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APPROACH AND LANDING AIDS.

1. G.C.A. - GROUND CONTROLLED APPROACH.

G.C.A. is an American runway approach system consisting of a mobile Radar Station which is normally positioned about halfway along the runway in use and to one side of it. It has it's own mobile electrical power unit and the whole equipment can be easily positioned on any runway provided a prepared site is available. Only a limited number of G.C.A. units are in use (about ten) but a British version of G.C.A. is being prepared which will require fewer personnel to operate it and which will probably be housed in the Controle Tower with only the aerial system near the runway.

One of the outstanding advantages of G.C.A. is that an aircraft using the system requires no equipment other than normal R/T and no special skill is required by the pilot other than the ability to fly accurately on instruments.

When carrying out a G.C.A. approach it is futile for a pilot to do anything other than obey the directions of the G.C.A. controller; for instance, a pilot might be told to turn left five degrees and thinking the correction not enough might turn ten, the Controller observes the ten degree alteration and thinking it five will be inclined to think that a cross-wind is drifting the aircraft much more than he thought; he therefore has a false mental picture of the let-down.

Description.

The G.C.A. equipment consists of three main parts:-

(a) Radar "Search" system-For the initial location of aircraft.

(b) Radar "Precision" system-For an extremely accurate picture of the final approach.

(c) R/T Communication System-A flexible R/T system which allows the G.C.A. crew to communicate with the pilot and give him approach instructions on almost any V.H.F. channel which may be in the aircraft.

The Search System: Scans through 360° over an area of twenty miles plus radius.

The Precision System: The aerial array is in two parts which scan two-wedge shaped fields along the line of approach to the runway.
One scans horizontally through 20° to display the aircraft's track. The other scans vertically from 1° below to 60° above horizontal, to show position relative to the glide path. Each display is shown on two Cathode Ray Tubes one with a ten mile range, the other with a two mile range for extreme accuracy on the last part of the approach. The aircraft's flight path is continuously watched on these displays by an "Azimuth Tracker" and an "Elevation Tracker" who control the direction of the aircraft in feet horizontally and vertically from the correct approach path.
This information is displayed on two meters in front of the "Final Approach Controller".

This officer is in continuous R/T communication with the pilot and by observing the readings of the meters and if necessary the Azimuth and Elevation Displays which are located on each side of him, he is able to tell the pilot what alterations of course and height should be made for a safe approach, what his range is from the airfield and of suitable positions on the approach for cockpit drill to be carried out.

Procedure.

When G.C.A. facilities are required, the pilot should first call airfield control on the Universal Airfield Control channel (Mcs:). The Air Traffic Control Officer will then pass initial instructions and homing bearings as necessary. After the aircraft has been identified on the Search System-this is done by asking the aircraft to complete a "Dog-leg" when contact appears on the search screen-it is brought in to a datum point where it is taken over on a different R/T channel by the "Feed director". He manoeuvres it into it's final approach and instructs pilot when undercarriage should be lowered etc. On "Finals" it is taken over by the Final Approach Controller and is "Talked Down" until finally told to "Look Ahead and Land".

All R/T instructions should be repeated back to the G.C.A. controller to avoid errors but, on being handed over to the Final Approach Controller, the pilot is instructed not to acknowledge further instructions thereby avoiding delay in the critical part of the circuit.

REMARKS: From the point of view of service use, the following considerations are important :-

(1) Availability: Equipment is, at present, entirely American, obtained under Lend-Lease. Less than a dozen R.A.F. units are at present operational out of the total equipment at British disposal.

(2) Simplisity: From the pilot's point of view, operation is extremely simple, but considerable training and skill is required from it's operators.

(3) Reliability: Skilled maintenance is necessary but, provided this is available, it can be relied upon to operate satisfactorily. The radio units of the precision system are provided in duplicate. Heavy rain may "Flood" the P.P.I. so that aircraft contacts may become obscured.

(4) Flexibility: Ground equipment is mobile but requires hardstanding.

(5) Capacity: During "Operation Planefare" which provided a very severe check on the capacity of G.C.A., aircraft were being "talked down" at the rate of one every five minutes.

(6) Cost: The initial cost per unit, excluding installation, is over £20,000 but no extra equipment is required in individual aircraft.

(7) Staff: In it's present form a crew of thirty six men, including six officers is required to man each unit, over and above the normal Air Traffic Control Staff.

(8) Usefulness: Although an excellent approach aid, ground echoes in the final stages of the approach handicap the development of G.C.A. as a blind landing system and it's future may be restricted because of this.

(9) Development: Progress has been made- mainly in the U.S.A.- with a slightly altered system known as "Split" G.C.A. which works in conjunction with a Radar system known as Airfield Control Radar. The aerials of the precision system are mounted on a small fixed sight alongside the runway and are operated remotely from the Control Tower where the G.C.A. equipment is installed and operated. With this system the operation of the equipment can be carried out by the normal A.T.C. staff.

G.C.A. R/T PROCEDURE.

