)NAL ADVISORY COMMITTEE
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TECHNICAL NOTES

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No. 150.

NOTES ON THE N.A.C.A. CONTROL FORCE RECORDER.

By H. J. E. Reid,
Langley Memorial Aeronautical Laboratory.

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By H. J. E. Reid.

This note emphasizes the desirability of using recording instruments in the investigation of the characteristics of airplanes with particular reference to the National Advisory Committee for Aeronautics control force recorder. The note contains photographs, records, and a description of the instrument which was developed by the technical staff of the National Advisory Committee for Aeronautics to be used as a laboratory instrument for investigations on different types of aircraft.

One of the prime requisites of a successful airplane is that it be easy on the controls. If any appreciable force is necessary to hold an airplane on a steady course, the pilot would soon tire on a long flight, and the added hazard of a tired pilot is not, of course, justified. On the other hand, in the design and construction of airplanes of the pursuit and combat types, the controls must be such that it is possible to maneuver with ease and rapidity and consequently should require a minimum of effort to manipulate the controls.

In investigating the characteristics of an airplane, it is necessary to determine whether the airplane is easily controlled and maneuvered. The usual method to obtain this information is to

have the airplane flown by several pilots who submit a report of their opinion as to the airplane's behavior. This method is not satisfactory or accurate as the different pilots often submit different reports on the same airplane. The time required to determine the characteristics of an airplane is considerably reduced by the installation of recording instruments which can be quickly installed and which will register the movements of the airplane as well as the movements of and forces on the controls. Laboratory recording instruments are being developed at the Langley Memorial Aeronautical Laboratory to accomplish this purpose and the object of this note is to describe the instrument for recording control forces.

The control force recorder at present registers only the forces exerted on the stick. Attachments are being designed, however, to enable the forces on the rudder bar also to be recorded. The instrument in its final form will consist of three parts, namely, the recorder, the controller for the stick, and the controller for the rudder. The first two are in use now and are shown in Figures 1 and 2.

The theory of operation is simple. In the controller, which is slipped over and fastened to the stick, are small electrical resistances which vary as the force applied to the handle. The recording apparatus then consists of suitable variable resistances properly connected to galvanometers whose deflections are proportional to the forces applied to the stick.

Referring to Figure 1, it will be seen that the recorder is quite similar to the rest of the standard N.A.C.A. flight instruments. There is a constant speed electric motor at A for driving through suitable gearing in the base the clutch D which in turn rotates a standard film drum placed in the gibs H. The method of recording is photographic, the light source being located in a tube, the top of which is shown at F. A light beam is focused on a little mirror in back of the lens C and is reflected through the lens again to the slot E whence it may pass to the drum and trace a record on the moving film. There are three galvanometers, the magnet for the top one being shown at B. These are used in conjunction with Wheatstone bridges, two arms of each being located in the controller and the remaining two in the recorder and shown at I. Connections between the controller and recorder are made by means of special cables, the ends of which may be inserted in the sockets G.

The instrument is shown in Figure 4, with the cover in place as it would be in use.

Figure 2 shows the controller with the cover off. It contains the variable arms of the Wheatstone bridge and is so designed that it may be placed over and clamped to the stick. The stick then extends up inside nearly to the top L, the only point of contact being at the body P. The handle O is connected through a universal joint R to the body and is restrained from movement by four stacks of carbon discs located at J. In operation the pilot grasps

the controller at the top L and the force is transmitted to the body through the carbon discs and the adjusting screws N. One of the characteristics of the carbon discs is that pressure upon the stack changes its resistance. A force on the stick then causes resistance changes in the Wheatstone bridges and the resulting galvanometer deflections are recorded. In operation it is only necessary for the pilot to close a switch when ready and open it after the run is made.

A few records taken on one of the Committee's airplanes are shown in Figure 3. The maneuvers are as noted, a sideslip, turn, loop and, the last, a record taken with the hand off the stick. In this case the ship was operated from the other cockpit and, of course, shows no force on the stick. With some improvement in the galvanometer and the damping the record will be somewhat clearer and finer.

The controller for the rudder will be similar in principle to that in use for the stick. When this is made and put into operation, much more accurate information can be obtained in the tests on new airplanes.

