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PART 1

ELEVATED-TEMPERATURE TESTING PROCEDURES

Part 1. Continuous Recording of Time-Deformation Readings During Creep-Rupture Testing at Temperatures Up to 1200° F

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FOREWORD

This report was prepared by the Metals Branch, Materials Laboratory, Directorate of Research, Wright Air Development Center and was initiated under Project No. 7360, "Materials Analysis and Evaluation Techniques", Task No. 73605, "Design Data for Metals", formerly RDO No. 614-13, "Design and Evaluation Data for Structural Metals", with Messrs. W. H. Rector and C. A. Townsley acting as project engineers.

The Materials Laboratory wishes to acknowledge the splendid cooperation of the Technical Photographic Services Branch of the Directorate of Material in the development of the photographic techniques.

ABSTRACT

A new method of recording deformation during creep-rupture testing at temperatures up to 1200°F is presented. This method has the advantages of: (1) obtaining a continuous time-deformation record up to failure, compared to the intermittent readings obtained using the former manual method and (2) being completely automatic and saving the technician's time required to make manual measurements. This method employs cameras to record the data. A description of the equipment is given.

PUBLICATION REVIEW

This report has been reviewed and is approved.

FOR THE COMMANDER:

M. R. WHITMORE
Technical Director
Materials Laboratory
Directorate of Research

Elevated-Temperature Testing Procedures
Part 1 - Continuous Recording of Time - Deformation Readings During Creep-Rupture Testing at Temperatures

I. INTRODUCTION

This report was written to describe the equipment and test procedures used in obtaining a continuous record of time-deformation readings during creep-rupture tests on various alloy sheet materials and metal-to-metal adhesive bonded specimens for time periods from a few hours up to thousands of hours of test time. Several types of materials have been tested using this equipment but no description of this particular procedure has been previously presented.

II. STRAIN GAGE

The test specimen normally used for sheet material is approximately twenty inches in length by one and one quarter inches in width with a two inch gage length which is one half inch in width. The extensometer is attached to the specimen gage length by means of pointed stainless steel or high temperature alloy set screws.

The elevated temperature strain apparatus employed in this procedure is of standard design, manufactured by the Baldwin-Lima-Hamilton Corp., Model P5H-8. The strain reading is indicated on a motor driven counter, which reads deformation in 0.000025 inch increments.

A test specimen mounted in a standard lever-type creep-rupture frame is shown in Figure 1 (Furnace removed) with strain gage, control and recording thermocouples attached. On the front of the test frame is shown the panel containing the electronic system for the strain gage operation, deformation counter, and timing devices.

Two time counters are used for accurately recording test time; one is a revolution counter calibrated to read to the nearest 1/10 hour while a standard clock with a sweep second hand is used to indicate the time in seconds and minutes during the initial loading of the test specimen and early stages of creep.

III. RECORDING EQUIPMENT

Since the strain measuring equipment described above required laboratory personnel to take several readings at various times throughout the day it was noted that a considerable amount of valuable test information was being lost during the nights and over weekends when personnel were off duty. Considerable thought was given to devising a more suitable means of recording these test data not only during off-duty hours but also automatically, thereby relieving laboratory personnel for other duties. Several methods of automatic recording were investigated.

A decision was reached to automatically photograph the strain counter and time meters at predetermined periods throughout the day. Several methods of photographing the different meters were studied and the final solution was obtained by revamping motion picture cameras for single-frame exposure operation. A Standard Aircraft Bomb Spotting Camera, which is a 35mm. motion picture camera with a shutter speed of 1/30 of a second was modified for this particular task. The motion picture drive assembly was removed and replaced by a specially designed tandem solenoid mechanism.

The solenoid mechanism serves a twofold purpose; first, it actuates the camera shutter and second, as the shutter closes, a second solenoid drives a clutch which in turn advances the film to the next frame. The camera holds 100 feet of film, with 16 exposures to the foot, which in most instances will record an entire creep-rupture test.

