content results in a decrease in the rate of creep, while the lower antimony results in a comparatively high rate of creep.

Exceptions may be found to these findings at intermediate temperatures, compositions, or loads due to several reasons, chief of which are variations in grain size of the lead, the mutual solubility of the lead and antimony, and the amount, size, and distribution of the excess antimony particles. No explanation is offered at this time.

The authors wish to express their appreciation to The Detroit Edison Company for the finaneial aid given to this work, and to C. F. Hirshfeld, Chief of Research for The Detroit Edison Company, for his kindly interest and advice.

## Discussion

R. L. Peek, Jr.[3] As an approximation to the type of analysis suggested by Dr. Nadai it should be possible, if determinations

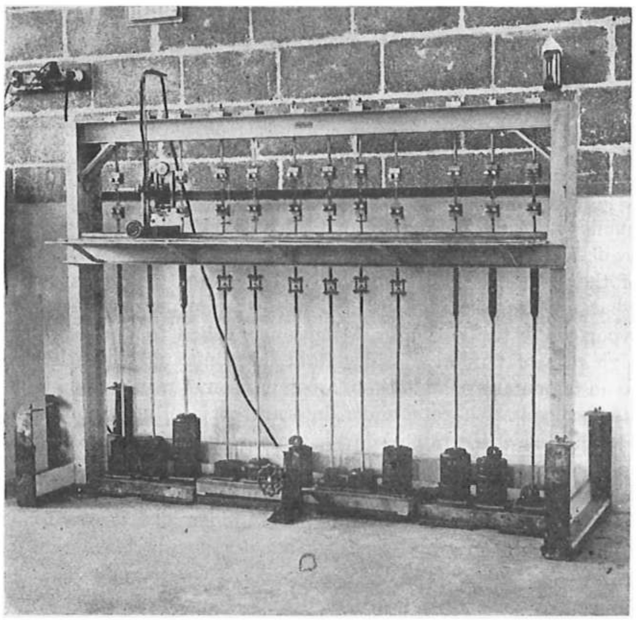

Fig. 11 Test Racks Arranged for Room-Temperature Tests

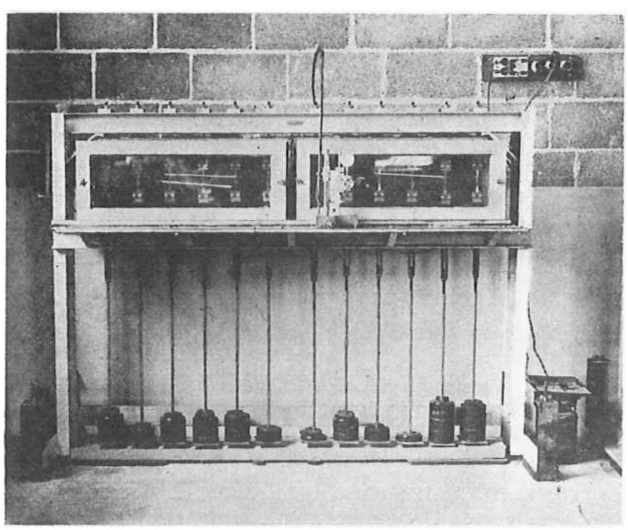

Fig. 12 Test Racks With Specimens Enclosed in a Heat-Insulating Chamber

[3] Bell Telephone Laboratories, New York, N. Y.

of creep are made under several loads at each temperature, to compute from the elongation the approximate average cross-section at any instant, and hence, approximately, the instantaneous average stress intensity. From such data there could

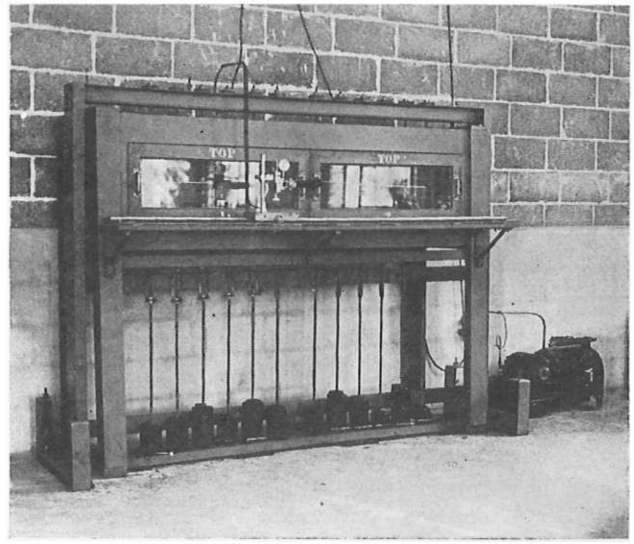

Fig. 13 Test Racks With Air-Cooling Equipment

then be obtained the rate of creep as a function of elongation for a constant stress intensity. When, as in some of the results given in this paper, the rate of creep for a constant load (increasing stress intensity) is constant through a considerable range of elongation, it would seem that the rate for a constant stress intensity must be decreasing and perhaps approaching zero for some limiting value of the elongation, i.e., that here there is also some strain hardening, or some similar effect.

