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MEMORANDUM REPORT

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U. S. AIR FORCE
AIR MATERIEL COMMAND
WRIGHT-PATTERSON AIR FORCE BASE
DAYTON, OHIO

TSEAA-694-8A

3 MARCH 1947

PROPOSAL FOR PRESENTING LOCALIZER AND GLIDE PATH INFORMATION TO THE PILOT

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PREPARED BY
AERO MEDICAL LABORATORY
ENGINEERING DIVISION

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ARMY AIR FORCES
MATERIEL COMMAND

TSEAA-8/WFG/mee

MEMORANDUM REPORT ON

Date: 3 March 1947

SUBJECT: Proposal for Presenting Localizer and Glide Path Information to the Pilot.

OFFICE Aero Medical Laboratory Contract or Order No.

SERIAL No. TSEAA-694-8a Expenditure Order No. 694-16

A. PURPOSE:

1. The effectiveness of any blind landing system in which the pilot controls the aircraft is limited by the ease with which the pilot can interpret and act upon the information presented to him. The purpose of this report is to describe a possible method of presenting localizer and glide path information, from SCS-51 equipment, in a manner which should considerably reduce the training period required for successful landings.

B. FACTUAL DATA:

2. The "cross-pointer" instrument currently used with SCS-51 equipment to indicate localizer and glide path information to the pilot is difficult to fly except by pilots with considerable experience in its use. Moreover, this instrument requires a portion of the already scarce space on the instrument panel and gives the pilot an additional but infrequently used instrument to read while performing the difficult task of landing the airplane.

3. Modifications of the cross-pointer instrument are currently being designed by the Communication and Navigation Laboratory of the Air Materiel Command which have promise of being a considerable improvement over the present instrument. In one redesign of the cross-pointer instrument a repeater magnetic compass pointer is being added. To operate this instrument the pilot sets the heading of the runway into the repeater compass, adjusting it so that the heading of the runway being approached is at the top of the instrument. This method will give the pilot a direct check of his heading with reference to the localizer path and should constitute a significant improvement of the localizer indication of the instrument. It will probably not improve the instrument for flying of the glide path except as it may allow the pilot to spend more time on the glide path problem. The proposal to be described in this report is an outgrowth of, and extension to, this redesign of the cross-pointer indicator.

4. It is proposed in this report that the localizer indicator be combined with a remote indicating magnetic compass (or directional gyro) with a rotatable scale and that the glide path indicator be combined with the gyro horizon. The localizer and glide path indications would be presented in such a way as to provide moving reference points for the compass and horizon

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indicators. By keeping the compass pointer on the localizer reference mark, and the horizon on the glide path reference mark, the pilot would make an asymptotic approach to the ideal landing path. This type of indicator should considerably simplify the pilot's task, and would eliminate the necessity of an additional instrument on the instrument panel. The proposed type of indication could serve also for other types of equipment (Ground Controlled Approach, Pilot's Director Indicator for bombing, and VHF Omnidirectional Range) which provides track or glide path information to the pilot. More detailed explanation of this proposed method is given in Appendix I.

5. For the glide path-horizon combination a revised type of indicator is proposed, in which the small airplane moves instead of the horizon. Experimental evidence is cited, suggesting that this type of gyro horizon is more easily interpreted than the conventional instrument.

C. CONCLUSIONS:

6. The method of presenting localizer and glide path information offers a possible means of increasing the effectiveness of blind landing equipment by simplifying the task of the pilot who must interpret and act upon the information presented.

D. RECOMMENDATIONS:

7. That the Navigation Branch of the Communication and Navigation Laboratory, the Instrument and Navigation Branch of the Equipment Laboratory, the Aircrew Training Branch of Base Aircraft Operations Section, and the All-Weather Flying Division comment upon the possible merits or objections to the proposed method of presenting localizer and glide path information.

8. That the Aero Medical Laboratory, in cooperation with the Communication and Navigation Laboratory and the Equipment Laboratory, carry out research on the proposed localizer and glide path indication under simulated flight conditions to determine its suitability to human requirements.

