BLIND-APPROACH PRESENTATION

Stereoscopic Range Indication Combined with Essential Flight Information

By MAJOR G. H. PARKES

A RECENT article by "Indicator" (January 27th, 1947) included some apt and outspoken comments on the subject of blind-approach systems and their unnatural methods of presentation of information to the pilot. The author, who is in full agreement with "Indicator's" views, has for some time past been working on the design problems associated with this question, as there is no doubt that there exists at present a definite need for a more natural and compact method of presenting to the pilot all of the information he requires during a blind approach.

In evolving the system which this article describes, an attempt has been made to approach the problem from a new angle, by first endeavouring to determine the optimum method of presentation from the pilot's point of view, and then trying to adapt this method for satisfactory operation by the energy recovered from the appropriate signals radiated by the transmissions from existing B/A systems. In the following description the essential items of information required during a blind approach are dealt with separately in the following order:—(a) Range from estimated touch-down point. (b) Position in the beam. (c) Airspeed. (d) Height above ground level.

Clearly, a normal daylight landing carried out in good visibility is effortless for the pilot because be obtains continuous and co-ordinated information relative to range, height and plan-position, through the medium of natural stereoscopic colour vision. For this reason, any system intended to provide similar information during a blind approach should endeavour, as nearly as possible, to present it in a similarly natural manner. Unfortunately, a radar television picture of the approaching runway, presented in colour with full stereoscopic effect, is not at present a practical proposition, owing to the weight of the necessary airborne VHF equipment and to the relatively poor definition of the picture.

Continuous Range Presentation

If one considers an aircraft operating on a clear, calm day, making a series of practice approaches down the B/A beam to an airport runway, it will be apparent that, provided the machine is always flown accurately down the centre of the beam, the actual physical details comprising the view of the approaching runway as seen from the pilot's seat will be identical on each occasion; the only quantity capable of variation is the apparent rate of approach. Let us suppose that a miniature cinematograph camera, designed for stereoscopic photography in colour, is fitted in the nose of this hypothetical aircraft, and that a film record is made of a "perfect" beam approach. When this film is run through the projector of a stereograph viewing apparatus, an observer will receive a startlingly real impression of being seated in the nose of an aircraft during a daylight approach down the beam to the particular runway of the airport in question. Furthermore, by varying the speed at which the film is being run through the projector, the observer will automatically vary the speed at which the runway appears to be approaching him.

> *LAST week our contributor "Vertigo" stressed the importance of not overlooking the vital link between the dashboard and the controls—the pilot. He drew attention to that dangerous moment when, after a long flight, the pilot suddenly has to shift his attention to a totally different set of indications for the let-down and final approach in bad weather.*
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> *The author of the present article suggests a scheme which, if proved practical, will provide the pilot with an artificial but highly realistic view of what he would see if he were making the approach in perfect visibility.*

Here, then, is a possible solution to the question of how best to present continuous range information in a natural manner, for it will be appreciated that, if means can be contrived whereby the speed of operation of the projector motor may be placed under the control of the range signals transmitted by the particular B/A system, it becomes possible for the indicated range to be kept in step with the actual range throughout the period of approach.

To make this point clearer, it is convenient to consider the case of a pilot and co-pilot seated side-by-side in the cockpit during a practice beam approach in daylight. Imagine that the pilot looks straight ahead, through the windscreen, at the runway, while the co-pilot looks through the eyepieces of a small and compact version of the stereograph viewing apparatus, through the miniature projector of which is passing the film of a previous daylight beam approach to the same runway. Under these conditions the details of the view of the runway presented to both the pilot and co-pilot will be the same.

If we further assume that, at the moment the film started to move through the projector, the indicated range as seen by the co-pilot is synchronized with the actual range as seen by the pilot, and that thereafter the speed of operation of the projector is so controlled by the B/A transmission signals that the indicated range remains always in step with the actual range, then under those conditions there will be nothing to choose between the indirect view seen by the co-pilot as distinct from the direct view seen by the pilot. When, therefore, visibility is such that no direct view of the runway is possible, the pilot may use the indirect but equally natural view of that same runway afforded him by the stereograph viewing apparatus.

