Development of a Portable Radar Simulator

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DEVELOPMENT OF A PORTABLE RADAR SIMULATOR*

SUMMARY

This report describes the development of a portable training device for the basic training of air traffic controllers in radar-vectoring and aircraft-spacing procedures Initial results indicate that such a device will speed up radar-training operations, provide more thorough training, and result in sizable economies in the over-all program

INTRODUCTION

In the early days of radar traffic control, no radar-training devices were available All practice runs had to be made on the actual radar equipment, using real aircraft for targets Per man, the cost of that training was very high, not only because of the high cost of aircraft operation, but because of the low degree of aircraft utilization due to equipment outages, poor weather, and the lack of a continuous supply of aircraft Use of real radar equipment for primary training often was undesirable because of interference with normal airport traffic Practice approaches often involved cross-traffic operations and frequent congestion of communication channels For these reasons it became desirable to develop some means of simulating radar-target operations for training purposes As a result, several types of radar-training devices were built

EARLY MODELS

One of the first designs was an attachment to a Link trainer This type was quite satisfactory for training programs conducted at a centralized location, however, it was too bulky to be carried around to various locations for local training programs The characteristic of portability was quite desirable because large amounts of travel funds could be saved if all basic training could be conducted at the home bases of the trainees

In 1950, a very simple portable radar simulator was developed It is shown in Figs 1, 2, and 3 This simulator presented a single spot of light to simulate an aircraft target moving across the display The target was motor-driven to move at a constant speed, and the direction of travel could be controlled manually in turns to any desired heading This simulator was used first at the Civil Aeronautics Administration Technical Development Center in the development of the tangential approach system [1] It then was used for several years in basic radar training at a number of airport traffic-control towers and at the CAA Aeronautical Center

THREE-TARGET SIMULATOR

Meanwhile, simulation studies at TDC indicated that the most effective function of terminal-area radar was not to conduct PPI approaches but to guide aircraft into the landing system and to space them precisely behind each other on the final approach path [2] To provide training in this phase of the operation, a simulator obviously was required which would be capable of presenting two or more controllable targets simultaneously on the display Therefore, work was started on the design of a three-target simulator To avoid mechanical interference

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[1] C M Anderson, N R Smith, T K Vickers, and M H Yost, "A Preliminary Investigation of the Application of the Tangential Approach Principle to Air Traffic Control," CAA Technical Development Report No 149, October 1951.

[2] C M Anderson and T. K Vickers, "Application of Simulation Techniques in the Study of Terminal-Area Air Traffic Control Problems," CAA Technical Development Report No 192, November 1953

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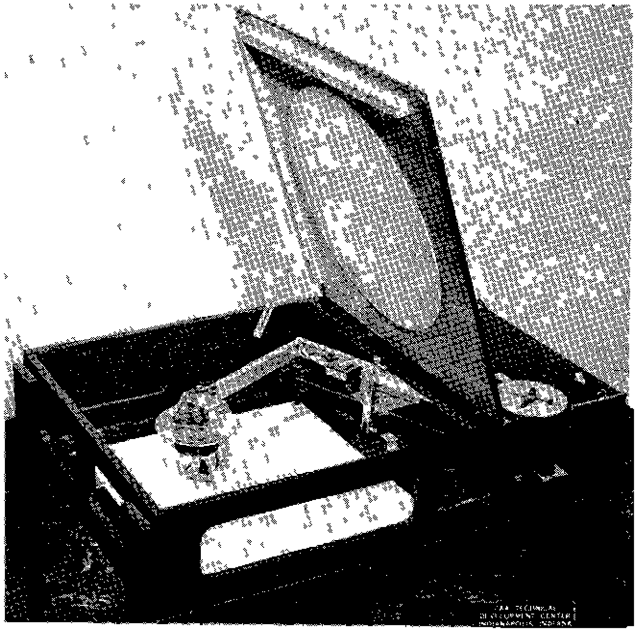

