THE POSITION PLOTTER

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TABLE OF CONTENTS

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INTRODUCTION

The Position Plotter was conceived in the Aeronautical Charts Section of Technical Development Service and the design was accomplished within that Section. The instrument was built by contract with I. M Schmidt, Schenectady, N. Y

The Position Plotter was designed to furnish a simple, speedy, and accurate method of plotting the position of an airplane when magnetic or true bearings from the plane to two points of known position (usually radio stations) are known Variations of the primary purpose may also be served, such as plotting a position from (1) a bearing to a station and a line of position (such as a radio range leg, celestial position line, or topographic feature), (2) a bearing to a station and a distance to the same or a different station, and (3) distances to two stations. Thus it is adapted to both directional navigational aids, distance measuring equipment, and a combination of the two While originally designed for air navigation, it may also be used for any form of navigation See Fig. 1, The Position Plotter in Operation.

CONSTRUCTION

The experimental model of the Position Plotter is composed of the following parts as shown in Fig 2

(1) Two circular disks, four inches in diameter.

(2) Two slotted protractor arms, ten inches in length, each equipped with a clamp

(3) A threaded metal stud with base and retaining nut.

(4) Two small metal pins with threaded stud and nut.

The two disks are made of xylonite or similar transparent material, approximately 0.01 inch thick. A hole is drilled in the exact center of each, to allow mounting upon the metal stud and free rotation about it as a pivot The two disks are designated as True and Magnetic.

The True disk is traversed by a series of red parallel lines, spaced one-fourth inch apart, the central line being a diameter with an arrow at one end and the designation "True N."

The Magnetic disk is graduated in black for every degree around the circumference A black radial line is drawn to the zero degree mark, with an arrow at its extremity and the designation "Mag. N "

The two protractor arms are made of transparent material, such as xylonite, of approximately 0.05 inch thickness At one end of each, a hole is drilled to allow mounting upon the central stud, which acts as a pivot, allowing the arms to be rotated through 360 degrees The arms are ten inches long from the center of the stud to the outer extremity and are one-half inch wide for the major portion of their length Each arm has a central radial slot one-tenth inch wide cut from the circumference of the disks to a point within about one-half inch of the extremity of the arm The center line of this slot is continued as an engraved line upon each arm from the disk circumference inward to the center stud Near the disk circumference each arm has a shoulder in which a hole is drilled to allow the insertion of a brass clamp Turning a nut on this clamp causes the arm and two disks to be pressed together, thus locking all three in one position in relation to one another. Two scales of statute miles are provided along the length of each arm at scales of 1 1,000,000 and 1 2,000,000 with graduations every 10 and 20 miles respectively from the center pivot These arms, called for convenience the left and right arms, are identical except that on the right arm the shoulder projects to the right and on the left arm to the left

The disks and protractor arms are mounted on the center stud in the following order from bottom to top True disk, Magnetic disk, left arm and right arm The center stud nut is then screwed on the threaded stud to retain the assembly A hole in the center of the stud and its base allows the insertion of a pencil for marking a position

Two small pins are provided, with threaded stud and retaining nut They are of such size as to slide easily, but without play, in the arm slots These pins are to be placed at the points on which bearings or distances