An f: 2.3 25mm. lens is used with the camera which covers a relatively wide area and has a focal length of approximately one foot. This allows the camera to be placed close to the test frame, thereby not taking up aisle space in front of the test frame. The camera is mounted on top of a 1-1/2 inch pipe which in turn is mounted rigidly to the floor to prevent the camera from moving while in operation. Originally a bracket was mounted on the test frame for holding the camera but this proved unsatisfactory, since energizing the camera vibrated the test frame which in turn transmitted the vibration to the strain gage causing false motion to be recorded on the strain counter.

A camera unit is shown in Figure 2 illustrating its location on the pipe stand and its location with respect to the testing frame.

In order to illuminate and reduce shadows on the strain counter and time meters, two 100 candle power, 24 volt DC, aircraft landing lights are mounted on the camera. One light is mounted three inches above and the other three inches below the center line of the camera lens. The location of these lights is shown in Figure 2.

IV. ELECTRONIC CONTROL

As was mentioned in previous paragraphs, the cameras and lighting were of aircraft type which were originally designed for airborne use for operation on a 24 volt DC power supply. Therefore, it was necessary to obtain a 24 volt DC supply for this operation. Since it was found that each camera and its lighting required 7 to 9 amperes for one quarter second time interval, it was concluded that the most satisfactory voltage supply could be obtained by using a 24 volt storage battery. The use of an AC - DC voltage rectifier was contemplated, but due to high amperage requirements per unit, the capacity and size of the rectifier required were prohibitively large.

A control panel for the cameras' operation was designed and fabricated for control of fifteen camera stations. It was designed using two timing units, one for short time periods and the other for long time periods. These timing units are of the tandem recycling type; that is, each unit is made up of two timers so designed as to enable two operations to be completed in each cycle. One timer of each unit controls the interval between photographic exposures while the second timer of each unit controls the time of the photographic exposures.

The two timing units installed in the control panel enable a variety of time intervals to be selected depending upon the particular test being conducted. One timer is for 0-3 minutes operation and other is for 0-60 minutes. The second or operational timer in each unit is a 0 to 5 seconds timer and is set for ¼ of a second operation. Each of the timers controls the holding coils of 60 ampere auxiliary relays which in turn control the direct current source for the cameras and lamps. A double pole, double throw, center position "off", toggle switch is located in the panel for each camera unit. This type switch enables the operator to connect the camera to either of the two tandem recycling timers or place it in the "off" position when not in use. Pilot lights at the top and bottom of each switch indicate which timer is being used by that unit.

Installed in the lower half of the control panel are a battery charger, two 24 volt storage batteries and auxiliary switches. This section is wired to permit the use of either battery as a voltage supply while the other is being re-charged or both batteries may be used at once thereby permitting little drain on either battery.

Located at the base of each camera is an auxiliary switch which permits manual operation of the camera and lighting. This enables the operator to check the function of the unit and aids in loading of film.

Figure 3 shows a photograph of the control panel with various sections indicated.

V. TEST DATA AND CURVES

All test data are recorded on Eastman Negative Super XX film and process developed. Processed film is read by means of a microfilm reader and the data recorded for each frame. The data obtained from these readings are used for the plotting of time-deformation curves. Shown in Figure 4 is a photograph enlargement of a single frame of 35mm. test film showing the strain counter and timers.

SUMMARY

Two time-deformation curves are shown in Figure 5, one of which was produced from readings taken by personnel during the normal eight hour work period while the second was produced from data obtained from a regular test film. This clearly shows that a continuous type of recording is necessary to obtain a reliable time-deformation curve. As shown by the curve plotted by manual readings it is difficult to determine where the final stage of creep really started while the second curve clearly defines all the deformation occurring in the test specimen. The difference is more pronounced in tests of shorter duration where creep is accelerated due to the application of higher stresses thus requiring manual readings to be taken almost continuously. The loss of data during off duty hours would also be more significant in the shorter tests.

