MIXING OF FLUIDS—EXPANSION BY HEAT.

T. O'CONOR SLOANE, PH.D.

The phenomena of diffusing fluids have already been alluded to, in an early article of this series. The mixing of thick silicate of soda solution with water was used as the illustration. To a suggestion from Mr. C. Trautwine, Jr., of Philadelphia, the experiment here illustrated is due. He observed that, in dropping whisky into glycerine, a peculiar effect was obtained. The whisky by its energy, due to falling, penetrated deep into the thick and heavier glycerine, and immediately tended to rise to the surface. In so doing, it subdivided the glycerine into veins, and seemed incapable of mixing perfectly with it.

In the illustration, a glass containing some glycerine is shown. From a height, in order to obtain impetus, alcohol is poured into the center of the surface. The effect described above is produced. If rightly done, the veins of subdivided glycerine will extend quite deeply into the center of the fluid, and produce a very curious and striking effect.

THE MIXING OF GLYCERINE AND ALCOHOL.

The subject of heat is susceptible of illustration by a number of experiments. Until reduced to the absolute zero, —273° Cent., the constituent molecules of all substances are assumed to be in intense and rapid vibration. This implies that they do not touch each other. By their oscillatory motion under the influence of the kinetic force, or objective heat, they are not allowed to rest touching each other. Hence, it follows that by applying more heat, their paths of vibration should be lengthened, and they should occupy more space. An *a priori* consideration would therefore lead to the conclusion that bodies increase in size as they grow hotter. Such is actually the case. The statement that heat expands and cold contracts is so old as to be known to all. It is a crude expression of a universal law.

To illustrate its universality, it should be shown experimentally as applying to all three states of matter—the solid, the liquid, and the gaseous. The expansion of solids shall first be considered here.

In general terms it is the most difficult of the three forms to use as the basis of a satisfactory experiment. Iron, per degree Centigrade, only expands 0 000012, brass 0·000018, and zinc 0·000029. Non-metallic substances are not so available as the metals, because they cannot, as a rule, be heated so highly. If a bar of metal is adopted, its expansion can only be shown by multiplying its movements very largely.

From the coefficients of expansion given above, it will be seen that zinc is a very suitable metal for the purpose. It is fusible at a rather low point, but not so much so as to impair it for experimental use where the temperature need not rise very high. The apparatus for exhibiting the expansion of metals is shown in the cut.

A wooden base, provided with two standards, is first constructed. It may be about twelve inches long and three wide. The standards are best mortised into the base, and glued or keyed so as to be free from shake, or they may be screwed or nailed directly to the ends of the base piece. These uprights should be about four inches high. Through one of them, the left hand one in the cut, a hole is bored, near the top, through which a wood screw passes freely, screwing in and out. In the inner face of the opposite standard, at the same height, two sharply pointed pieces of wire (about one-sixteenth inch in thickness) are inserted, whose points project about an eighth of an inch from the wood.

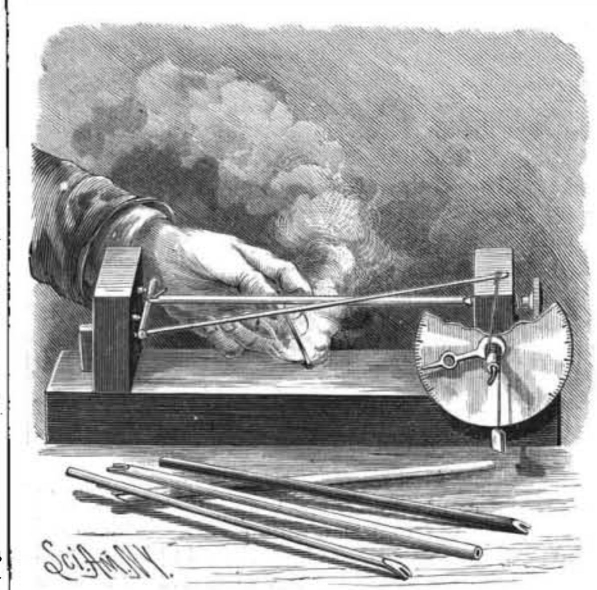
SOLDERING HEAD ON SCREW.