Fig 1 Single-Target Radar Simulator

Fig 2 Single-Target Radar Simulator in Use

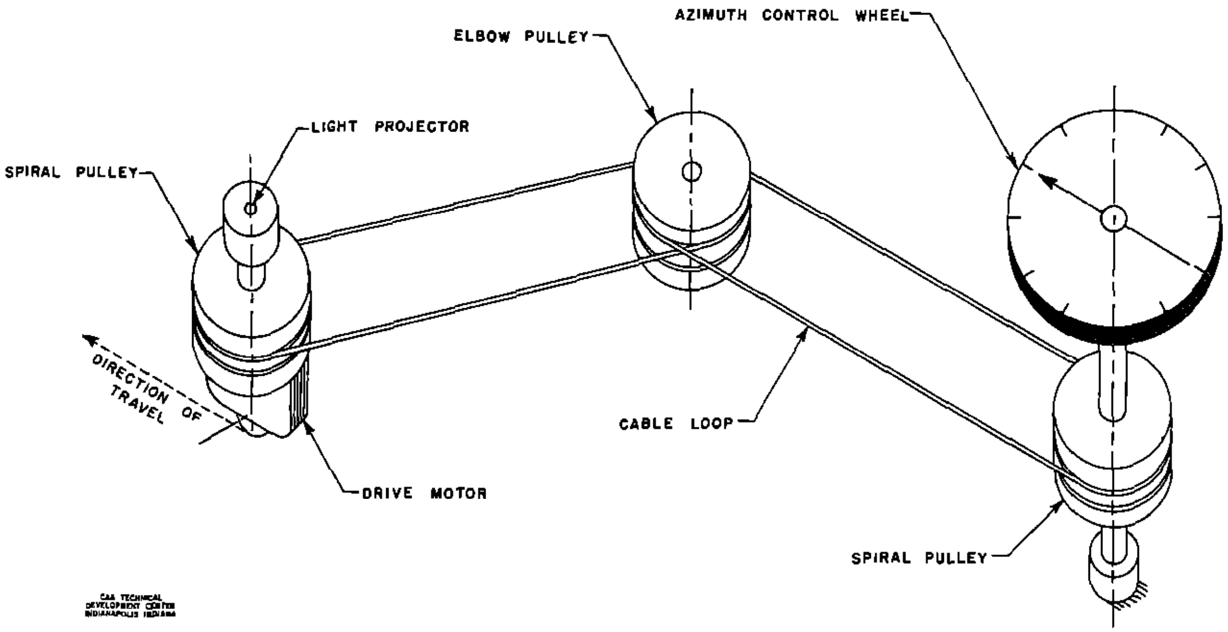

Fig 3 Mechanical Hookup of Single-Target Radar Simulator

between two or more drive units moving on a common surface, the simple mechanical drive of the type used in the previous design could not be adopted Instead, an entirely different type of drive mechanism employing optical means of target movement was designed, as shown in Fig 4

Each of the three-target drive units is a motor-driven integrating device, employing turning motors to produce standard rate, 3° per second turns in either direction Targets are displayed on a 12-inch scope face, as shown in Fig 5 Target speeds are controllable from 100 to 700 knots using a 40-mile radar range, or from 50 to 350 knots using a 20-mile radar range Figure 6 shows the layout of one of the target-control panels, and Fig 7 presents the wiring diagram for that installation

The entire simulator fits into a shipping case approximately 16 by 18 by 24 inches, as shown in Fig 8 The power supply is installed beneath the three-target control panels shown in Fig 9 The individual target-control panels may be left in their rack as shown in Fig 9, or they may be detached for remote operation, as shown in Fig 10 For stowage, the scope unit which contains the target-drive mechanism is locked in the retracted position as shown in Fig 10 For operation, the scope unit is tilted forward toward the operator as shown in Fig. 11 By opening a door in the side of the scope box, individual targets may be positioned in the scope face manually at the start of each run

DESIRED REFINEMENTS

The prototype three-target portable radar simulator has been used for several months at the Indianapolis airport traffic control tower and at the Army Electronic Proving Ground, Fort Huachuca, Arizona As a result of this operation in basic radar training, the following minor design changes are recommended

1 The power supply operates whenever the cord is plugged into a power source For additional convenience, it would be desirable to provide a master switch with a pilot light located in a prominent place on the chassis

2 For economy, the prototype simulator was equipped with surplus autosyns for heading indication on the control panels These autosyns originally were designed for operation at 26 volts, 10 cycles per second (cps), but they actually operate at 6 volts, 60 cps As a result, the heading indicators occasionally lag noticeably during turns To eliminate this difficulty, it is recommended that the present synchros be replaced with units of a more suitable type