	EXAMPLE.	EXPLANATION.
(1)	This is Baker Seven to Lyneham Tower, request G.C.A.- Over.	Request for G.C.A. in initial call.
(2)	Lyneham Tower to Baker Seven, Roger, QNH 996-fly at fifteen hundred feet -Steer one zero zero-over.	Initial reply.
(3)	Baker Seven, what is your aircraft type ? - over.	From tower after receiving acknowledgement to 2.
(4)	"You are in sight".	To indicate that contact has been identified on search screen.
(5)	"Steer right zero three zero".	Courses to steer to Datum.
(6)	"Wrong. I say again- Steer right, zero three zero".	If order repeated back incorrectly.
(7)	"Fly at one thousand five hundred feet".	
(8)	"What is your altitude?".	Querying altitude if after lapse of time pilot has not reported a change of altitude.
(9)	"Maintain your present heading - or, You are on your downwind leg, you will land on runway two nine- or, you are on your crosswind leg ten miles north of the airfield".	To reassure the pilot that he still is in contact with G.C.A. transmission should be made fairly frequently, the expressions opposite for example may be used to fill in silences.
(10)	"Change to channel Baker and standby, acknowledge, over".	Change of V.H.F. channel.
(11)	"You are on crosswind leg, seven miles from airfield".	Position report.
(12)	"Perform cockpit check for landing".	
(13)	"Baker seven, this is the approach controller, do not acknowledge further instructions".	
(14)	"You are six miles from touchdown".	
(15)	"Your present heading is good,-track good".	
(16)	"Steer right, two seven five".	
(17)	"Loose altitude at 500 feet per minute".	
(18)	"You are fifty feet above the glidepath, adjust your rate of descent".	
(19)	"Forty feet above, twenty feet above- you are on the glide path".	
(20)	"Check landing gear down and locked".	"2-to-3 miles out."
(21)	"Land when in visual contact, runway is to your right- left- straight ahead".	When close to runway.
(22)	"Climb immediately to 1500 feet and report".	In case of obstructed runway, followed by explanation to pilot as soon as possible.

A.C.R. (Airfield Control Radar.)

(1) Operation.

A.C.R. MK.111. one version already developed, is similar to the G.C.I. equipment used for night fighter control. An aerial system scanning through 360° uses a normal P.PI. presentation on which the range of coverage can be adjusted to 25, 10, or 4 miles. Vertical range is restricted to 6,000 feet, but, owing to the characteristics of the aerial transmission, low angle cover is poor on the 25 mile radius.

(2) Purpose.

Airfield Control Radar is an adaptation of ground radar to provide air traffic controllers with an accurate picture of aircraft movements within it's area of coverage.

(3) Identification.

To permit identification of the different echoes, V.H.F. Cathode Ray equipment is provided as an integral part of the system, the bearing of any aircraft that transmits being shown as a line of light intersecting it's echo on the Cathode Ray Tube. It is intended that aircraft will orbit as their standard holding procedure and a special type of mechanical plotting board is being designed to record their identity and to aid the operators memory.

The Cathode Ray Tubes are normally located in the Control Tower.

(a) Approach Control Operator - 25 mile scale.
(b) Airfield (circuit) Control Operator - 10 mile scale.
(c) Air Traffic Control Officer - Adjustable scale as required.

In an emergency, the four mile range sweep can be used for controlled approaches to an airfield or to a particular runway, but no indication of height is available.

Developments.

(1) By fitting a coded responder beacon, similar to I.F.F. to the aircraft and interrogating it with an Interrogator built into the A.C.R., it is possible to display automatically the identity of any aircraft at selected bearing and distance. This appears as a code group of three letters alongside the P.P.I. and four aircraft per minute can be interrogated.

The effort involved in fitting and maintaining all aircraft with responder beacons make it unlikely that this will be introduced into the R.A.F. at the moment. It might, however, ultimately provide an answer to many problems of A.T.C. and of air defence.

(2) Moving Target Indication:

This technique allows only returns from moving objects to appear on the P.P.I. and is obviously of great value in removing the snag of ground returns which obscure aircraft contacts as the aircraft approaches the ground.

(3) Operation on higher frequencies in future marks of A.C.R. will make them less subject to interference by precipitation and improve range and clarity of presentation.

(4) A.S.M.I. (Airfield Surface Movement Indicator.)

Is an extension of the principle of A.C.R. applied to assist in controlling aircraft on the ground.

COMMENTS.

(1) Availability.

A.C.R. with V.H.F./CR/DF identification is unlikely to come into general use for a number of years and the finalised production form has not yet been decided.

(2) Simplicity.

From the point of view of boath aircrews and A.T.C. staff, A.T.C. will considerably simplify boath instrument landings and safe and afficient air traffic control. A course in the operation of the equipment will be required by all the A.T.C. staff.

(3) Reliability.

There is apparently no reason why the system should not be reliable although proof awaits trials of the production prototypes.

(4) Flexibility.

The system could ultimately be provided in fixed, mobile or air transportable form and should be suitable for sitting at most airfields. Providing V.H.F. R/T equipment is available, all aircraft will be able to make common use of airfields using this system.

(5) Capacity.

The system is specifically designed to increase landing rates and lessen the risks of collison.

(6) Manpower.

As the A.T.C. staff will operate the equipment, no special staff will be required. Maintenance will require at least two radar mechanics per installation.

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