Jan. 2, 1951 L. R. SUSDORF 2,536,474

BLIND FLYING TRAINER

Filed April 16, 1941 4 Sheets-Sheet 1

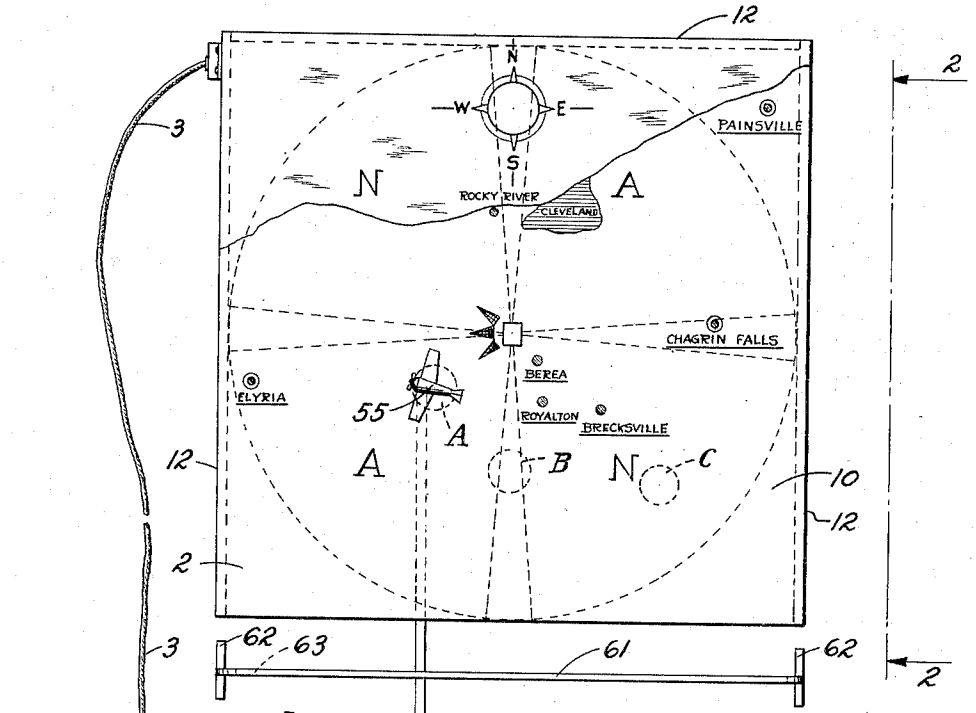
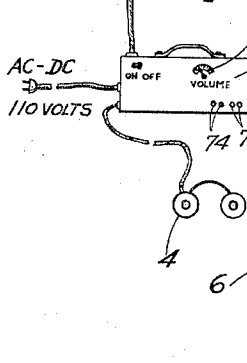