The photographic method of recording test data is highly beneficial in many ways. It (1) provides a permanent test record, (2) allows skilled personnel who were formerly taking manual readings to be free to accomplish other tasks, and (3) provides for reading of completed test films by clerical help. Formerly the manual readings were taken by qualified engineering personnel due to the accuracy and other requirements which were essential in obtaining the readings. It has been found that since this method of recording has been employed a saving of approximately 75% in man hours has been attained.

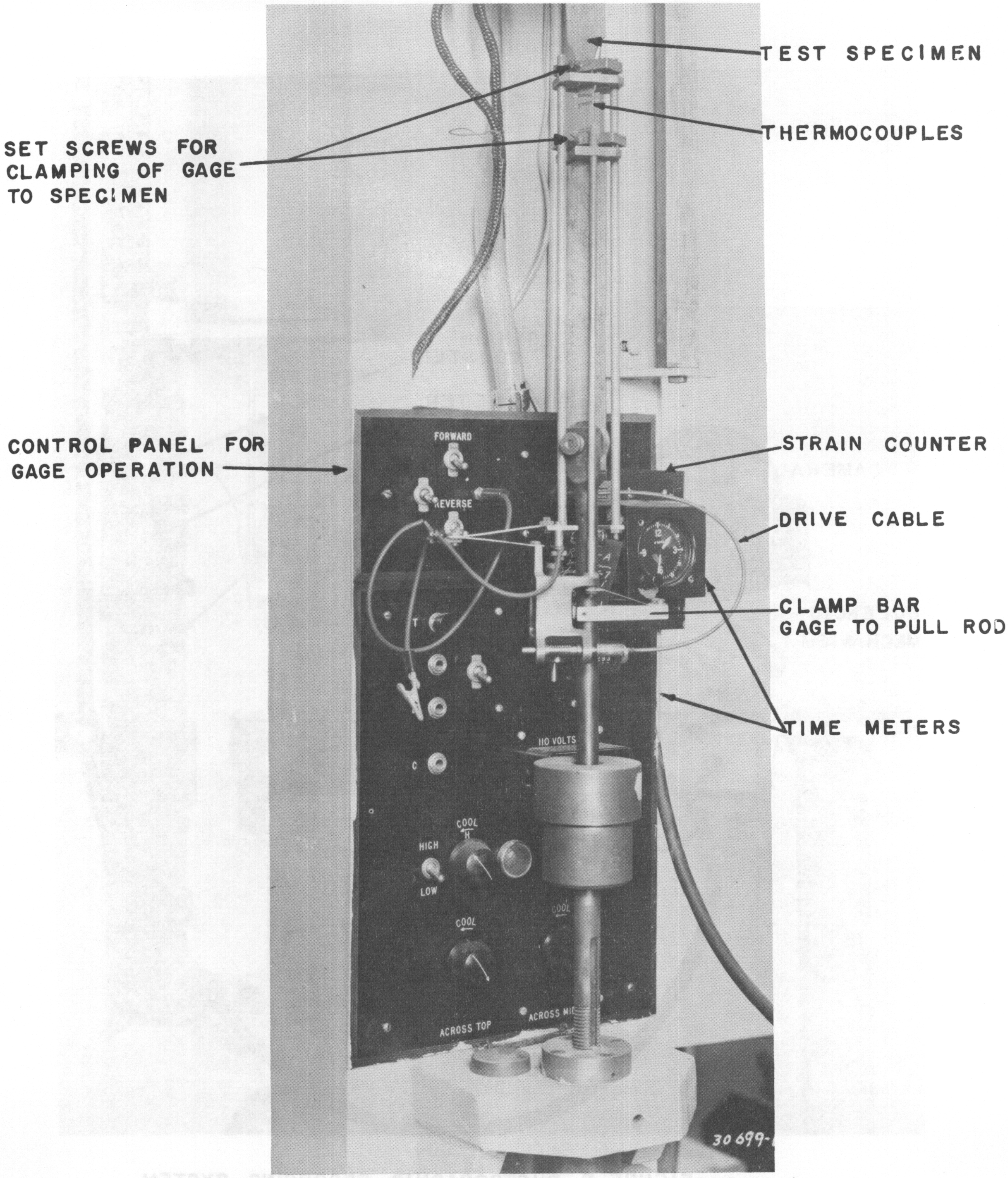

FIGURE 1. STRAIN GAGE ASSEMBLY

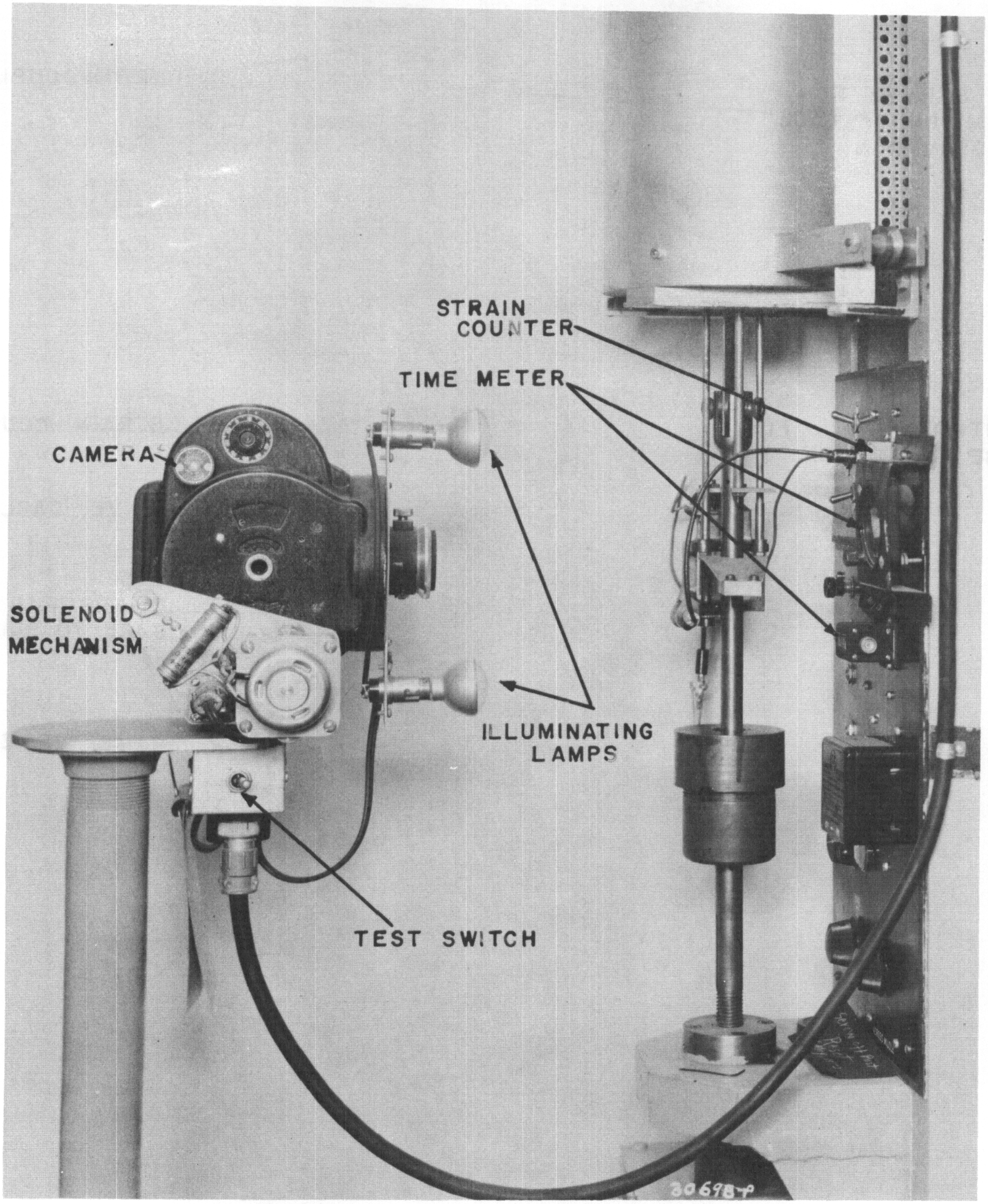

FIGURE 2. PHOTOGRAPHIC RECORDING SYSTEM

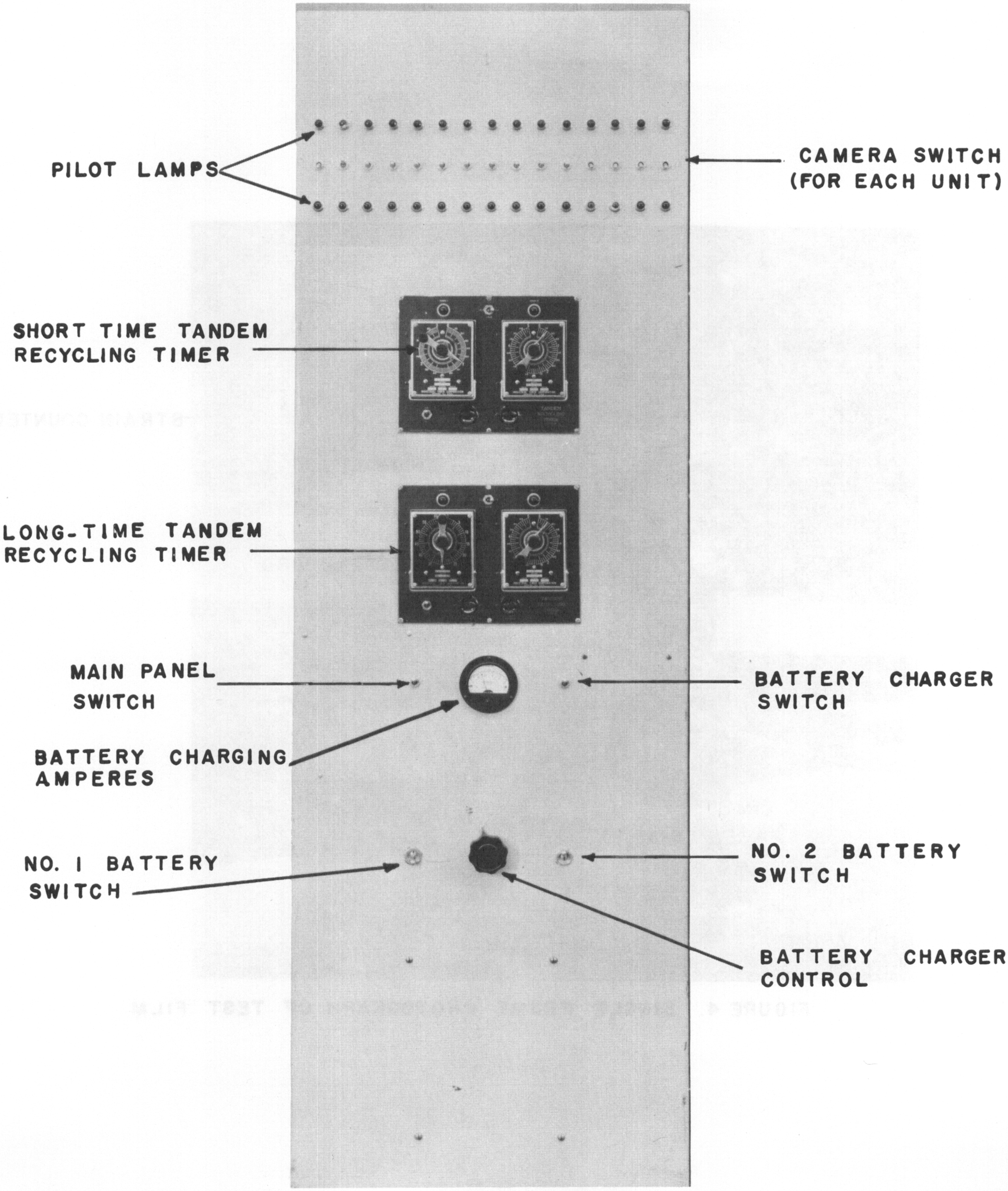

