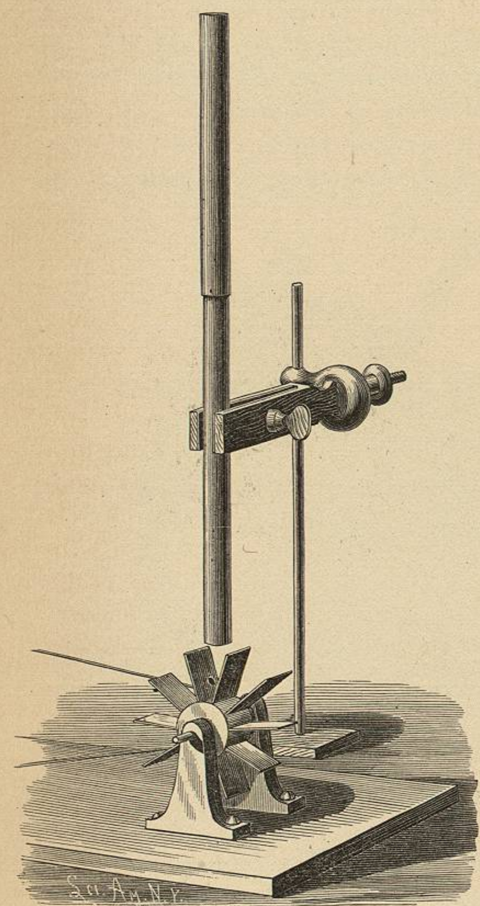


Sensitive Flame with Gas at Ordinary Pressure.

Another sensitive flame, which has several advantages over the one described, is shown in Fig. 171. It requires no extra gas pressure, and it is more readily controlled than the tall jet. It was discovered by Mr. Philip Barry, and the discoverer's letter to Mr. Tyndall concerning it is found in Tyndall's work on sound. In the production of this flame a pinhole burner, like that already described, is employed. Two inches above the burner is supported a piece of 32-mesh wire gauze, about 6 inches square. The gas is turned on and lit above the wire gauze. It burns in a conical flame, which is yellow at the top and blue at the base. When the gas pressure is strong, the flame roars continuously. When the gas is turned off, so as to stop the roaring altogether, the flame burns steadily and exhibits no more sensitiveness than an ordinary flame. By turning on the gas slowly and steadily, a critical point will be reached at which any hissing noise will cause it to roar and become non-luminous. Any degree of sensitiveness may be attained by careful adjust-

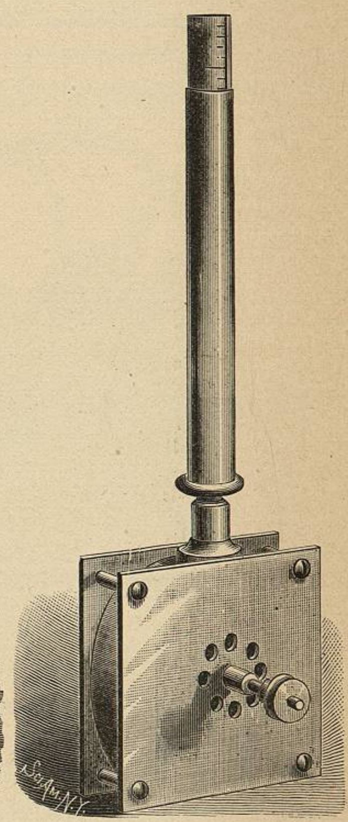
ment of the gas supply. A quiet room is required for this experiment. The rustle of clothes, the ticking of a clock, a whisper, a snap of the finger, the dropping of a pencil, or in

Fig. 172.



Determining Speed by Resonance.

Fig. 173.



Siren for Measuring Velocities.

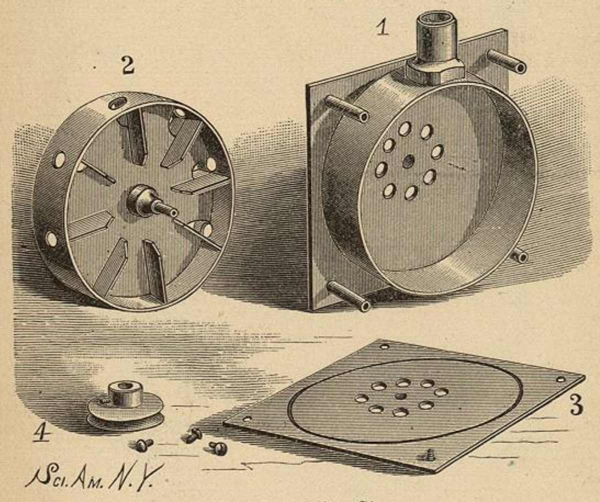
fact almost any noise, will cause it to drop, become non-luminous, and roar. It dances perfect time to a tune whistled *staccato* and not too rapidly.