In practice, the realization of the conditions assumed in the preceding paragraph is not such a difficult problem as may at first be supposed. It is not, however, intended at this stage to describe the method of control evolved, as the successful operation of the system depends upon the accuracy with which the aircraft is held in the centre of the beam during the period of approach, and this brings us to the next item on the list, namely, information relative to the position of the aircraft in relation to the centre of the beam.

Position in Beam

An average person, visualizing in his mind a picture of the beam formed by, for example, the glide path and directional transmissions of the SCS.51 system, sees it as a cone of small included angle, extending from the touch-down point out into space, over and beyond the end of the runway concerned. This is a useful picture to have in mind, the only unnatural point about it being that the cone is not in fact visible. But supposing it *were* visible and that, so long as an approaching aircraft remained within the cone, the pilot could see a clear picture of the airport and runway ahead, although the visibility everywhere outside the cone was ten-tenths. Would a pilot have any difficulty in effecting an approach under these conditions? No, because if his aircraft swung off-course to port or starboard, or if it climbed above or sank below the edge of this imaginary cone of vision, the fact would be made known immediately to the pilot by a progressive "blacking-out" of his field of vision, originating

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from port or starboard, or from top or bottom, according to the position in which his aircraft was cutting across the edge of the cone into the conditions of zero visibility beyond.

Now it has already been suggested that it may be possible to provide continuous range presentation in the form of a natural-colour, stereoscopic, cinematograph film reproduction of a perfect approach, which gives a picture of the approaching runway that is true in every respect, *provided that the aircraft is held in the centre of the beam.* Suppose, therefore, that we arrange that this picture shall only be visible to an observer so long as the aircraft does, in fact, remain within a few degrees of the centre of the beam. We shall by this means guard against the possibility of the range picture falsely representing plan-position, or height above ground level, actually obtaining at any instant during the approach ; in other words, if the range picture is not a true one, then there must be no picture at all.

The simplest way to achieve this end is to arrange that the picture shall be "blacked-out" progressively, from right or left, or from top or bottom, in the manner described when discussing the imaginary "cone of vision" in the previous paragraph. Fortunately, it is a simple matter to arrange for such a method of indication, since it is only necessary to take our old friends the centre-zero microammeters (normally used to indicate departure from the glide-path or directional transmission data) and, utilizing them in a slightly modified form, to introduce them at some suitable focal point in the optical system of the range picture presentation in such a manner that the deflections of the respective needles cause appropriate "blacking-out" from the edges of the range picture. We have thus succeeded in presenting to the pilot such information relative to the position of his aircraft in the B/A beam that, after the minimum of practice, he will receive the information subconsciously and will automatically tend to make the appropriate corrections on the normal flying controls, while at the same time keeping his attention fixed on the range picture of the approaching runway.

Airspeed and Height

It cannot be denied that, during a normal blind approach, it is desirable to keep a close watch on the A.S.I. lest a too intense concentration on the B/A and other instruments should allow a falling-off of airspeed to pass unnoticed, with horrific consequences. For a similar reason, no pilot can afford not to keep a careful eye on the sensitive altimeter, in case unforeseen distortion of the beam is calmly directing his aircraft into the deck. This being so, it is of little use to provide a splendidly natural method of continuous range and beam position presentation if the pilot is required continually to keep shifting his attention from the range picture to the instrument board. Clearly, matters must be so arranged that the pilot, while keeping his attention concentrated on the range picture, can at the same time see, out of the corner of his eye, the indications of the A.S.I. and the sensitive altimeter.

In operation, the stereograph viewing apparatus which provides the range picture is temporarily located, as will be described later, in a position in front of the pilot's face so that he may look closely and comfortably into the eyepieces whilst remaining seated facing forward in the normal position. Consequently, a simple system of optical lenses can be placed in the bottom part of the apparatus in such a manner that, by suitable adjustment, the dials of any two single instruments located on the dashboard may be "picked out," magnified, and their images projected on to the bottom part of the range picture. Thus the pilot, watching the range picture of the approaching runway and maintaining the aircraft in the beam as previously described, is all the time conscious of the indications of the A.S.I. and sensitive altimeter.