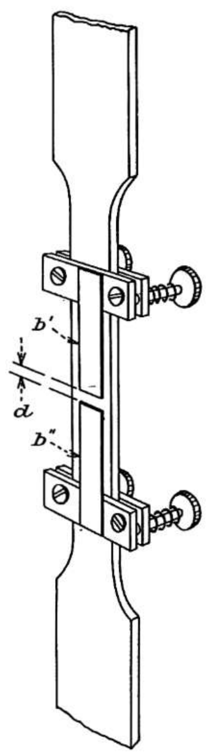

Fig. 14 Methods of Clamping Brass Strips to Specimens

H. F. Moore.[4] This paper presents interesting and valuable results and is of especial interest in emphasizing the importance of flow at room temperatures of certain of the softer metals. A series of flow tests of lead cable sheathing is in progress at the University of Illinois under the auspices of the Utilities Research Commission, and it is thought that some comment on these tests may be of interest in connection with this paper.

The tests at Illinois are being made on unalloyed lead, lead alloyed with antimony, and lead alloyed with tin. At present most of the tests have been on unalloyed lead. The general arrangement of the test racks are shown in Figs. 11, 12, and 13. Lead specimens with a minimum section $^1/_4$ in. wide are subjected to the direct load of dead weights. The elongation of the specimen is measured by means of a microscope with micrometer-controlled travel. To each specimen are clamped two pieces

[4] Research Professor of Engineering Materials, University of Illinois, Urbana, Illinois.

of brass ($b'$ and $b''$) as shown in Fig. 14, and the distance between the edges of the brass pieces ($b$ in Fig. 14) is measured by the traveling microscope shown in Fig. 13, and in somewhat greater detail in Fig. 15. Tests are run at (1) room temperature, (2) at a temperature approximately 32 deg. fahr., and (3) at a temperature approximately 150 deg. fahr. Fig. 11 shows the rig for room temperature tests. The six specimens in the center of this test rack are arranged so that they may be readily loaded and unloaded, and are tested in cycles of eight hours under load followed by 16 hours with load released.

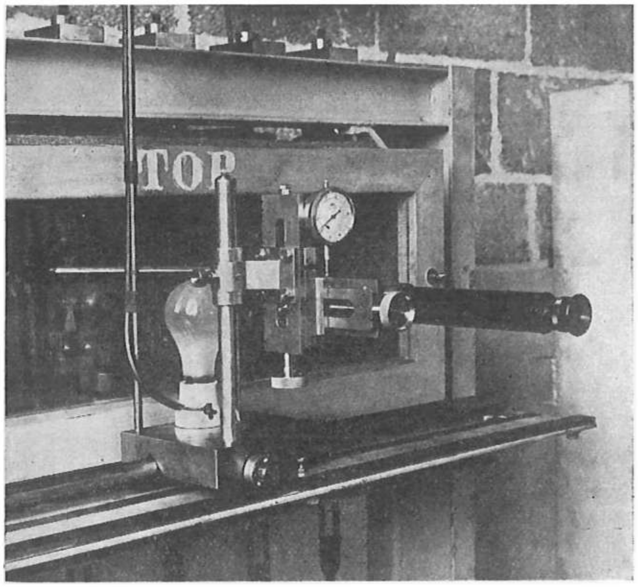


Fig. 15 Traveling Microscope for Making Measurements

Fig. 12 shows the rig for 150 deg. fahr. The specimens are enclosed in a heat-insulating chamber, which is heated by a small electric heater, and the temperature is controlled by a thermostat circulation. A good degree of uniformity of temperature is secured by baffles. Fig. 13 shows the rig at 32 deg. fahr. The air is cooled by means of a Frigidaire unit. All three test racks are suspended from springs so adjusted that the racks rest lightly on sponge-rubber pads. This insures a minimum of vibration in the specimens.

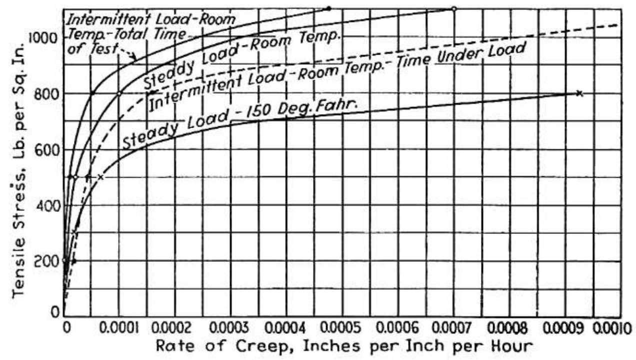


Fig. 16 Test Results With an Unalloyed-Lead Transverse Specimen—Intermittent Load, Eight Hours On and Sixteen Hours Off

Fig. 16 shows some results which have been obtained with unalloyed lead. Test data for tests at 32 deg. fahr. are not yet available. In general these tests are in agreement with those of the authors, but the unalloyed lead seems to have a somewhat greater rate of flow than does the antimony-lead alloys reported by the authors. Attention is called to the relatively high rate of flow at 150 deg. fahr. as compared with that at room temperature, and also to a comparison of rate of flow under steady load with rate under intermittent loading. As might be expected, if the rate of flow is measured by the entire elapsed time of test it is somewhat less for intermittent loading than for steady load. However, if the rate of flow is measured by the time the specimens were actually under load it was to be greater for intermittent loading than for steady load.