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APPENDIX I

A. Proposal for Combining Localizer Indication with Remote Indicating Magnetic Compass with Rotatable Scale.

It is proposed that the localizer indication, now presented on the cross pointer instrument, be displayed as a moving reference mark on the remote indicating magnetic compass or a suitably designed directional gyro. One possible method of doing this is shown in Figure 1-A. This reference mark could be positioned by means of an electric meter as on the conventional cross pointer. After reaching a position near the localizer beam at a sufficient distance from the runway the pilot would set the heading of the runway at the top of the compass dial, making allowance for any known drift or compass deviations and variations. He would then take up whatever heading was necessary to line up the compass needle with the localizer reference mark. Doing so would result in a diagonal approach to the center of the localizer beam. As the wedge-shaped localizer path is entered, the localizer needle or reference mark would move toward center. If the pilot then continually changed his heading to keep the compass needle pointed at the localizer mark he would make an asymptotic approach to the line projected from the midline of the runway as shown in Figure 1-B.

It follows from the nature of the system that the localizer needle or reference mark will stop at the center of the scale if the pilot is able to make continual changes in heading as required and if there is no wind drift or error in compass setting. If, for example, there should be a 5 degree wind drift to the left, the localizer mark would come to rest with the magnetic compass pointer at approximately 5 degrees to the right of center, since a crab of that amount would be required to hold a course parallel to the localizer path. This would presumably result in a slight error in touchdown position on the runway, but it is believed that this error would be insignificant in magnitude except under conditions of zero ceiling and very large drift or compass error. In any event, the instrument itself would provide the pilot with a reasonably accurate estimate of the error due to drift or other causes and make it possible for him to reset his compass dial to a more nearly correct heading.

When flying an outbound course, away from the runway, the interpretation of the instrument, as on the present "cross pointer," would have to be reversed. During this part of the approach the pilot could set in the runway heading and fly the rear end of the compass needle away from the localizer reference mark in order to bring it to center. An alternative procedure would be to set in the reciprocal of the runway heading and fly the indicating end of the compass needle away from the localizer mark.

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Added to this indicator should be some means of preventing the pilot from using the localizer indication when it is not functioning. For this purpose it is suggested that a small flag cover the localizer mark at any time that this equipment is not operating, and that this flag carry the words, "localizer off." A similar type of flag is already included on the recent models of the "cross pointer" indicator.

This type of combined localizer and heading indicator should be useful not only for blind landings, but also for any other situation where flying of a particular track is required. It should be possible to have the same instrument serve as a pilot director indicator during bombing runs, as a track flying indicator for VHF omnidirectional range navigation, and as a visual indicator for Ground Controlled Approach (radar) equipment.

B. Proposal for Combining Glide Path Indication with Gyro Horizon Indicator.

It is suggested that the glide path indication could be combined with the conventional gyro horizon somewhat in the manner shown in Figure 2A. There is reason to believe, however, that this combination would be confusing to the pilot. In order to serve as a reference point for the horizon bar the glide path needle would move upward when the glide path is below the plane and vice versa. If the pilot were to interpret the glide path needle in terms of the reference airplane he would be led to make the wrong correction. Moreover, in flying a combined gyro horizon and glide path indicator it would probably be poor technique to attempt to keep the horizon bar on the end of the glide path needle, since this might lead to extreme attitudes and danger of stalls. Returns to the glide path are normally made by changes in throttle setting and relatively small changes in attitude of the airplane.

Many pilots, particularly during their early flying training, find the conventional type gyro horizon indicator to move in the opposite of the expected direction. A number of people have suggested that it would be more natural to have the horizon bar remain fixed with respect to the instrument panel, and to have the small airplane indicate the movements of the aircraft. Thus, the small airplane would move up when the plane is put into a climb and rotate clockwise to indicate a right bank, both motions being exactly the reverse of the motion of the horizon bar in the conventional instrument. There is ample reason to believe that already trained pilots could shift to this new type of indication without difficulty. An experimental combined gyro horizon and directional gyro, built for the Navy, substitutes this type of movement of the indicator airplane for movement of the horizon. Two research studies, one by Loucks (2) at the AAF School of Aviation Medicine and another by Brown (1) in Great Britain, have shown that this type of indication is easier to fly in the Link Trainer by individuals not already trained on the conventional instrument.