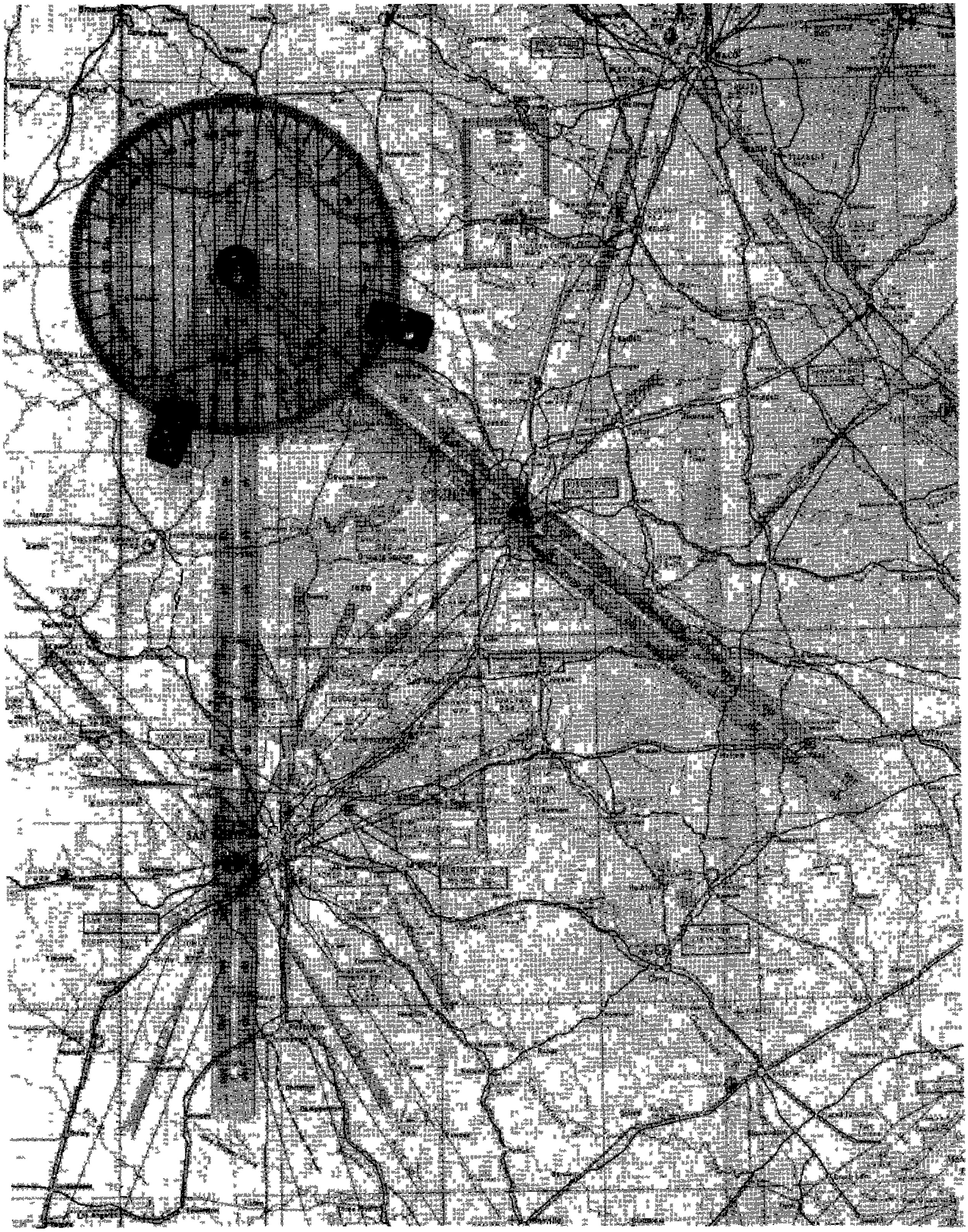

Fig 1 The Position Plotter in Operation

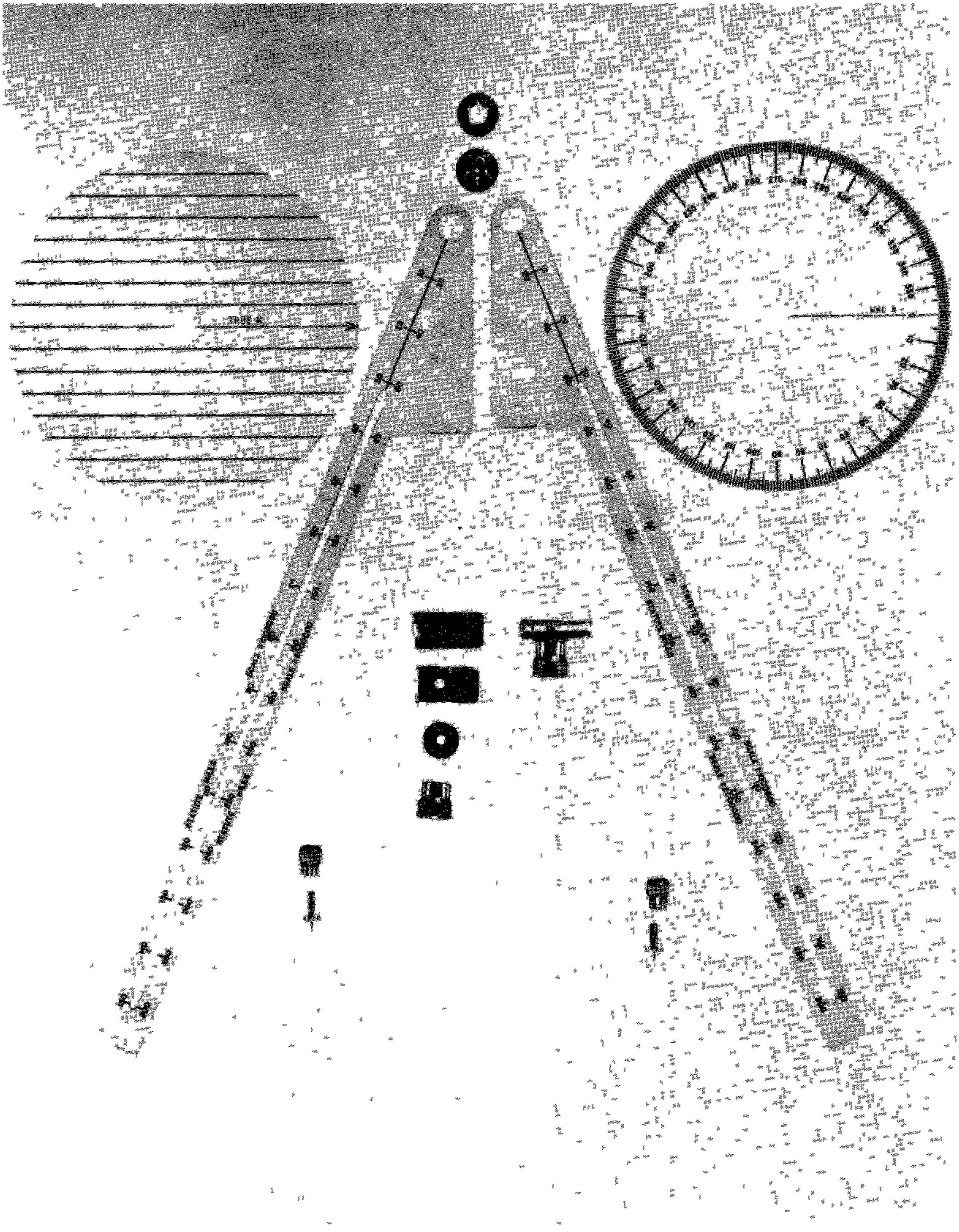

Fig 2 View Showing Parts of the Position Plotter

are taken and inserted through the chart into a drawing board or table.

THEORY AND METHOD OF OPERATION

As stated in the Introduction, the Position Plotter may be used to plot positions with four different combinations of data, as follows

(1) Bearings to two known stations.

(2) A bearing to one station and a known line of position.

(3) A bearing to one station and a distance to the same or a different station

(4) Distances to two stations.

A brief description will be given here of the method of plotting the position under each of the afore-mentioned conditions.

(1) When magnetic bearings to two stations are known

Place the pins on the stations observed. With both arms unclamped set the Magnetic disk with reference to the True disk with the proper magnetic variation for the plane's approximate location Holding the two disks at this setting, set the right protractor arm to the bearing of the right hand station and clamp. This clamps the right arm and the True and Magnetic disks together, but allows the left arm to rotate Set the left arm to the bearing of the left hand station and clamp Place the slot in the right arm over the right hand station pin and the left arm slot over the left station pin The center of the instrument may now be rotated, with the pins riding in the slots. Rotate until the True disc is oriented to true north by lining up one of the red parallel lines with the chart meridian nearest the position. The center of the instrument is then the position of the plane and may be marked through the center hole with a pencil