The rod or piece of metal to be expanded comes next. Several are shown lying in front of the apparatus. A perfectly straight piece of brass, copper, or iron wire, or a corresponding rod of zinc is needed. The piece should be of slightly less length than that of the space between the standards. One end is filed off square, and a slight excavation is drilled or punched in its center. This is to receive the point of the wood screw. The other end is filed off obliquely, and a slit filed in the center axis of the rod. If the rod is very thin, less than a quarter of an inch, its end may also be slightly upturned, so as to produce a larger oblique surface. One of the pieces is shown thus constructed. In any case, a shape is given the end somewhat similar to that of the claws of a carpenter's hammer.

A short piece of wire has two holes punched or drilled in its surface, to receive the two points projecting from the right hand standard. Another very fine hole is drilled almost or quite through its center, in which a pin about the diameter of a ladies' hair pin is soldered. This pin should project a quarter of an inch, and should be about 135° from the two holes, as referred to the circumference of the wire. Finally, in the end of this short piece of wire another hole is drilled, and the long arm seen in the drawing is soldered therein. The experimental rod is placed in the position shown, and adjusted by screwing in or out the screw until the least motion affects the movements of the long index wire. Now if the rod be heated, it will expand, and raise the index wire perceptibly.

To still further multiply the extent of motion, the index attached to the left hand standard is provided. A wire axis is thrust into the wood. A thin tube, which may be of glass, is placed over this axis, a paper index is secured thereto by sealing wax, and the end of the wire is bent to secure all. If desired, a graduated dial may also be pasted to the standard. A thread is attached to the end of the wire index, is carried three or four times around the tube. At its end is a small weight.

By the wire index every movement of the rod in the direction of its length is multiplied, perhaps eighty or a hundred times. This, by the paper index, is again multiplied probably twenty times, giving a total increase of motion of two thousandfold. Hence the sensitiveness is very great. A match held under the rod will produce a visible movement in the index, while a candle or alcohol lamp will produce more than a full rotation of the index.

