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A TRANSFER STRAIN GAGE FOR LARGE STRAINS

By Martin Greenspan and Leroy R. Sweetman

ABSTRACT

A simple strain gage, suitable for measurement of strains of from −16 to +32 percent on a 1.5-inch gage length, is described.

CONTENTS

	Page
I. General	595
II. Construction	595
III. Operation	596
IV. Accuracy	596

I. GENERAL

A simple and inexpensive strain gage, having a range of −16 to +32 percent on a 1.5-inch gage length, has been devised and successfully used at the National Bureau of Standards for the determination of the stress-strain relations in the plastic range of some aluminum alloys and steels.

The gage consists of two distinct steel blocks equipped with steel knife edges (or conical points) which are kept in contact one with each end of the gage line by means of spring clips. The blocks move in relation to each other when the length of the gage line changes, but are kept in alinement by means of a rod attached to one block passing through a hole in the other. One block, (the indenter block), carries a hardened steel indenter mounted on a cantilever leaf spring; the other block, (the target block), has cemented to it, before the test, a brass target. The gage is operated by depressing the spring manually so that the indenter leaves a small mark on the target; a record of the deformations of the gage line corresponding to the various loads is thus transferred to and preserved on the target, from which it is read after the test is completed by means of a travelling micrometer microscope.

II. CONSTRUCTION

The gage is shown in figure 1. The alinement rod, *a*, is a piece of ⅛-inch-diameter drill rod pressed into a hole in the indenter block, *b*. The guide hole in the target block, *c*, which engages the alinement rod, is subdrilled and reamed to size. Although the clearance between the alinement rod and the guide hole is very small, it is large enough to allow the blocks to tilt with respect to each other and affect the accuracy of the gage. For this reason the alinement rod is provided along its entire length with a flat about 0.08 inch wide, against which bears a flat-end setscrew, *d*, seated in the shoulder of the target block. By means of this setscrew the clearance is adjusted to the smallest value that will not cause binding.

The knife edge, *e*, which has an included angle of 60 degrees is made from ⅛-inch drill rod, hardened. The shank presses into a 1.8-mm-diameter hole in the block. The faces are ground and then lapped in a small indexing grinder constructed for the purpose.

The indenter (not visible in fig. 1) is made from ⅛-inch square drill rod, hardened. The striking face is in the form of a square pyramid, with an included angle of 120 degrees between opposite faces. The intersections of the two pairs of opposite faces are slightly offset, so that the extreme tip of the pyramid is not a point, but a line 0.002 to 0.003 inch long. An end-on view of an indenter is given in figure 2. The faces of the indenter are ground and lapped in the same indexing grinder as the knife edges.

The indenter is provided with an 0–80 threaded shank which passess through a hole in the ¼ by 0.006-inch spring-steel leaf, *f* (fig. 1), and is secured by a nut, *g*. A 2–56 steel machine screw, *h*, secures the spring to the indenter block.

The brass target, *i*, is a piece of ⅛-inch square brass rod ¾ inch long. Each target is used for four tests. Before use, one surface of the target is polished on abrasive paper to remove the major surface imperfections. The target is then cemented to the target block so that the polished surface is uppermost and one end of the target is in contact with the shoulder of the target block. This position of the target gives a range of almost 0.5 inch in tension and almost 0.25 inch in compression if the initial gage length is 1.5 inch Shellac is a convenient adhesive; it dries sufficiently well in a few minutes, and the target can be detached from the block by hand when the test is completed.

III. OPERATION

Fine scratches are scribed at the ends of the gage line on the specimen and the knife edges of the gage are set in the scratches. The gage is held by spring clips as shown in figure 3. The indentations are made by pressing with a finger the nut which holds the indenter. A light touch, such as produces indentations 0.0003 to 0.0005 inch wide is best from the standpoint of legibility. The photomicrograph, figure 4, shows part of a record obtained in a test.

IV. ACCURACY

The record may be read by means of any suitable measuring microscope. A Zeiss travelling microscope at 56 magnification, accurate to about 0.00015 inch has been used for all the tests thus far made with these gages.

The microscope is focussed on the botton of the indentation which appears as a sharp line. These lines are not visible in figure 4, but they would appear as vertical lines bisecting, approximately, the indentations.

The six gages that have been used at the Bureau were calibrated against standard gage blocks in the extensometer comparator [1] of

[1] Ambrose H. Stang and Leroy R. Sweetman, An extensometer comparator, J. Research NBS **15**, 199 (1935) RP822.

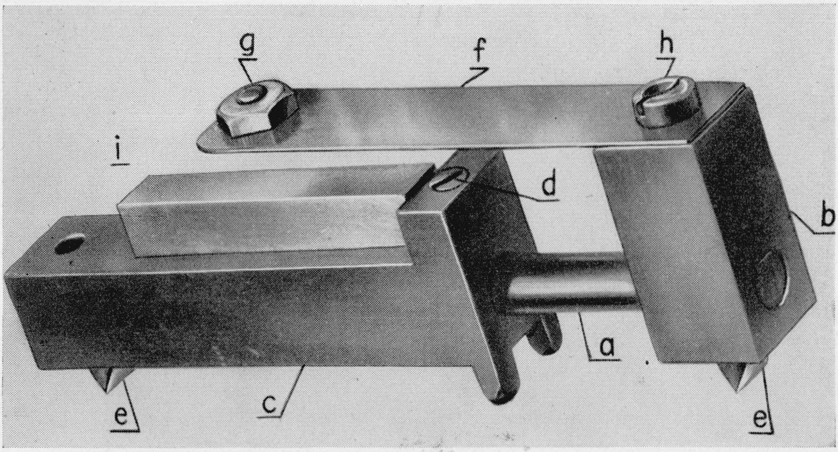

FIGURE 1.—*Transfer strain gage, 2×.*
The gage weighs about ½ ounce.