(2) When a magnetic bearing to one station and a position line, such as a radio range leg, are known

Place a pin on the station observed. With both arms unclamped set off the magnetic variation of the approximate position and holding the disks at this setting, set one of the arms at the observed bearing and clamp Place the slot in the arm over the station pin and move the center of the instrument to the position line and along the position line until the True disk is oriented to true north by means of the red parallel lines and the chart meridians The center of the instrument is then the desired position

(3) When a magnetic bearing to one station and a distance to the same or a different station, are known

Assuming in this illustration that the bearing and the distance are to different stations, place pins on both stations Set the magnetic variation and the bearing as before and clamp. Use the right arm if the bearing station is the right of the two stations and the left arm if it is the left. Place the pin of the bearing station in the slot of this arm. With the remaining arm still unclamped, place the distance pin in its slot and run the slot along the pin until the proper distance is reached Screw the pin retaining nut tightly on the threaded stud, thus clamping the pin at the correct distance from the center of the instrument. Now rotate the instrument about this distance pin with the bearing pin riding in its slot until the instrument is oriented to true north The center of the instrument is then the desired position It is obvious that when both bearing and distance are taken to the same station the method to be used would be a simpler variation of the above method.

(4) When distances to two stations are known

Place pins on both stations With both arms unclamped place the slot of the right arm over the right station pin and the slot of the left arm over the left station pin Set the distance to the right station on the right arm and clamp with the pin retaining nut Rotate the instrument about the right pin with the left pin sliding in the left arm slot until the left station distance is read at the left pin. The center of the instrument is then the desired position The left arm may be locked, if desired, by means of the other pin retaining nut

In the preceding examples, bearings are assumed as magnetic In solving problems where bearings are true, the zero on the magnetic disk is set at true north on the True disk and the operation proceeds as before with the setting for magnetic variation eliminated

The afore-mentioned problems are probably the most important and oft occurring ones, which the Position Plotter may be used to solve It is quite probable that other problems will arise where the instrument may be used advantageously, for example, a line of position known and a distance to some station known

ADVANTAGES OF THE POSITION PLOTTER

In plotting any position where the use of bearings from the airplane to one or more stations is involved, the following advantages in using the plotter may be mentioned

(1) Immediate position is obtained with no error introduced by convergence of the meridians On a Lambert Conformal or other such chart with converging meridians, if the conventional method of transferring a bearing from the most convenient chart compass rose is used, allowance should be made for the convergence between this rose and the estimated position, introducing a mathematical computation with consequent possibility of error. Also, if the estimated position is found to be much in error, the computed convergence may also be in error, requiring a second computation and plotting The Position Plotter automatically eliminates this

(2) The need for any chart compass roses for solution of these problems is eliminated

(3) The process of transferring a bearing from a compass rose to another part of the chart by means of parallel rules, sliding triangles, or other processes is eliminated.

(4) The two disks allow the relation between true and magnetic north to be set off mechanically and allow problems to be solved on either a true or magnetic basis with equal facility

CONCLUSIONS

Experiments with the original model of the Position Plotter indicated several ways in which the instrument could be improved, not in basic design, but in the sturdiness of the parts The original disks warped somewhat after a long period of time, leading to the conclusion that their thickness should be increased It is recommended that the thickness of the arms be increased and that the widths of the arms be increased from one-half to about one inch. Also the clamps and pins should be of sturdy design When the computer was originally designed, there was no thought of plotting fixes by two distances or a distance and a bearing, consequently the arm mileage scales were graduated only to the nearest 10 and 20 miles as a possible convenience in reading approximate distances to the stations to which bearings were taken. However, with the recent advent of distance measuring equipment, it became evident that this plotter could be used advantageously in determining position from a distance and a bearing or two distances. Therefore, it is recommended that the 1 1,000,000 scale be graduated every mile and the 1 2,000,000 scale every two miles

These are minor modifications which in no way affect the basic theory of the computer The present computer has been tested and plots positions with speed and accuracy from data as given in the sample cases