Fig. 1



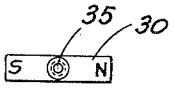


Fig. 4a

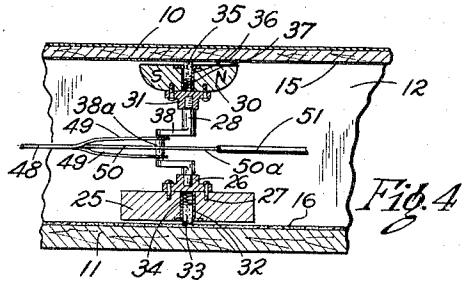


Fig. 4

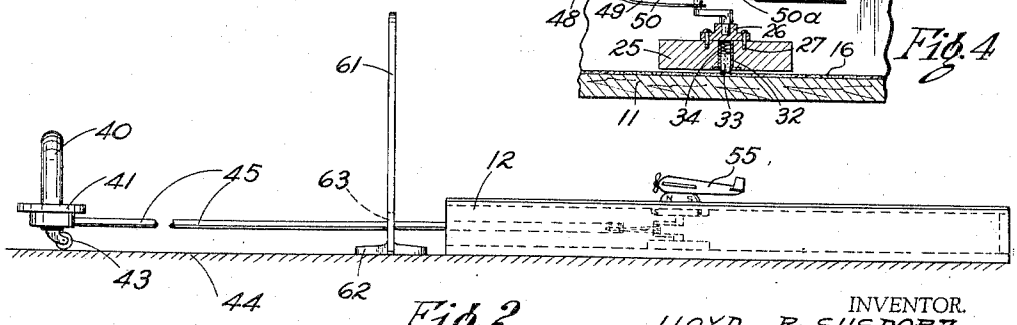


Fig. 2

INVENTOR.
LLOYD R. SUSDORF

BY

Richey & Watts
ATTORNEYS

Jan. 2, 1951 L. R. SUSDORF 2,536,474

BLIND FLYING TRAINER

Filed April 16, 1941 4 Sheets-Sheet 2

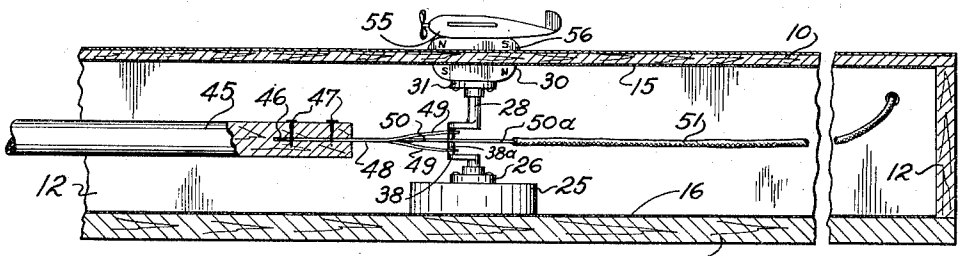


Fig. 3

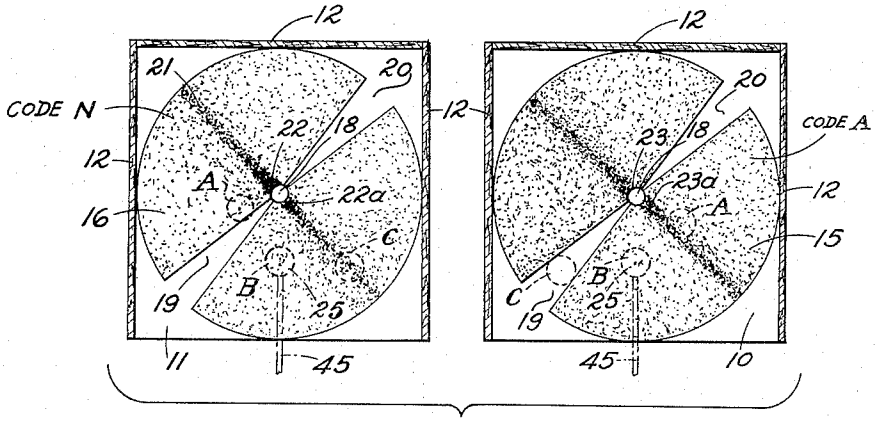


Fig. 5

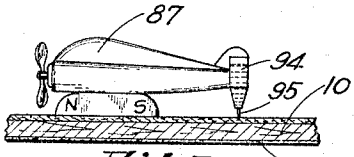


Fig. 7

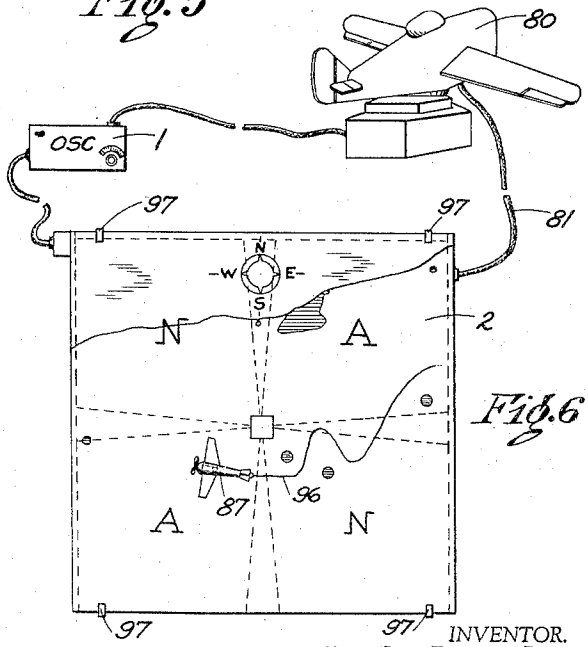


Fig. 6

INVENTOR.
LLOYD R. SUSDORF

BY

Richey & Watts
ATTORNEYS

Jan. 2, 1951 L. R. SUSDORF 2,536,474

BLIND FLYING TRAINER

Filed April 16, 1941 4 Sheets-Sheet 3

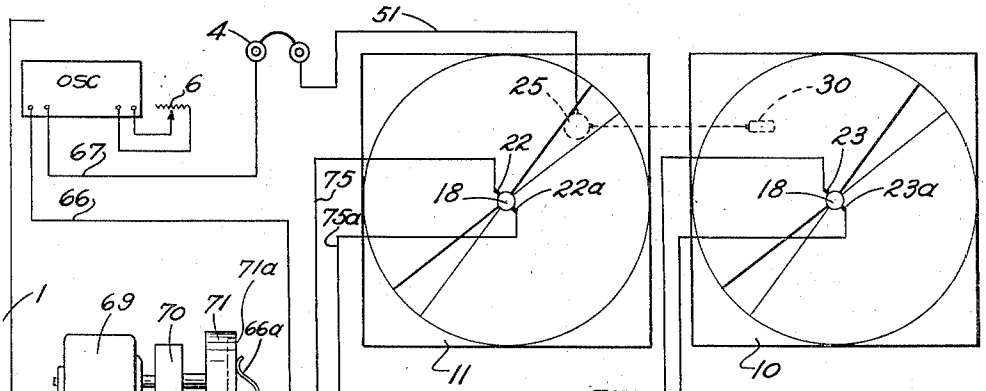


Fig. 8

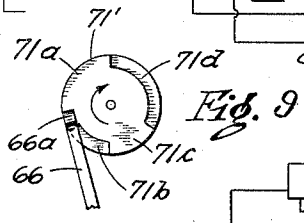


Fig. 9

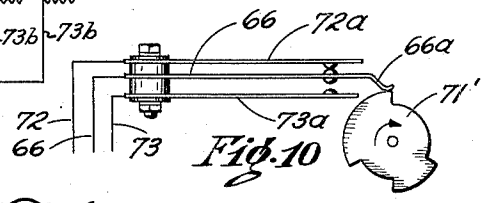


Fig. 10

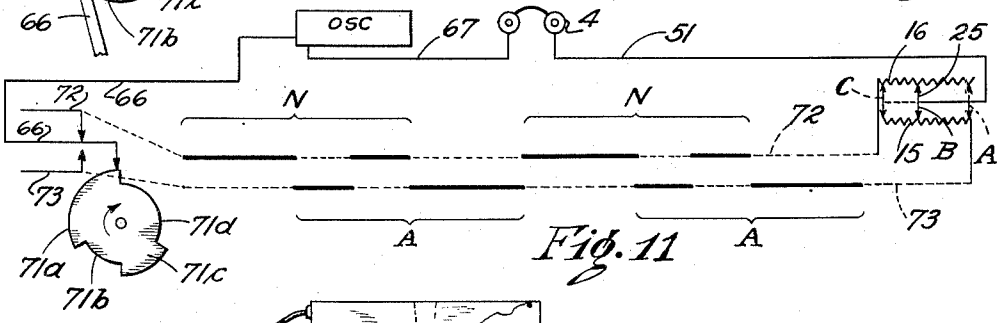


Fig. 11

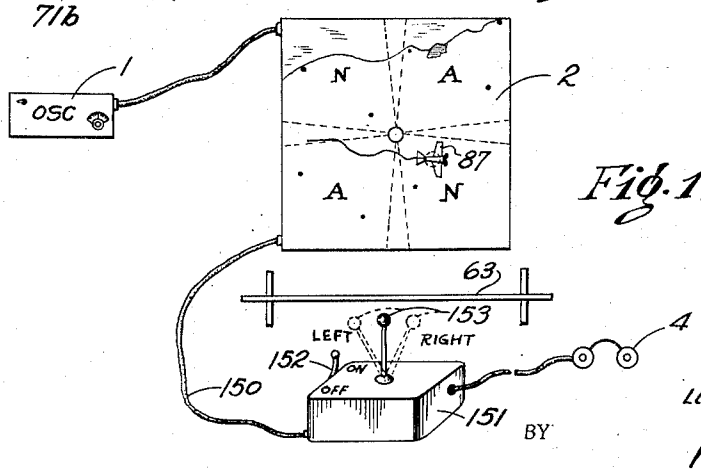


Fig. 12

INVENTOR.
LLOYD R. SUSDORF

BY

Richey & Watts
ATTORNEYS

Jan. 2, 1951 L. R. SUSDORF 2,536,474

BLIND FLYING TRAINER

Filed April 16, 1941 4 Sheets-Sheet 4

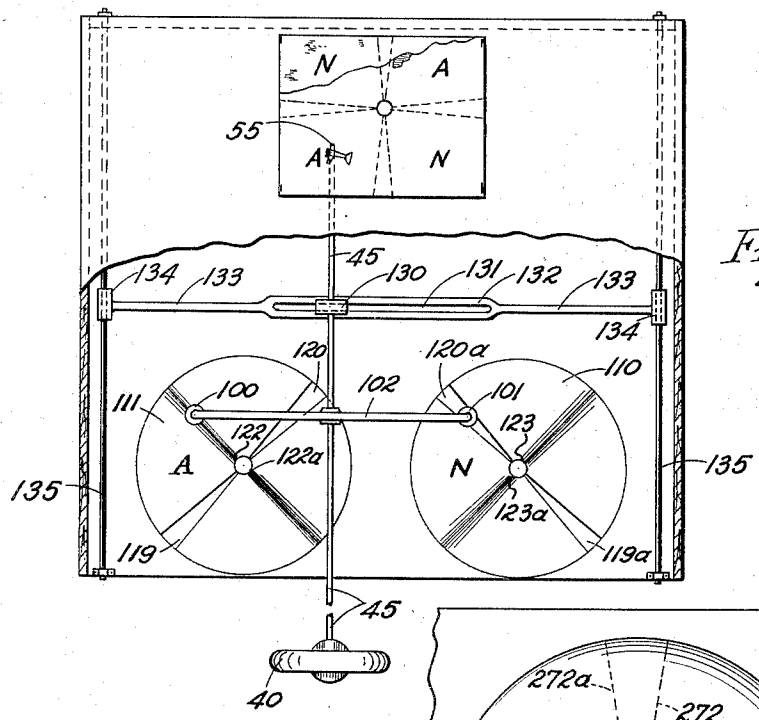


Fig. 13

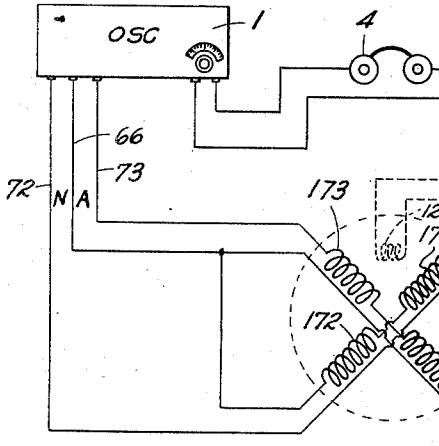


Fig. 14

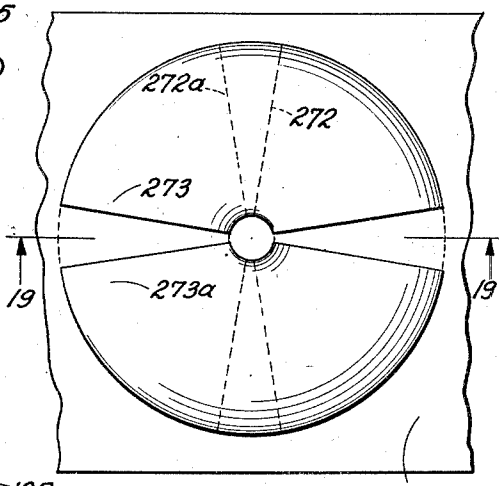


Fig. 15