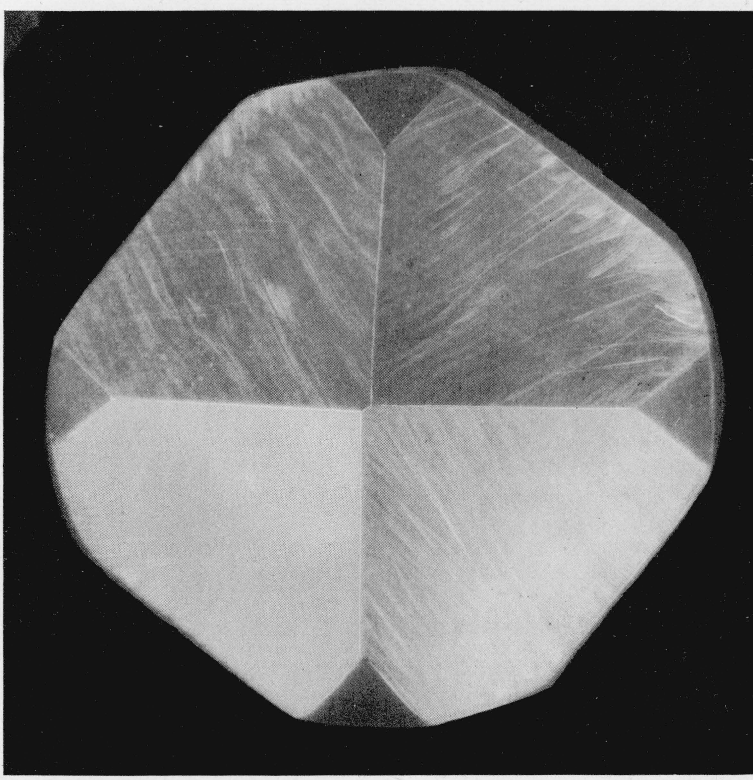

FIGURE 2.—*Indenter, end-on view, 25×.*

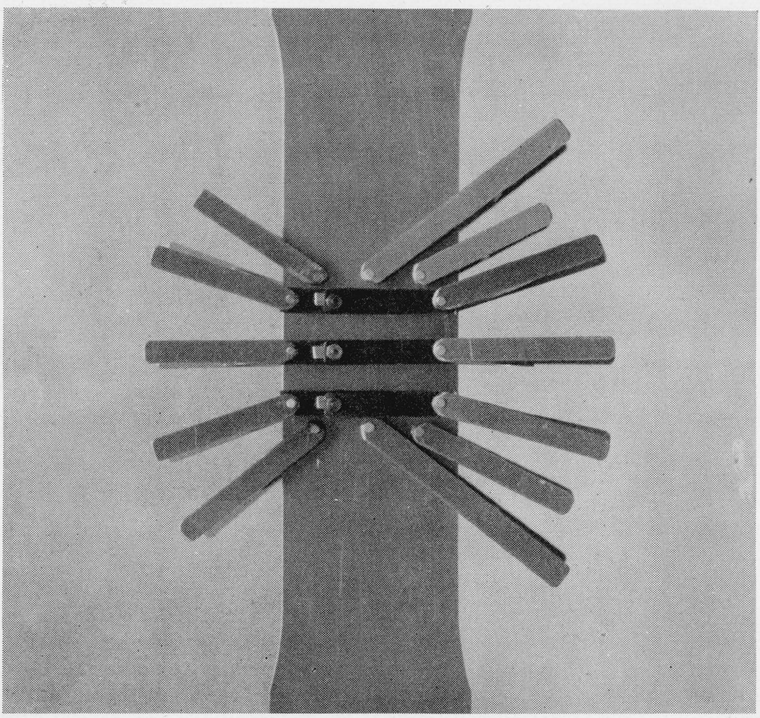

FIGURE 3.—*Three transfer gages in place transverse to the axis of a tensile-test specimen of aluminum alloy.*

Three additional gages, parallel to the axis of the specimen, are on the other side.

FIGURE 4.—*Part of a record obtained in a tension test, 80×.*

Stang and Sweetman. Three of these gages exhibited only random errors of the same order of magnitude as the errors in the micrometer screw of the microscope. The other three gages were affected by an additional systematic error not exceeding 0.2 percent. This systematic error is probably a result of the relative tilt of the blocks produced by the take-up, during separation of the blocks, of the clearance between the alinement rod and guide hole.

During a test, conditions for the production of legible, uniform indentations are not as favorable as during a calibration, especially if more than one gage is to be operated simultaneously by one operator. However, it is felt that the gages can be relied upon to measure extensions within perhaps 0.4 percent plus 0.0002 inch. Thus on a 1.5-inch gage length, strains greater than 2 percent may be measured with an error of less than 1 percent.

WASHINGTON, April 3, 1945.