By far the most satisfactory method is to fill in between the walls of the tin box with mineral wool, and to use wire coils and an electric current to heat the enclosure.

In the earlier part of my work I used distilled water from the Chemical Laboratory. Subsequent tests showed that it contained considerable organic matter. I am now using water which has been distilled three times in glass; once with permanganate of potassium to remove organic matter. My observations range from 0° to 80°, and cover a period of four months.

Briefly, my conclusions are as follows:

Between 0° and 80° the temperature coefficient curve is concave toward the x axis, when we use tensions as ordinates and temperatures as abscissas. This coefficient increases with the temperature, its value being about .17 dynes.

The formula usually used to represent the tension (T) at any temperature (t°) is

$$T_{t^\circ} = T_0 - .14\ t^\circ.$$

I find that the tension can not be expressed as a linear equation, and that .14 dynes is too low for the average temperature coefficient.

Much of my work so far has been toward perfecting the method and my apparatus. I am now making some observations, using exceedingly thin mica frames, and standardized thermometers reading to one one-hundredth of a degree. For temperatures below 0° I shall use the method described by Messrs. Humphreys and Mohler in the "Physical Review," March-April, 1895. I shall endeavor to extend my observations above 100° by using the capillary tube method, the water and tubes being enclosed in an air-tight plate glass box and under whatever pressure is necessary to maintain the desired temperature without boiling the water.

Physical Laboratory, Indiana University, December, 1895.

Strains in Steam Machinery. By W. F. M. Goss.

Masses of metal when of considerable strength and weight would appear to be proof against distortion under the influence of any force which may be brought to bear upon them. We think of the *strength* of metals, but it is not often that we consider their elastic property, yet, physically speaking, nothing, probably, is more elastic than steel. A piano wire, if tightly strung, increases its length, and if loosened again it contracts. Within certain limits it behaves precisely like a spring. When force is applied it stretches, and when the force is withdrawn it recovers itself again. If the force is considerable, change in the length of the wire may be easily observed; with a less force it will not be so apparent but still measurable, and, finally logic requires us to believe that if the force applied and withdrawn is infinitely small, there will still be a change in the length of the wire acted upon.

That which is true of a wire is equally true of all masses of metal of whatever proportion. A cube of steel may resist an enormous load tending to crush it, and yet the application of a slight force effects a decrease in its height. The change in form under light loads is certainly small, but actual. nevertheless. That which is true of steel is, in a general sense, equally true of wrought and cast irons, and, in fact, metals of every sort.

The machine designer, therefore, can not, as some suppose, make the several parts of his machine so strong that they will remain fixed in form, but he must choose rather so to distribute the metal with reference to the stresses to be transmitted, that the change in form which is sure to occur, will not interfere with the action of the proposed machine.

Some years ago the writer became interested in tests involving a measurement of the strain, that is the change in form, of various parts of steam engines, parts supposedly invariable, while the engines were being worked under load. The apparatus employed consisted of a fine micrometer screw mounted upon a frame work wholly apart from the engine and having no connection with it, but so arranged that the screw could be brought in contact with the part to be examined. In making observations, one terminal wire from a telephone receiver was attached to the part of the engine which was under examination, and the other terminal from the telephone to the micrometer; the observer placed the telephone to his ear, and slowly screwed the micrometer in towards the desired point on the engine. If the part of the engine in question was in vibration it first touched the point of the advancing screw for an instant for each oscillation, the contact being made manifest to the observer by a sharp click in the telephone as the circuit was made and broken again. This fixed one boundary by which the amplitude of the vibration was to be determined. Next the micrometer was advanced towards the engine until the screw did not break contact with the machines, a condition which was denoted by a cessation of sound in the telephone, while for all intermediate points the clicking in the receiver kept time with the revolutions of the engine. It was assumed that this last position of the micrometer marked the other boundary of the vibration. The difference of the two readings of the micrometer gave the amplitude of the vibrations, or the extent of the motion in the part examined. A large number of readings from several parts of two engines in the Laboratory of Purdue University were taken by Mr. Adam Herzog, B. M. E., a summary of which is as follows:

First, measurements were taken from a 15 x 24 Corliss engine; this machine has unusually massive parts, the frame being a heavy girder, and the whole being mounted in an excellent manner upon a deep foundation. Observations were made while the engine was developing only 35 horse-power with an initial steam pressure of 80 pounds. The head end of the cylinder was found to move in a horizontal direction with every revolution of the engine, a distance of 0.009 of an inch; the frame over the guides moved in a vertical direction 0.014 of an inch, and the pillow block castings in a horizontal direction 0.030 inches.

Secondly, measurements from a 14x16 engine, having a modification of the box-bed, mounted upon a substantial foundation, capped by a single stone of massive size. The details of the engine are heavy and well designed. Its center line, however, is considerably above the line of resistance offered by the bed. Observations were taken during a time when the engine was running under an initial pressure of only 40 pounds and while developing only 14 horse-power, which is less than half its rated power. The head end of the cylinder was found to move horizontally 0.018″, and the top of the cylinder at the flange on the crank end to move vertically 0.022″.

These vibrations, while taking place with every stroke of the engines, would not ordinarily have been detected with the eye, and were not accompanied by any shock or other manifestation which would indicate their presence. The measurements will serve to show to what extent the heavy fixed parts of well-designed machines may move under the influence of the forces which they are designed to resist, and they emphasize the necessity for a distribution of the metal which will give strength in direct line with the stresses to be transmitted.

Viscosity of a Polarized Dielectric. By A. Wilmer Duff.

[Abstract.]

Very few observations of mechanical actions produced in liquid dielectrics by electro-static stress have been made. Faraday found that fibres of silk in the liquid set themselves along the lines of force. Quincke thought he had detected an alteration of volume, but his results have been doubted. König tried to find a variation of viscosity by finding the rate of flow through a capillary tube placed between charged plates, but failed. A limit was set to the accuracy of his method by the difficulty of maintaining the tube at a constant temperature.