TECHNICAL NOTES

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS.

No. 123.

AN OPTICAL ALTITUDE INDICATOR FOR NIGHT LANDING.

By John A. C. Warner,
Bureau of Standards.

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That practical commercial aviation has come to stay must be admitted by even the most skeptical. The rapid advance which the past few years have witnessed is unmistakably the forerunner of greater activity in this comparatively new field of communication and transportation. It is at once evident, however, that the greatest benefit cannot be derived from the use of aircraft as commercial carriers unless their operation can be extended over the full twenty-four hour day; for their inactivity during the hours of darkness robs them to a great extent of their advantage over the systems of ground transportation.

For this reason the problem of flying at night and under other conditions of low visibility is now demanding the attention of many aeronautical experts. We must equip our airways and aircraft with suitable means for surmounting the obstacles offered by these adverse conditions. This of course involves the installation of markers and beacons to clearly define the routes and fields, and also the equipping of aircraft with suitable instruments for navigation and landing. One of the most ingenious of the devices intended for use in night landing, especially emergency landing, is a very simple optical instrument known as the Jenkins night altitude indicator.

Referring to Fig. 1, we note three projectors: A, B, and C, each of which is equipped with an incandescent lamp properly mounted at the upper extremity to project a beam of light downward through the tube to the ground or water upon which a landing is to be made. Two of these projectors: B and C, are attached rigidly and parallel to each other to the side of the aircraft, while the third, A, is made rotatable (upon rails D and E) through a certain angle in a plane parallel to the fore-and-aft axis of the ship. Motion of A is brought about by the aviator who manipulates a hand-wheel operating through a pinion mating with rack F.

Projectors B and C are each equipped with an object screen which provides a characteristic image on the landing surface; as shown in Figs. 2 and 3, a rectangular bar is projected by B and two blunt arrowheads by C. The ground image from A is the altitude figure representing the particular altitude for which the projector is set.

In determining the altitude of the aircraft the pilot simply turns the wheel attached to the pinion mating with rack F until the light-beam from A intersects that from C at the landing surface. As A rotates, a toothed metal disc G attached to A and extending through the walls of the projector tube into the light-beam is caused to rotate in a definite manner by virtue of the action between the teeth of G and those of the fixed rack with which they engage. The rotating disc acts as a rotatable object screen, for it is pierced by openings in the form of the altitude numerals corresponding to the particular setting of the projector. Thus it is that the image seen upon the landing surface between the arrowheads projected by C is that of the altitude numerals cut in G, through which the light passes.

The altitude may also be observed on the transparent scale H, for an opening in the case containing the illuminating element of A allows a beam of light to fall upon the scale graduation which corresponds to the particular setting of the projector at which the ground images are seen to meet. The intersecting beams (from A and C) form two sides of a triangle whose altitude, determined with the instrument, is also that of the aircraft above the landing surface.

Inasmuch as 50 feet is the lowest direct indication of altitude for the instrument described, the illuminated bar image projected by the fixed source B is employed in estimating altitudes of less than 50 feet. It will be seen that as the aircraft approaches the ground with all three projectors stationary, the numeral "50" will move from the arrowheads toward the bar image. The prevailing altitude is then estimated by observing the position of the altitude image with respect to the bar and arrowheads.

For example, an altitude of 25 feet would be indicated when the numerals were observed midway between the other two images as shown by Fig. 2. The maximum direct indication of the instrument is 500 feet (see Fig. 3).

The night altitude indicator described has been used in Great Britain. Tests of the instrument conducted in this country have shown satisfactory results.*

The Germans have developed several types very similar in principle to the Jenkins device. One of the most interesting of these involves the projection of a beam downward and forward from a light-source fixed to the tail of the aircraft. Diffusely reflected rays are in turn thrown upward from the landing surface and pass through an optical arrangement in the cockpit where the pilot may observe his altitude by noting the position of a spot of light against a transparent scale.

Various possible modifications and improvements of the above instruments are readily apparent. For example, the Jenkins indicator might be simplified by omitting the second projector (B) whose advantages are of doubtful importance; for at altitudes below 50 feet a pilot would generally prefer to watch the landing area ahead of him rather than to observe the ground images and estimate their relative positions.