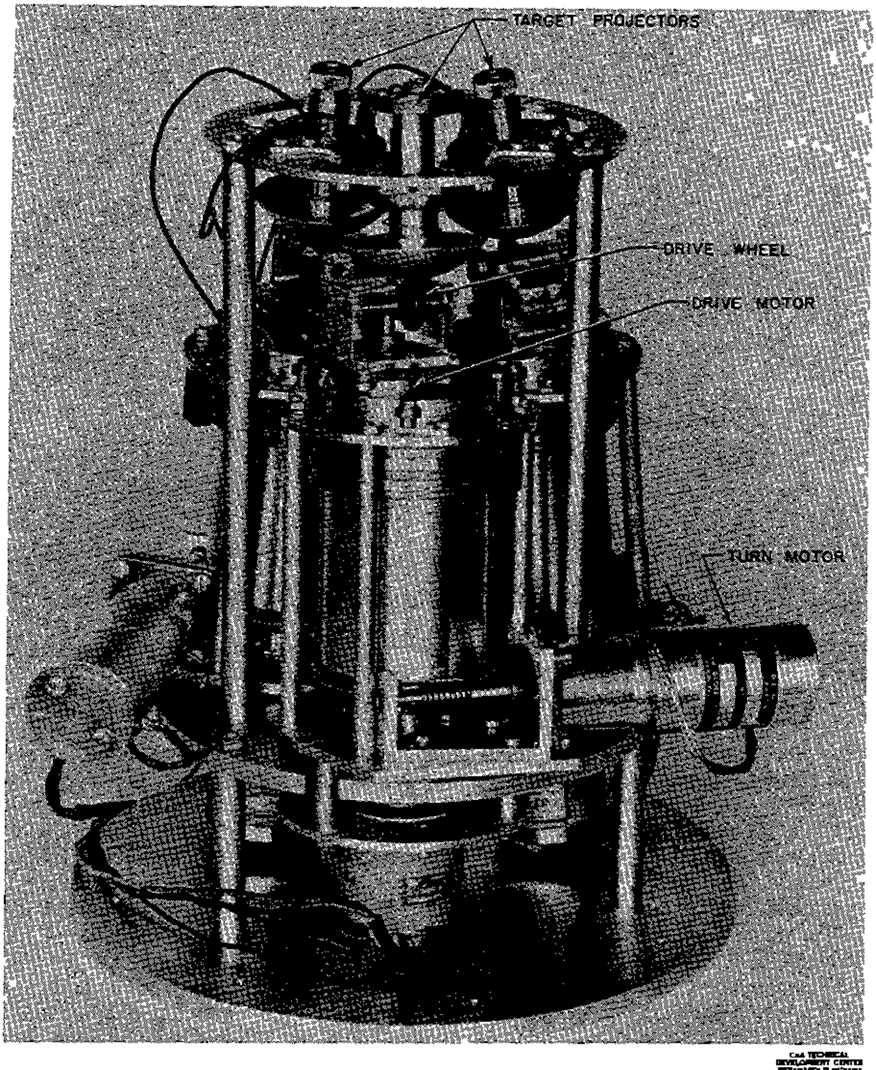

Fig. 4 Drive Mechanism for Three-Target Simulator

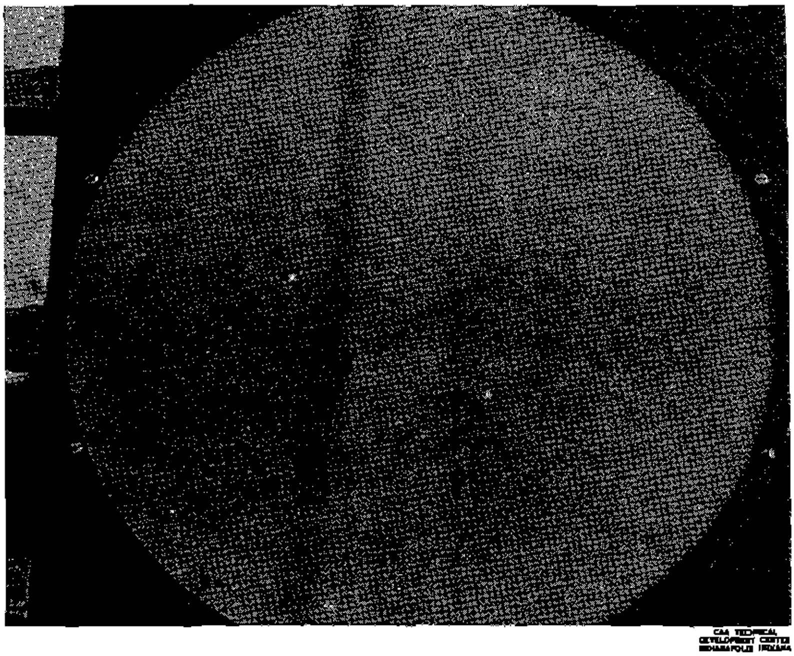

Fig 5 Target Display

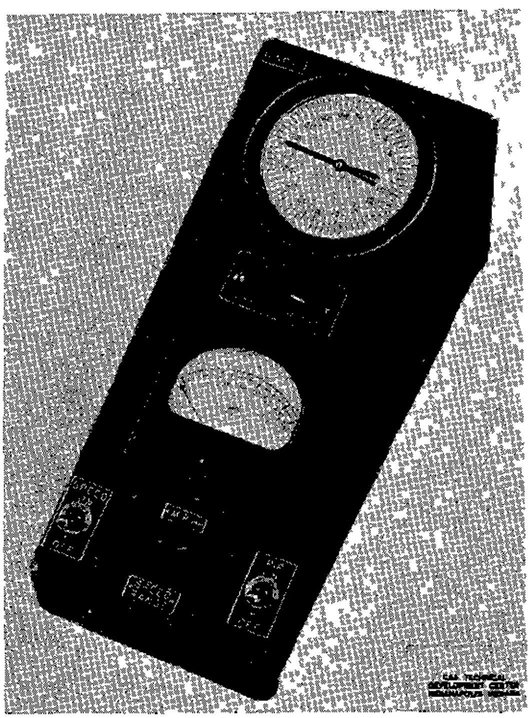

Fig 6 Individual Target Control Panel

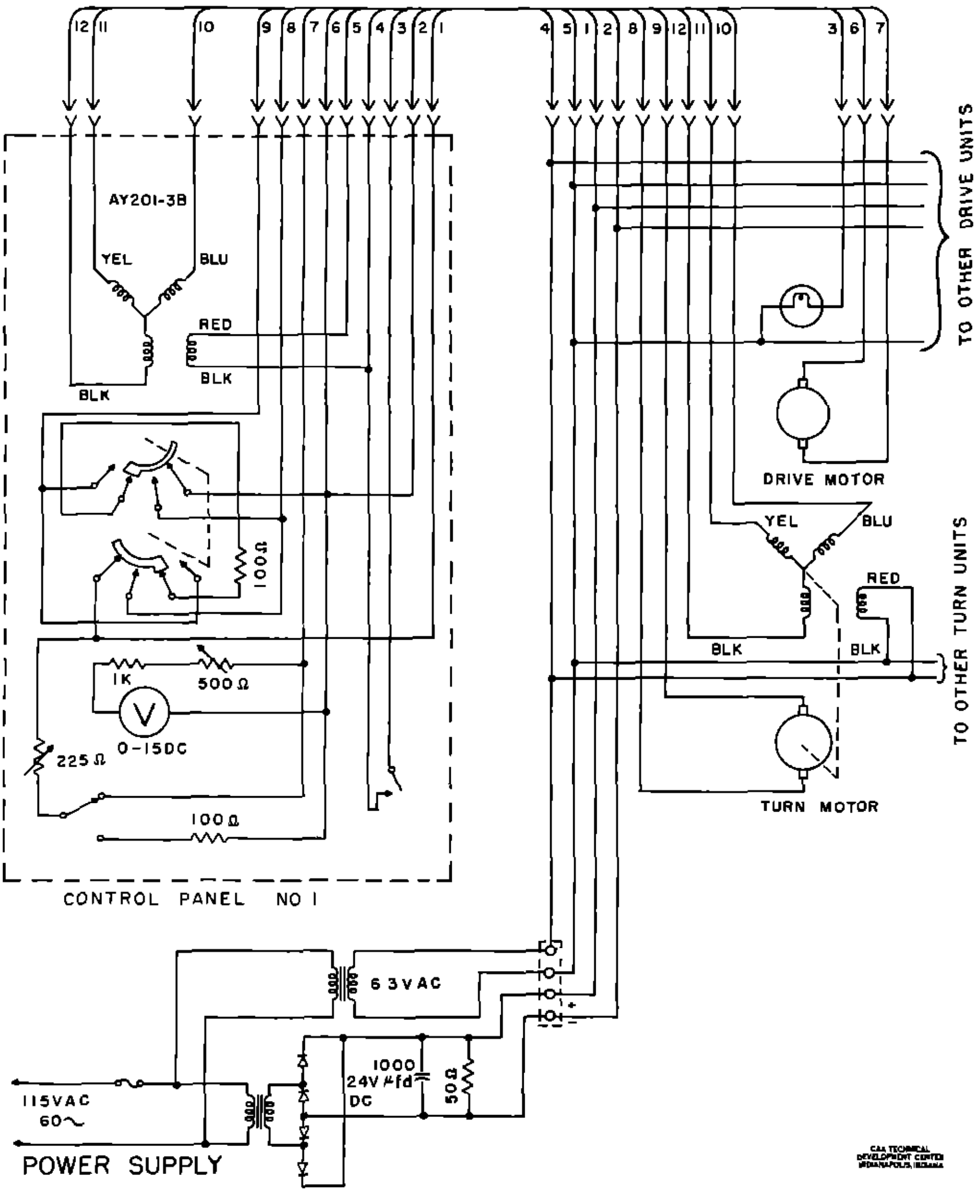

Fig. 7 Wiring Diagram of Three-Target Simulator

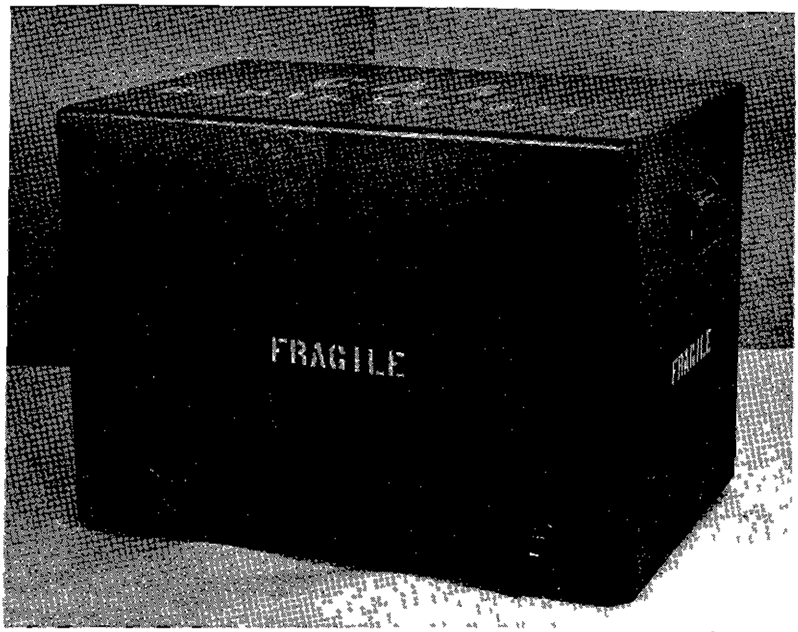

Fig. 8 Three-Target Simulator Packed for Shipment

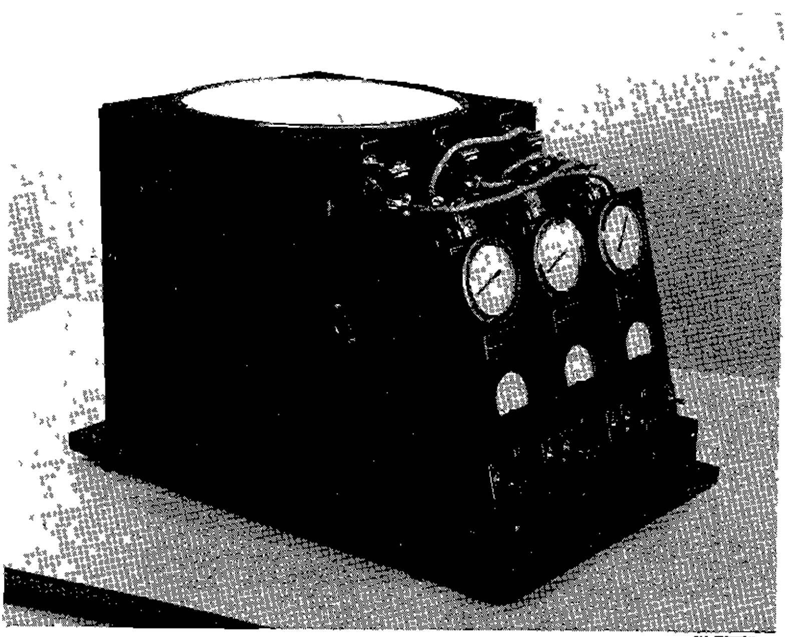

Fig 9 Control Panels Mounted in Rack

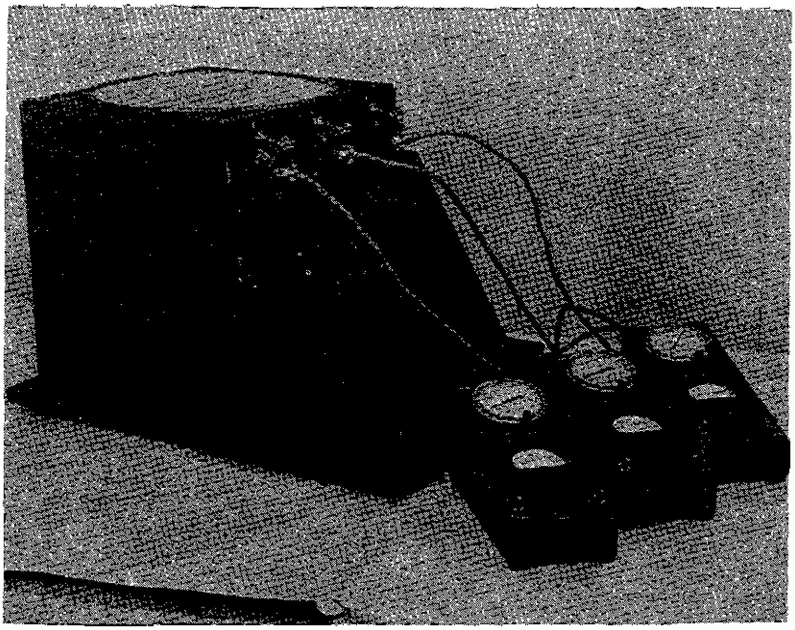

Fig. 10 Control Panels Detached for Remote Operation

Fig 11 Simulator in Operating Position
(U S Army Photograph)

3 The hinged door of the scope box is equipped with a Dzus fastener which requires a screwdriver or similar tool for unlocking Because this door must be opened often for manual setting of the targets, it is recommended that the present fastener be replaced by a flush-type Camloc fastener which can be unlocked manually and lifted by means of a retractable handle