For the reasons discussed in the preceding paragraphs, a combined glide path and horizon indicator as shown in Figure 2-B is proposed. Figure 2-B shows a direct front view of the instrument face. On this indicator the

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horizon would remain fixed with reference to the instrument (except for a slight vertical adjustment to correct for parallax). The airplane silhouette would move up to indicate climb, clockwise to indicate right bank, and vice versa. The small diamond near the top of the instrument would rotate with the airplane silhouette to indicate the actual angle of bank, thus avoiding the contradictory relationship between the bank indication on the conventional gyro horizon and the rate of turn indicator. There is ample reason to believe that already trained pilots could shift to this new type of indication without difficulty.

In Figure 2-B the glide path reference marker is shown as an enlargement on the end of the meter needle, and would indicate the direction of the glide path from the airplane. The interpretation by the pilot of where he is with reference to the glide path should be immediate and direct. The corrective action required, in terms of throttle setting and attitude change, should likewise be readily apparent to the pilot. In flying this instrument the pilot would be instructed to keep the meter needle centered over the miniature airplane, by the combined use of throttle and elevator (or elevator trim). In a normal glide the miniature airplane will be only slightly, if any, below center. In a perfect approach, therefore, the plane might be slightly above the actual center of the glide path, but this deviation would be insignificant in magnitude at the touchdown point.

It is suggested that when inoperative, the glide path needle be in the extreme upper position and hidden behind a baffle. This would make flying by it impossible and would remove it as a distraction when it is not functioning.

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2. Loucks, R. B. Evaluation of aircraft attitude indicators on the basis of Link Instrument Ground Trainer performance. AAF School of Aviation Medicine Research Report, Project No. 341, Report No. 1, 1945.

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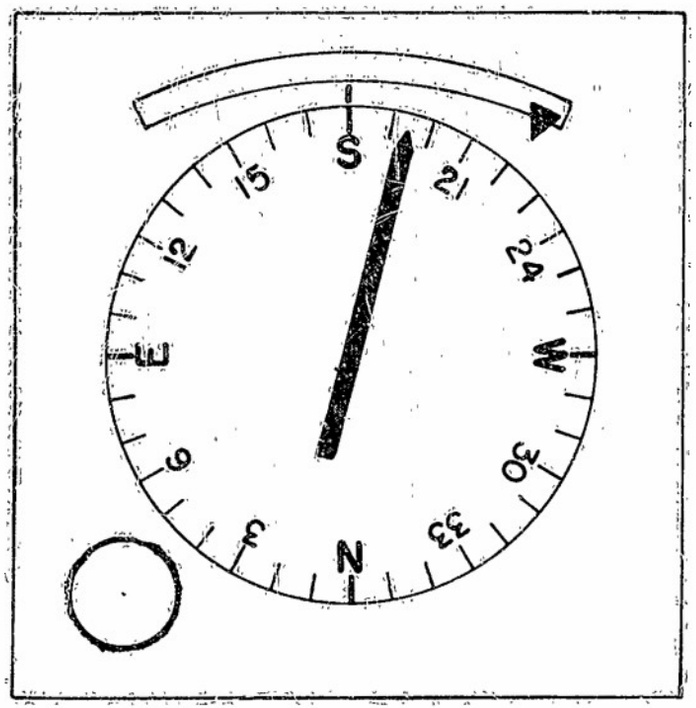
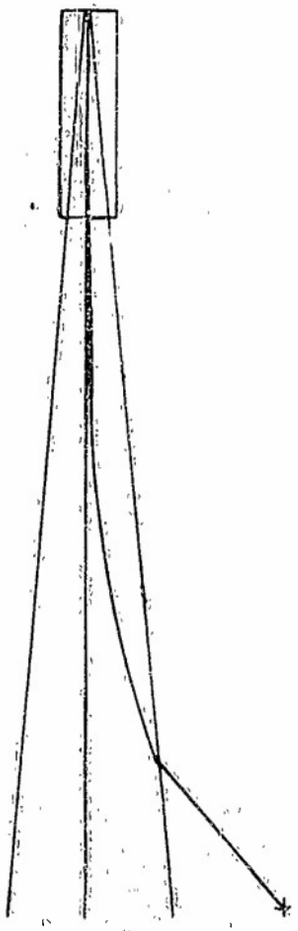


A

INDICATOR



B

THEORETICAL FLIGHT PATH

Fig. 1. Localizer Indicator Combined with Remote Indicating Magnetic Compass (with Rotatable Scale).