The flame at its base presents a large surface to the air, so that any disturbance of the air sets the flame in active vibration.

A SIREN FOR MEASURING VELOCITIES.

In this instrument advantage is taken of the well known fact that for every tone a resonator may be provided that will respond to and re-enforce the vibrations producing that tone. The length of a closed resonant tube is one-fourth that of the sound wave to which it responds. The length of an open resonant tube is one-half that of the sound wave to which it responds. It is obvious that a telescopic tube

FIG. 174.



Details of the Siren.

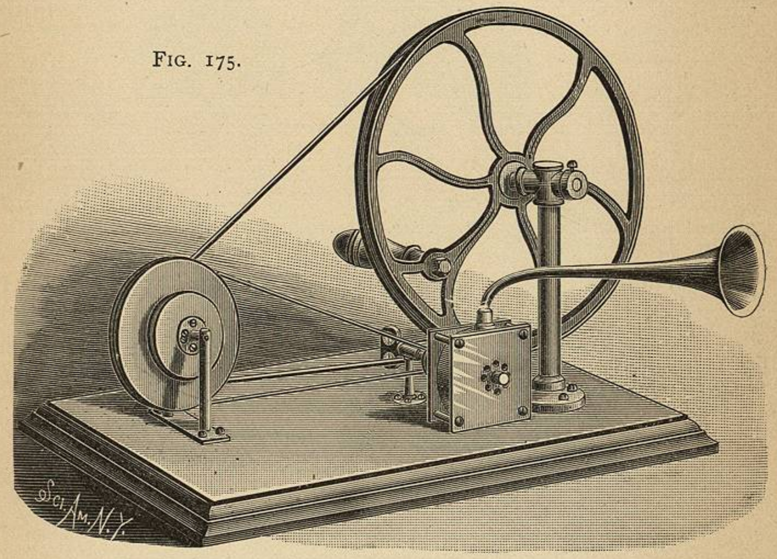
may be adjusted to respond to different pitches. Knowing the number of vibrations required per second to produce a certain pitch, it is comparatively an easy matter to determine the rate of any series of regular air vibrations by adjusting the tube to such a length as to cause it to respond to the vibrations.

In Fig. 172 is shown a resonant tube supported over a small fan wheel. The fan has ten blades, so that during one revolution it sends ten puffs of air up the tube. By gradually increasing the velocity of the fan a speed will be reached

at which the tube yields a low but distinct musical tone. If, for example, this tone corresponds to middle *c*, it is known that 261 puffs of air are made in the tube, and that since there are ten blades to the fans, the number of revolutions of the fan shaft must be $261 \div 10 = 26{\cdot}1$ per second, or 1,566 revolutions per minute.

In Fig. 173 is illustrated a siren constructed on this principle. The parts of this instrument are shown in detail in Fig. 174. It consists of a circular casing containing a rotary fan which draws in air at the center and discharges it

FIG. 175.



Centrifugal Siren.

through an opening in the top of the casing. The blades of the fan are arranged radially upon opposite sides of the disk, and the fan is encircled by a perforated rim, which fits the circular casing and acts as a valve in controlling the escape of air. The perforations of the rim correspond in number and position with the fan blades.

The discharge opening of the casing is provided with a socket for receiving a resonator. The resonator shown in Fig. 173 consists of a pair of tubes made to slide telescopically one within the other, the inner one being graduated to indicate the different lengths required for different pitches, and consequently for different speeds. As the fan revolves, the air drawn in through the holes at the center of the casing is thrown ontward by centrifugal force, thus maintaining a pressure of air at the periphery of the fan. The holes in the rim of the fan allow the air to escape in regular puffs, the frequency of which depends upon the velocity of the fan. These puffs produce sounds varying in pitch and intensity with the speed of the fan, and the resonating tube re-enforces the particular note to which it is tuned, so that when a speed is reached corresponding with the adjustment of the tube, the fact is known by the superior strength of that particular note. Any change of speed may be detected by the lessening of the intensity of the sound and the change of pitch.

The siren is shown in Fig. 175 in connection with mechanism for driving it by hand. It is provided with a revolution counter and with a trumpet-shaped resonator. It is designed to be used in the same manner as the siren of Cagniard Latour, and, like that instrument, it yields sounds under water.

CHAPTER IX.

EXPERIMENTS WITH THE SCIENTIFIC TOP.

Several experiments possessing more or less interest are illustrated in Plate III. This chapter is introduced at this

PLATE III.

Experiments with the Scientific Top.

point on account of the relation of its subject matter to the preceding and succeeding chapters.

The ability of the heavy top to run for a long time and