4 Because of fouling of two cable connectors, the scope box cannot be tilted forward or retracted unless the No 3 control panel is removed from its rack or unless its connecting cable is unplugged temporarily A slight relocation of the cable connectors would eliminate this nuisance

CONCLUSIONS

1 In the present five-year program of the CAA Office of Federal Airways, which involves a greatly expanded use of radar for air traffic control purposes, use of a suitable number of portable radar simulators offers an opportunity to train all control personnel in basic radar procedures at a considerable saving in over-all cost of the training program This saving could be effected through a drastic reduction in travel and per diem expenses by conducting most of the basic training at the home bases of the trainees In a large program of this nature, extensive savings in man-hours would result from the fact that training schedules could continue uninterrupted by weather, traffic conditions, or the lack of available aircraft Training sessions could be more intensive because training devices can handle more runs per hour than can be handled with real aircraft Simulator targets can be repositioned almost instantly to start a new run In addition, training runs can be started, stopped, or repeated at any point for explanations, discussions, or concentrated practice on certain phases of the operation Various types of emergency situations or other abnormal conditions can be simulated with complete safety Trainees can learn their basic lessons without jeopardizing the safety, good will, or confidence of the flying public

2 The three-target portable radar simulator has proved suitable for conducting the following phases of the radar-training program

A Application and timing of standard radar phraseologies
B Co-ordination of information from the symbolic and pictorial displays
C Comprehension of the geometrical relationships involved in intercepting and tracking desired courses (including allowance for the turning radius of the aircraft)
D PPI-approach procedures
E Multifeed approach operations, including optimum spacing of aircraft on the final approach path
F Departure operations
G Air route control problems (involving not more than three aircraft)

The objective of this phase of the program is to give the trainee a complete understanding of the basic principles involved as well as an opportunity to become proficient in integrating the various procedures into a smoothly functioning operation It has been found that extensive practice on the radar simulator can build up the trainee's proficiency and poise to a high level After completion of this phase of the training, the trainee must make the final transition to the actual radar equipment The more realistic his basic training has been, however, the fewer problems he will have in learning to use the actual radar equipment

ACKNOWLEDGMENT

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