External Form and Method of Mounting

Preliminary investigations suggest that an outer container, manufactured in the form of a box of roughly cubic shape with sides some six inches square, should be of adequate size to accommodate the required mechanism without being too bulky from a practical aspect. The complete apparatus in this form should weigh some six to eight pounds only.

This box is to be mounted by means of a counterbalanced arm in a manner which allows that, while the box is normally stowed flush with the underside of the roof, the pilot may, by reaching up with his right hand, swing it down in front of him, where it becomes automatically secured rigidly in position. He may now look closely through the usual contoured sponge - rubber face - guard provided into the eyepieces of the stereograph viewing apparatus mounted inside. When the apparatus is no longer required, a firm push sideways with the left hand will cause the box to swing back up to the roof, where it once more becomes locked in the stowed position.

Construction

The construction is based on a special design of miniature cinematograph projector, equipped with an integral optical system permitting one observer to obtain a correct stereoscopic view of an appropriate film. This projector is und[er] the very precise speed control of a governor, which is capable of being pre-set to give any desired basic operating speed and is also capable of being altered automatically while running. An electro-mechanical computer mechanism, linked with both the governor control and the film-track control, serves two purposes. In the first place it measures elapsed time intervals occurring between certain recorded range indications on the film track and certain other range indications received externally by the aircraft, and feeds a proportionate mechanical correction to the governor.

In the second place it ensures repeated synchronization of indicated range with actual range, by a method of mechanical interlock. In a B/A system employing the marker-beacon range-signal method these two functions of the computer are separate and distinct, forming a corrective cycle repeated each time the aircraft crosses a beacon. On the other hand, with a system of continuous range signals, such as could be provided by ground or airborne radar equipment, the two functions are merged into one.

Separate film records are made of daylight correct beam approaches to each B/A runway of any one airport. These records, in the form of small reels of miniature film designed to run for about three minutes and consequently of small diameter and negligible weight, are mounted on a common spindle and may be inserted as a unit into the projector. Subsequently, the film of any particular runway may be pre-selected by means of an external dial. The spools containing the film records of approaches to the runways of any given airport are intended to be issued to airline and other operators, who will ensure that their machines always carry the appropriate spools for the terminal and diversion airports of the route being operated.

Method of Operation

In actual operation, on entering the control zone the pilot will contact control, who will give him the correct runway number for pre-selection and will give him also an estimated approach ground speed, based on knowledge of local wind velocity and direction and on aircraft type and operating weight. The pilot pulls down the apparatus and pre-selects the correct film number and also the initial basic operating speed of the projector motor, by means of another dial calibrated directly in knots. He then pushes the apparatus aside again for the time being.

On leaving the orbit circuit and passing through the approach "gate," the pilot, for the first few moments, controls his aircraft in the beam by

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means of the normal system of instrument presentation, retained as a standby. As soon as a warning lamp indicates that the viewing apparatus has been automatically started by the first B/A range transmission signal, he pulls down the box and, looking through the eyepieces, proceeds to give his undivided attention to the range picture presented, until such time as his first officer informs him that the aircraft has broken ceiling.

The pilot now sees a natural picture of the airport runway about three thousand feet below, and about six miles dead ahead. He knows that so long as the apparatus continues to present the picture it will be a true one, so far as range and position in beam is concerned, and that if anything should go amiss with the functioning of the apparatus the fact will be made known to him at once by the extinguishing of the picture and the lighting of warning lamps, when he can immediately push the box aside and carry on, on the normal presentation. All the time he is watching the picture of the approaching runway he is making a correct mental estimate of the distance of his aircraft to touch-down point, while the slightest deviation from the centre of the beam is made known at once in the manner described. On top of this, the indications of the A.S.I. and sensitive altimeter are always before him, optically projected on to the bottom of the picture. Provision for the detection of movement about the roll axis is purposely omitted, as it seems fairly certain that future practice will be to bring in commercial aircraft, during B/A, under control of one of the latest types of automatic pilot, control corrections being made on the trim knobs and throttles.

In conclusion, the author feels that it is a bad tendency these days to lay too great emphasis on the merits or otherwise of one particular B/A system.

