ation can be accomplished by several electronic means. The most practical method for short-range determination appears to be the polar-coordinate system in which the angle from a reference direction and the distance from the center determine the position. The accuracy with which angle and distance can be measured thus determines the accuracy with which position is known, and the accuracy of position determination is one of the main factors in establishing the rate at which air traffic may flow.

An improved angular measurement system has been described in a previous paper.[1] The present paper describes a distance-measuring technique which is technically compatible with the azimuth system, permitting integration of equipment and joint use of the same radio channels, thus conserving radio spectrum.

Well Known: The techniques for the measurement of distance by radio means are well known and well established. Radar, loran, and shoran, all of which measure distance are in everyday use. More recently a specialized type of distance-measuring equipment (DME) has been evolved in which distance is measured between the airborne equipment and a suitably arranged ground transponder, and the result is displayed automatically in the aircraft on a special dial calibrated in miles. The only essential difference between the presently labelled DME and the older devices is one of utility. All use pulses of one type or another. The newer DME indicates distance automatically on a dial while the older methods used a cathode-ray tube which required interpretation.

The DME coming into use today has been developed specifically to handle many of the problems in the enroute portion of flight, and was not conceived with the rigid requirements of terminal area navigation in mind. This paper will presently describe a different type of DME designed so as to be capable of meeting the anticipated operational requirements. A detailed study of these requirements indicates that standards of accuracy of measurement considerably beyond those required for enroute flight must be established. However, it is perhaps more important to integrate the technique and the actual apparatus of distance measurements into an over-all plan of terminal area guidance and control so that the essential quantity of position determination is achieved by the cooperative use of both azimuth and distance measurement equipment.

Important Savings: By handling the problem as a whole we can not only achieve very important savings in apparatus weight and complexity but also take up a minimum possible amount of the moderate radio-frequency spectrum assigned to the navigation of aircraft. This latter consideration has great significance because of the large number of important terminals throughout the world and the high ratio of the number of using aircraft to each terminal.

Because of these considerations it now seems best to review once again the whole problem of air traffic control before discussing the specialized requirements which any DME in the terminal must meet. Navigational problems in the terminal area are so complex that a full understanding must be had of the overall problem before any particular piece of radio equipment can be properly evaluated, discussed or described. Accordingly, the operational requirements of the terminal area which affect the distance-measuring part of a navigation system will be discussed at some length before any mention of the characteristics of distance-measuring equipment itself will be made.

The Traffic Problem: As air traffic approaches the airport and the terminal area surrounding it, the traffic density increases rapidly. Traffic on any particular air route between cities may be light, but since all air routes tend to converge on major terminal areas, such as New York, Washington, and Chicago, the density of air traffic around one of these major terminals is much greater than on any particular air route. Figure 1 illustrates this basic problem. Six airways are shown entering a terminal area (30 to 50 miles radius around the airport). By adequate instrumentation each airway can have several tracks disposed either horizontally or vertically. For example, ten altitude layers are often employed for air traffic, using the altimeter for defining the vertically seperated airways. It is also possible to use a polar-coordinate system to define horizontal parallel airways.[2]

Six horizontal parallel airways with ten altitude layers can provide 60 lanes of air traffic. These can be employed to solve some of the problems previously mentioned, such as the large speed differential existing between different types of modern-day aircraft. Air-traffic lanes can be assigned on a speed basis, giving express tracks to high-speed aircraft. Other lanes might be used for avoiding adverse weather such as icing conditions and rough air. Traffic intersections, such as the familiar clover-leaf pattern used on park-

[1] *J. Lyman and G. Litchford, A Precision Omni-Directional Radio Range for the Terminal Area, a paper presented before the Annual IAS Meeting, January, 1950.*

[2] *J. Lyman and G. Litchford, The Effect of Position Determination on Air Traffic Control, a paper presented before the joint ION, RTCA, RTCM Meeting, September, 1950.*

CF-100 Crash

The cause of the crash of the Avro Canada CF-100 prototype near London, Ontario, April 5, was a failure in the oxygen supply to the crew, according to the findings of an RCAF board of enquiry. The board was conducted by the Air Force after hearing witnesses from Avro Canada, the National Research Council, and the Institute of Aviation Medicine in addition to a number of civilian eye witnesses.

According to the announcement from the Air Force, there will be no delay in production of the CF-100, the first ten of which are being fitted as trainers, and it is expected that within the next few weeks the first Orenda-powered CF-100, will make its initial test flight.

ON OPPOSITE PAGE is an artist's conception of the USAF-Sperry navigation system centered on MacArthur Field, Islip, Long Island, N.Y. The map indicators show how pilots in each of four aircraft approaching MacArthur traffic zone receive their position and guidance information from the omni-range DME system. The radial lines and concentric circles represent position fixing grid set up by the navigation system. Each circle represents a constant distance from the ground station as determined by the DME. Each radial line represents a constant bearing from the ground station as determined by ODR. Radius of system as shown covers 30-mile terminal area.