Further simplification might be effected by having both projectors (A and C) fixed to the aircraft in definite posi-

*Bureau of Standards tests conducted in flight and in the laboratory by A. H. Mears and J. B. Peterson.

tions. In this case the beams of light would intersect at the landing surface for only the one chosen altitude to which the arrangement had been adjusted. Other altitudes might be estimated by noting the separation of the images. For such purposes, it would be desirable to have the projected images characteristic of their source; otherwise difficulty would arise in readily determining whether the forward or aft image was leading.

To the writer's knowledge no tests have been conducted in this country to determine the characteristics of the German adaptations as mentioned above. However, one might reasonably doubt the feasibility under all conditions of using the diffusely reflected rays from a landing surface for other than direct observations.

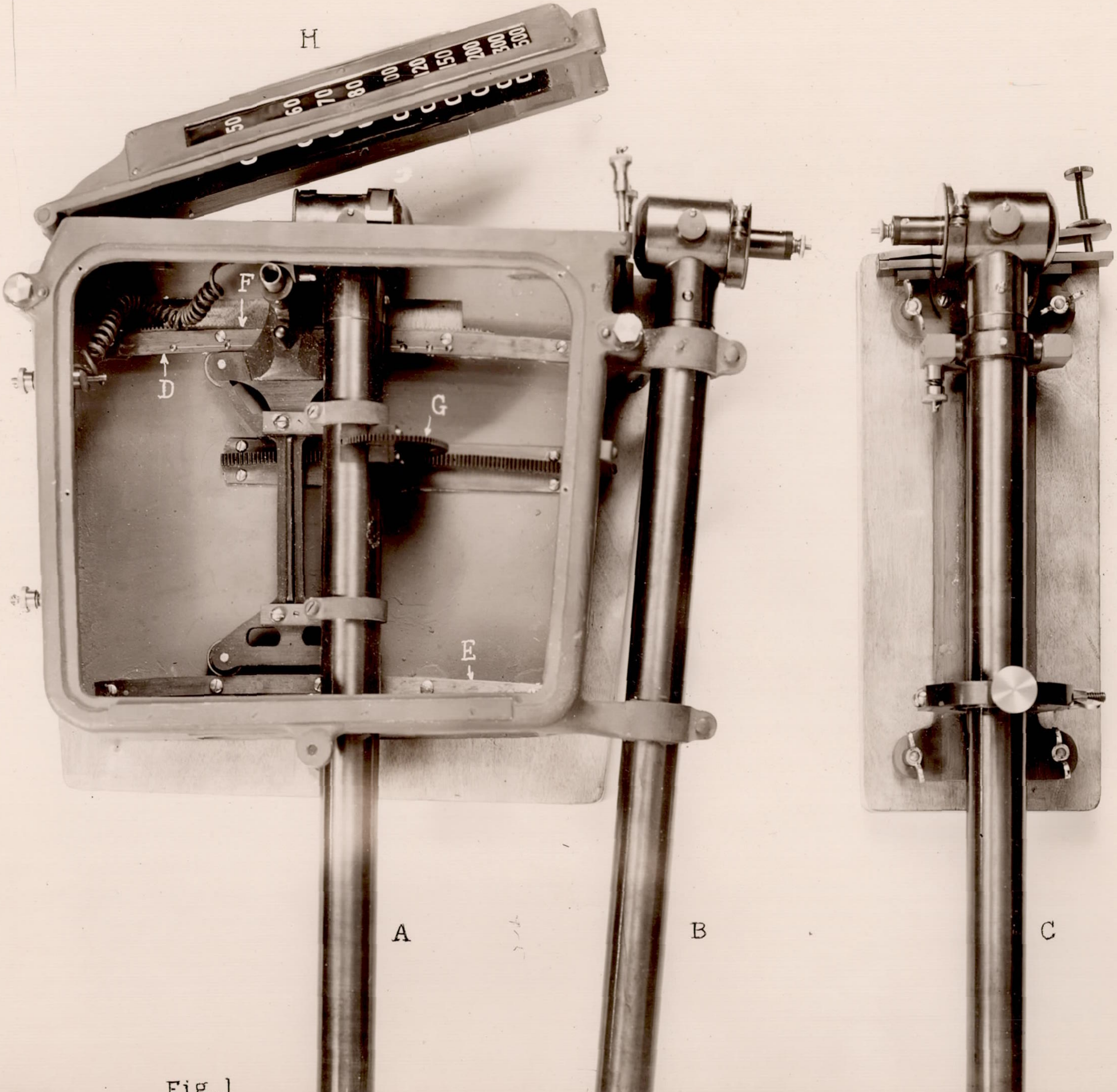
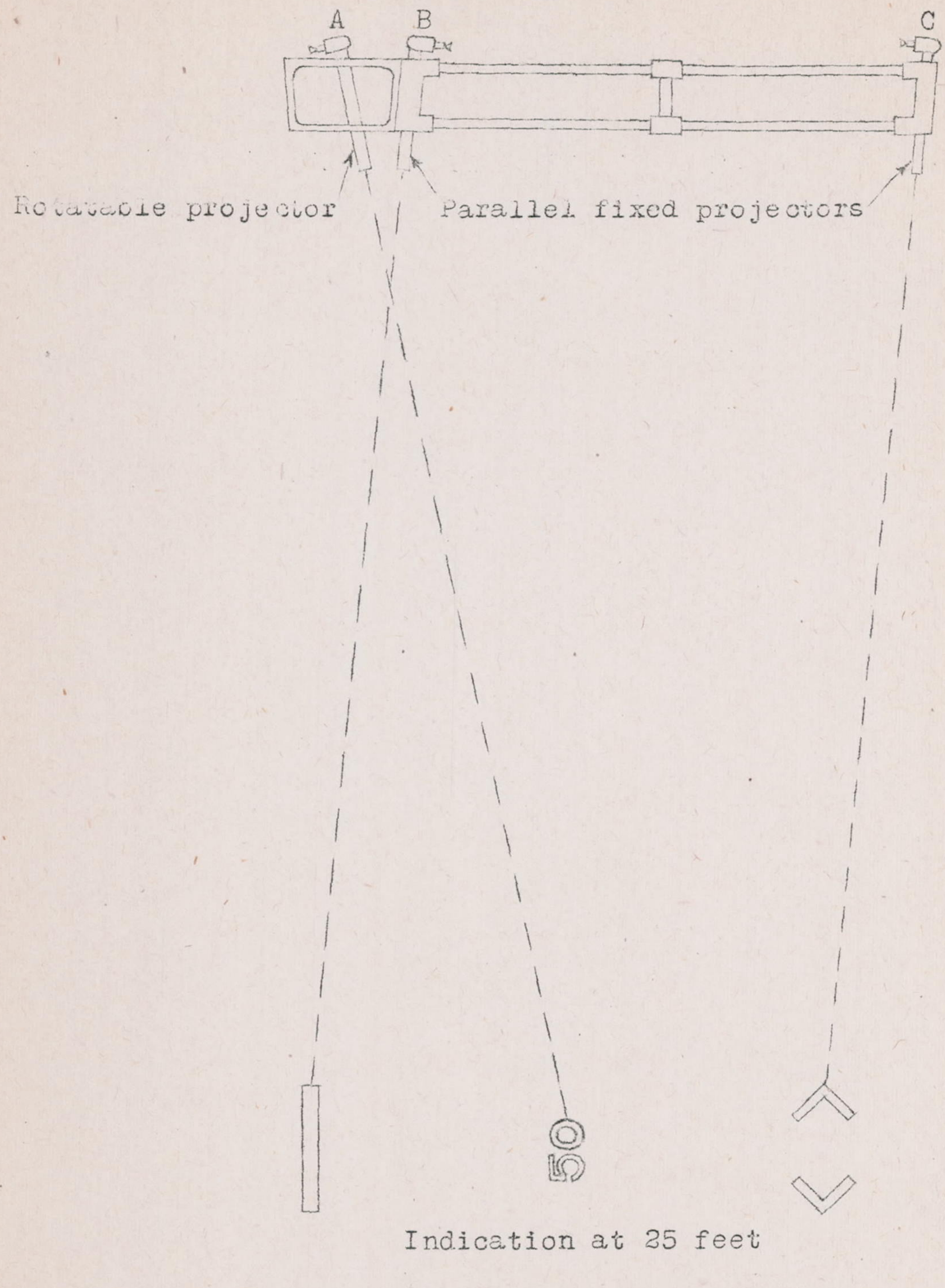


Fig.1



Indication at 25 feet

Jenkins night altitude indicator

Fig. 2

Indication at 50 feet

Indication at 500 feet

Ground images

of

Jenkins night altitude indicator.

Fig. 3.