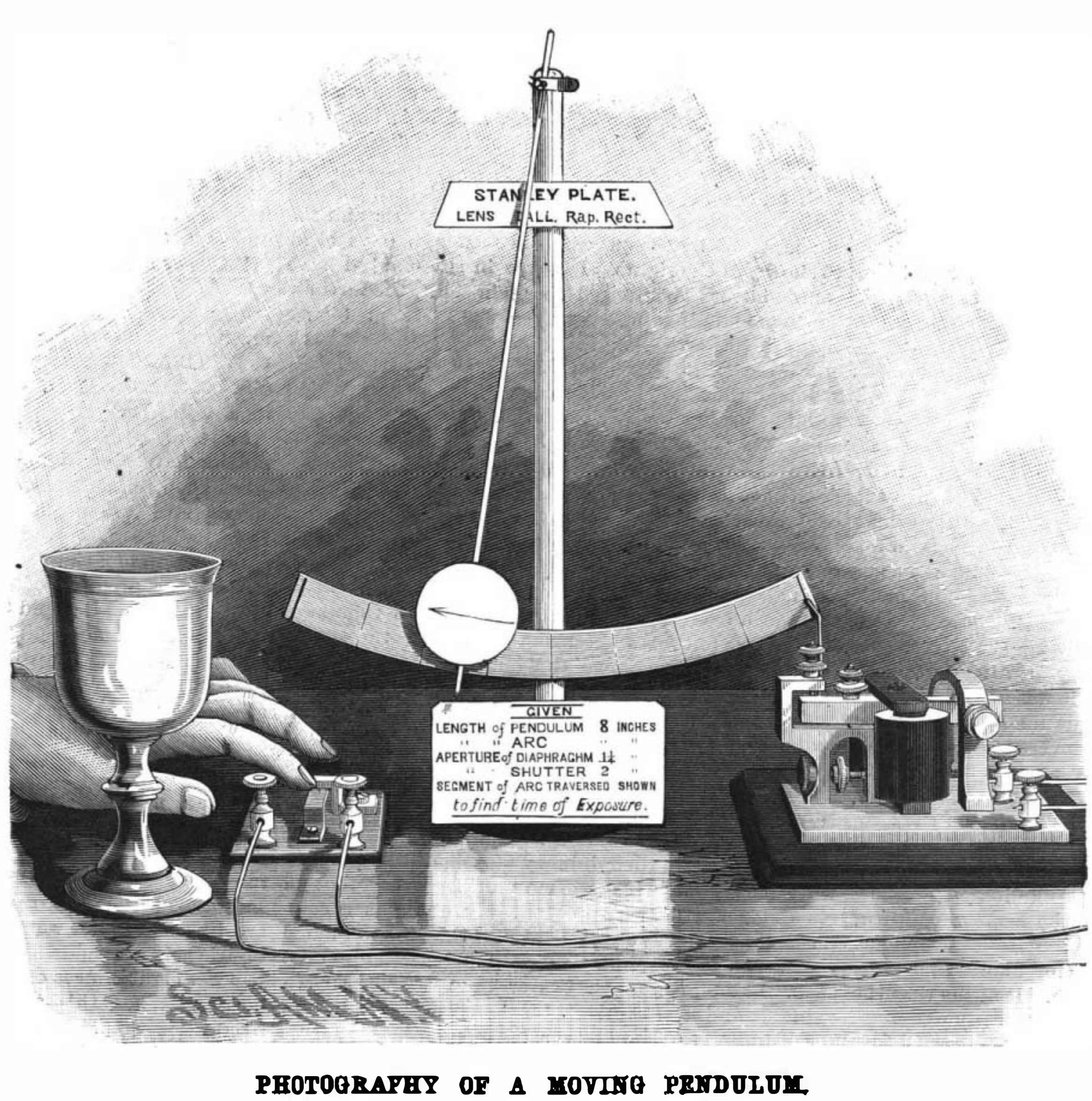


APPARATUS FOR ILLUSTRATING THE EXPANSION OF METALS BY HEAT.

The soldering is very easily done. A little hydrochloric acid is neutralized with zinc. The places to be soldered are cleaned and filed up bright, and a little of the "soldering acid," as it is called, is placed on them with a wire or a match. On heating one of the pieces in an alcohol lamp, with a bit of solder resting on it, the solder will melt and flow over the metal. This is done to both pieces separately, and afterward they are heated until the solder melts, and pressed together while held in the flame, removed, and allowed to cool. In the cut the operation is shown of attaching a head, which may be a copper cent, to the wood screw, to facilitate its manipulation. After tinning or coating with solder one side of the cent and the screw head separately, the screw and cent are placed as shown, are heated until the solder melts, and allowed to cool, when the union will be secure.

PHOTOGRAPHY OF A MOVING PENDULUM.

We represent in the cut accompanying this article an interesting achievement in photography. It is not only of value in itself as a perfect production of the art, but is very suggestive. It opens the question as to how much movement can be allowed to an object which shall not be detected in the blurring of its image, and also as to the relation between the distance, speed of object, and time for instantaneous exposure in photographing a moving object. Thus the one-hundredth of an inch is a distinctly visible quantity. A movement during the time of exposure which would, on the plate, produce this amount of displacement would tend to cause a blur. By one high authority the amount allowable is placed at 1-10 millimeter, or the 1-250 of an inch. It is uncertain how far this can be accepted as an absolute law.



PHOTOGRAPHY OF A MOVING PENDULUM.