Surely it would be better practice to make all such blind approaches with the aid of one good system, providing main and standby methods of presentation and backed up by a second, independent B/A system (such as G.C.A. ?) which will serve to reassure the pilot by providing confirmation of the correctness of the approach he is making.

New Landing Gear

Cantilever Spring Struts : No Moving Parts : Low Parasitic Drag

A NEAT and ingenious form of landing gear has recently been developed by the Cessna Aircraft Company, Wichita, Kansas.

Essentially the new design consists of two cantilever spring struts of chrome-vanadium steel carrying the wheels. Landing loads impose lateral bending in each spring leg, the resultant being a splaying of the struts and a consonant increase in track.

Since the shock *absorption* characteristics of any form of metal spring are limited by the molecular friction of the metal, and can thus be very slight, one would naturally imagine that liberation of the energy stored during the landing impact would cause the aircraft to bounce back into the air. That this does not, in fact, occur is ascribed to the lateral deformation of the tyres acting as snubbers during the "rebound," and it is claimed that many extremely hard landings have been made without any apparent damage whatsoever.

Fatigue tests to determine the life of this form of undercarriage under normal landing and ground handling conditions were effected by imposing deflection equivalent to normal landing or taxying at a specific number of cycles per minute. A production unit was subjected to this test and completed 1,961,124 cycles before failure: another unit was subjected to a test equivalent to unusually hard landings (no data are given by the manufacturers as to the test conditions) and endured 145,131 cycles. In each of these cases the life of the undercarriage would far exceed that of the aircraft.

The new Cessna undercarriage showing the unusual thinness of the struts.

Cardinal points of advantage offered by this new development would seem to be complete freedom from maintenance requirements since there are no moving parts, and very small parasitic drag by virtue of the extreme thinness of the spring strut.

KING'S VIKING FOR N.Z. ?

REPORTS from New Zealand state that the King's Viking is to go on tour through Australia and New Zealand when the present Royal Tour of South Africa is finished. The reports may be true, or there may be some confusion with the Viking which left Hurn airport recently on a goodwill tour to the Antipodes.

TRANSATLANTIC "SPIT"

THE longest journey ever attempted by a fighter started last week when ex-R.A.F. pilot, South American Capt. Jaime Storey, flying a Spitfire, left England for Buenos Aires. One leg of the journey will be non-stop over a distance of 1,850 miles from Dakar to Natal, and is estimated to take about 8½ hours. The "Spit" is the personal property of Capt. Storey, and is fitted with extra tanks to give it a range of ten hours. During the war Capt. Storey was engaged on aerial photography with the R.A.F.

MODEL GALA AT LANGLEY

BY permission of Hawker Aircraft, Ltd., Langley airfield will be the venue for the Northern Heights Model Flying Club Gala on Sunday, June 30th. The programme will include a flying display by full-size aircraft and contests for all types of models.

BOBBYSOX AVIATION?

A NEW school Link Trainer designed to assist teachers in making aviation realistic to pupils has now made its appearance on the American market. Like its big brother, the new Link can emulate most of the basic attitudes of real flight, and is equipped with standard instruments but no hood.

DIPLOMATIC JOURNEY

WE raise our hat to the First Secretary of the Belgian Legation at Teheran who lately flew to Teheran with his wife in a Percival Proctor I. Starting from Brussels and flying via Nice, Tunis, Benghazi, Cairo and Baghdad, 5,000 miles in all, the journey was completed without trouble apart from a heavy hailstorm over the desert.

A PIONEER REMINISCES

TALKING recently to the Yorkshire section of the Institution of Production Engineers, Mr. Robert Blackburn recalled some of his early experiences as a designer, constructor and pilot. Describing his first "flight" he said: "After racing along the sands at what seemed a dizzy speed, the machine certainly took off and then started a series of wobbles. Inexperience of manipulating the flying controls, and endeavouring to keep the machine straight by too jerky action, increased the wobble and eventually ended in a side-slanting dive from the dizzy height of approximately two feet. I had probably been in the air for a minute only, but it seemed ages when I eventually pulled myself together and looked at the wreckage. That was the end of a lot of work, and of my beautiful aeroplane." The same remark was probably made at some time or other by all pioneers of flying.