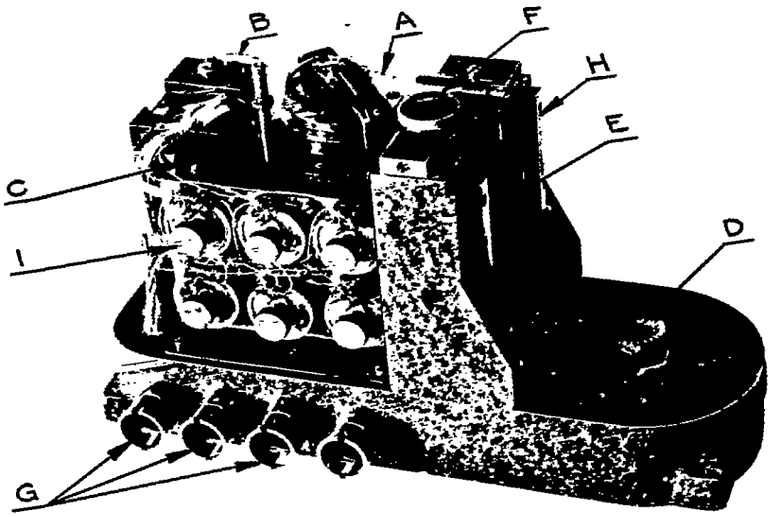

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Fig. 1

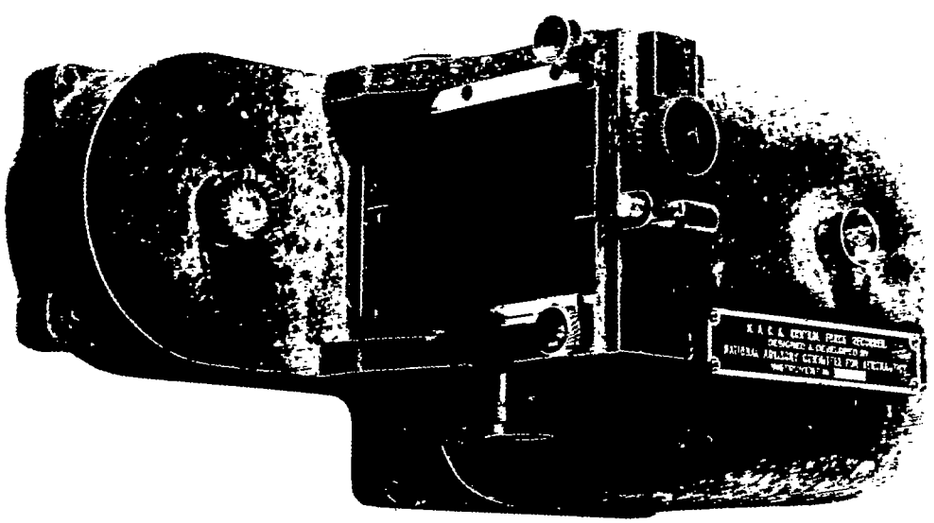

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Fig. 4

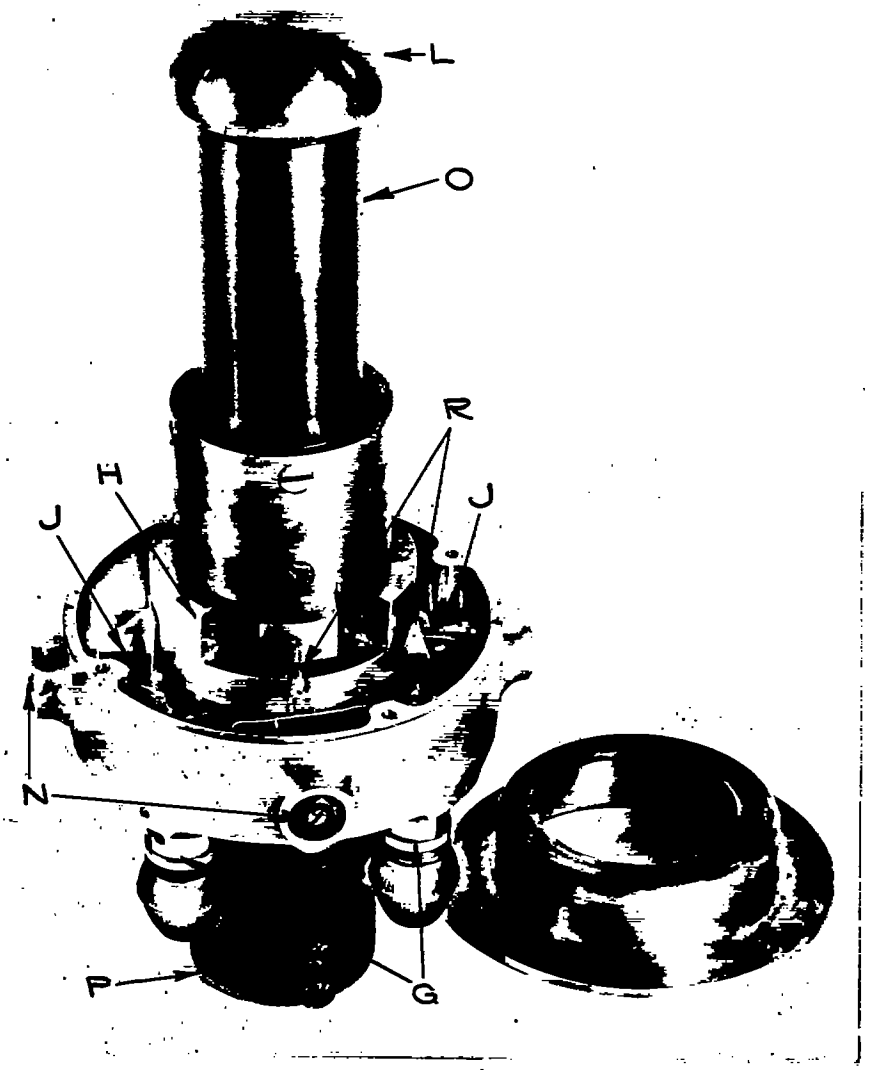

Fig. 2

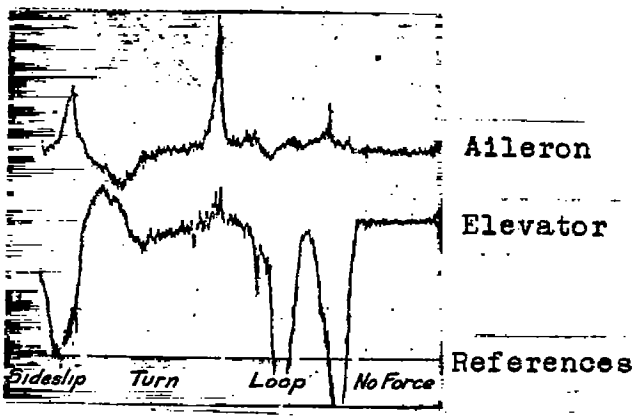

Fig. 3

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