FIGURE 3. CONTROL PANEL

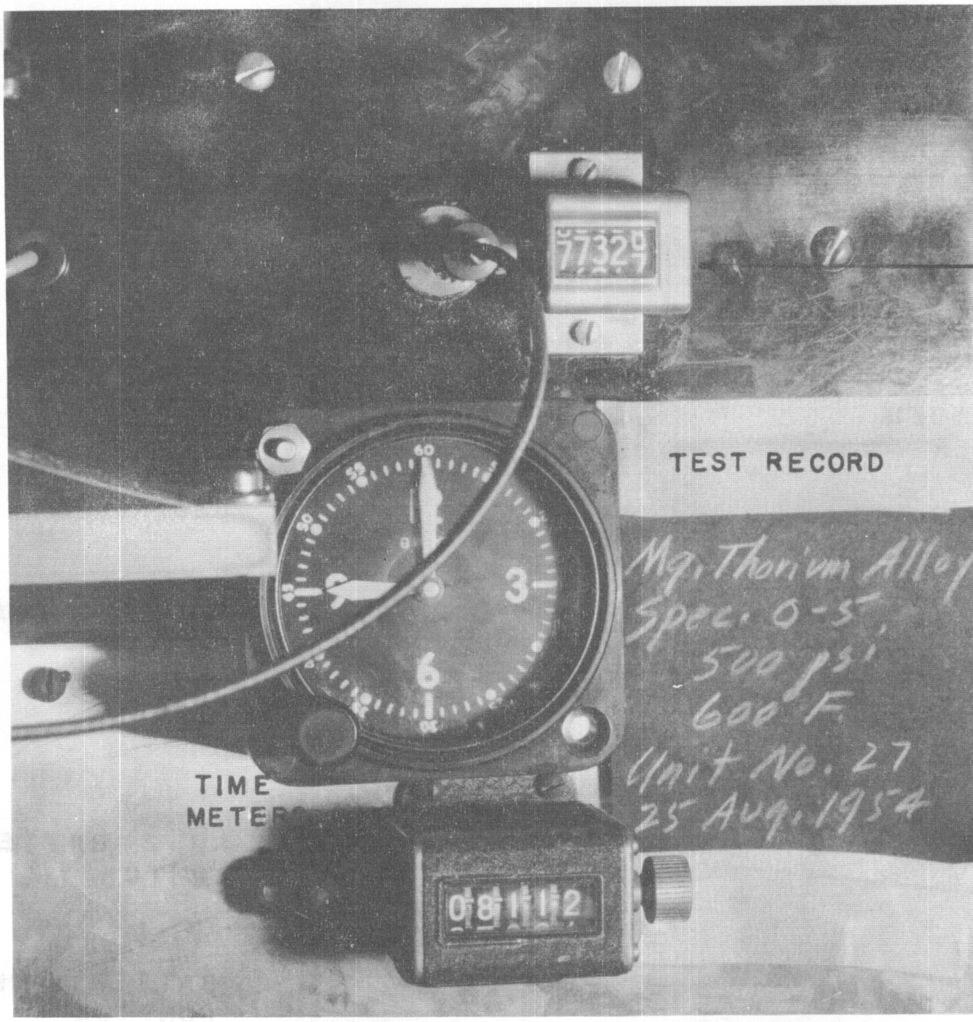

FIGURE 4. SINGLE FRAME PHOTOGRAPH OF TEST FILM

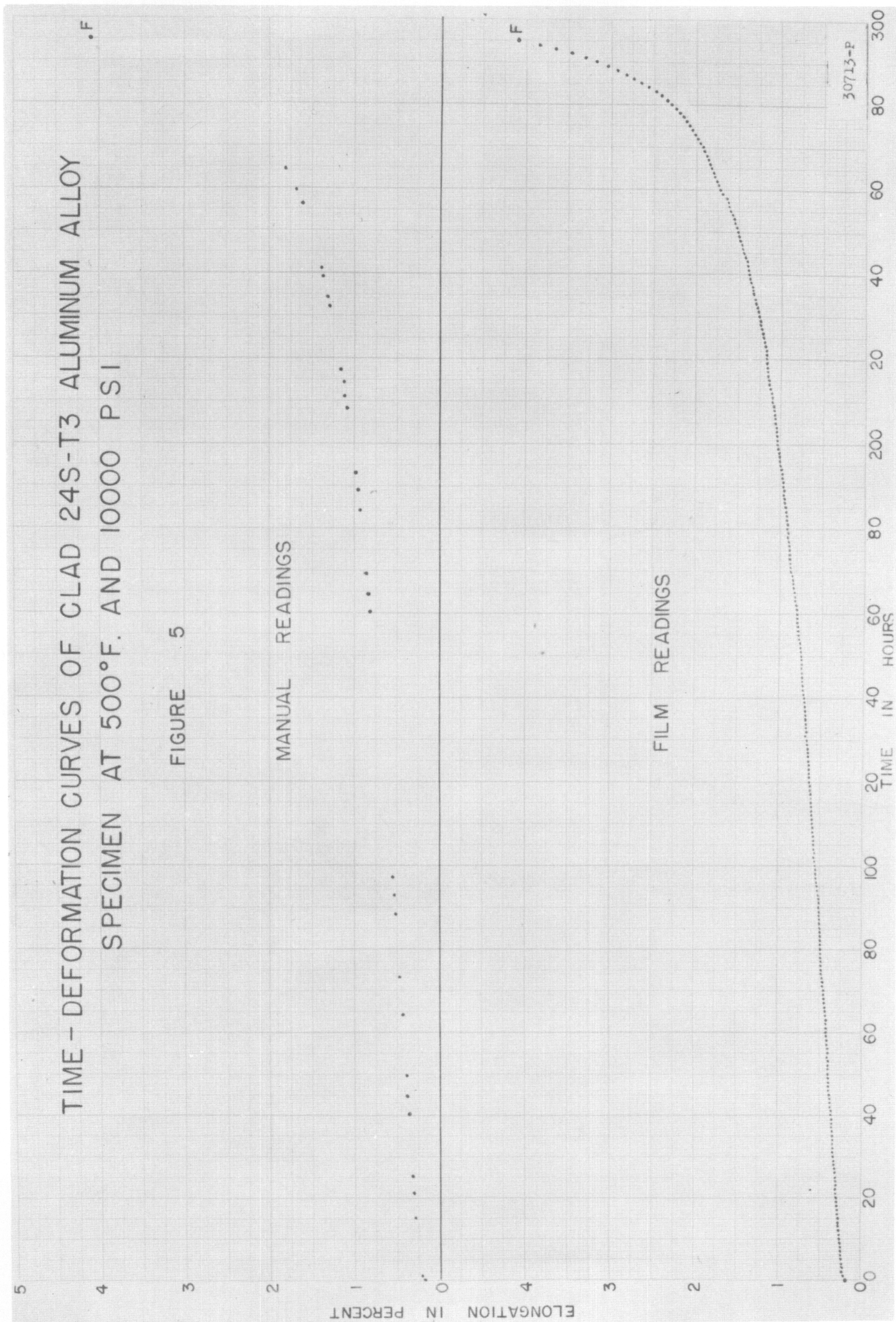

FIGURE 5. COMPARISON OF MANUAL AND FILM READINGS