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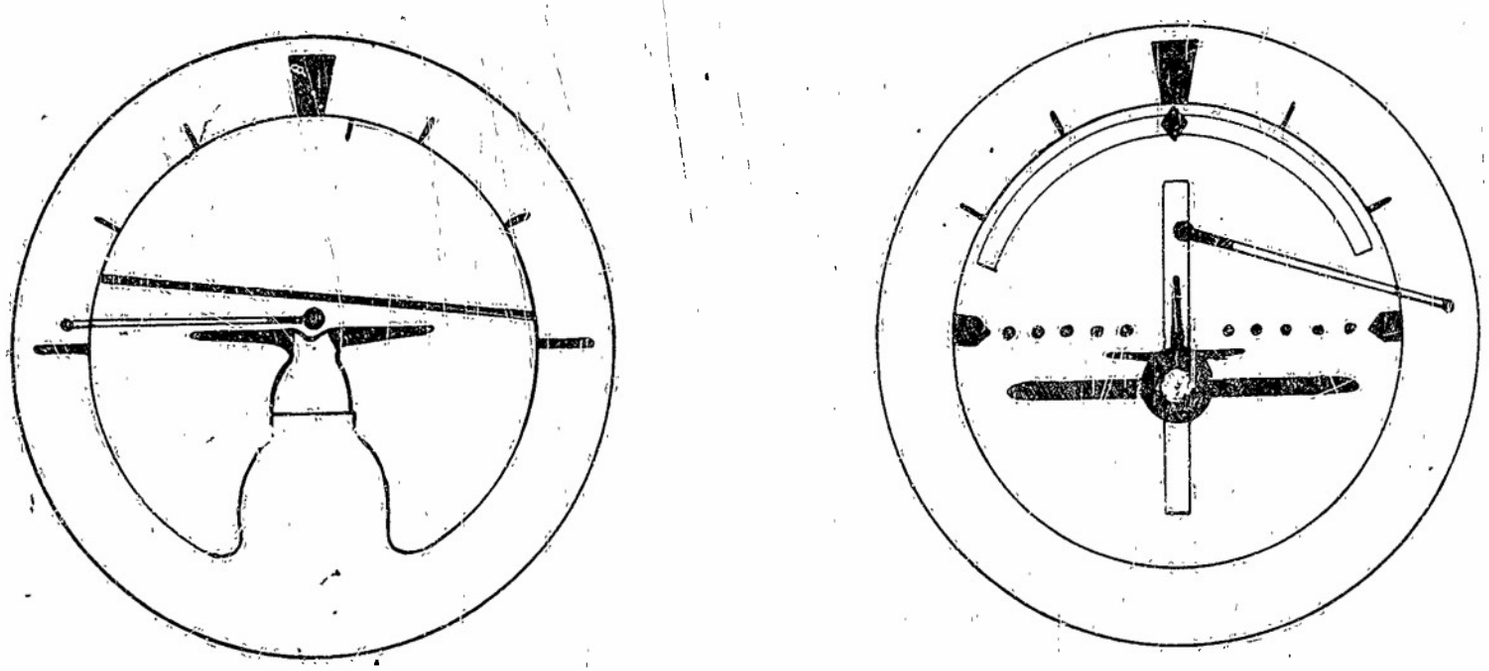

A

CONVENTIONAL GYRO HORIZON

B

SUGGESTED MODIFIED GYRO HORIZON

Fig. 2. Glide Path Indicator Combined with Gyro Horizon Indicator.

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M.C.
1/29/47
W. H. Zeth
M. J. Warrick

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