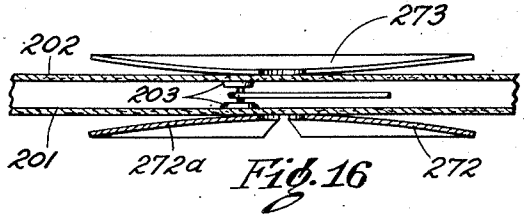


Fig. 16

INVENTOR.
LLOYD R. SUSDORF

BY Richey & Watts
ATTORNEYS

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UNITED STATES PATENT OFFICE

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BLIND FLYING TRAINER

Lloyd R. Susdorf, Cleveland, Ohio, assignor of fifty per cent to Claude F. King, Berea, Ohio

Application April 16, 1941, Serial No. 388,917

7 Claims. (Cl. 35—10.2)

1

This invention relates to improvements in aviation training devices, and more particularly to an apparatus for training airplane pilots in the art of so-called blind flying wherein the pilot determines this position by the radio beam signals.

With the increase of interest in aviation and the establishment of more airports, it has been necessary to provide means and systems whereby in inclement weather it is possible for a pilot to find his way back to the airport or between spaced airports. It is a well known fact that often after a pilot has been in the air for a few hours the weather closes in on him before he has a chance to reach his objective or return to his point of departure. Systems have been devised whereby he can locate and land at the airport in spite of the fact that there is little or no visibility.

The accepted system at the present time is to provide a system for sending out directional signals by radio which are picked up by the pilot and whereby from familiarity with their character he can orient his position. These signals commonly emanate from a so-called "radio range station" located subjacent the airport. The common practice is to have the station so designed and arranged that it provides a beam being a continuous tone which lines up directly with the airport. Should the pilot fly to the left of the beam, the character of the signal changes, and instead of the continuous note, he hears the international code letter "N" comprising a dash followed by a dot. If he strays to the right of the beam the signal changes to the code letter "A" being a dot followed by a dash. If the signal increases in intensity he knows he is coming into the airport; and if it decreases he knows that he is leaving. These signals are also interrupted periodically to allow the identification letters of the particular beam which the pilot is flying to be sent, which serves to tell him which beam he is on. These beams do not necessarily extend east and west, and north and south, but are usually so arranged that they extend in the direction of the airlanes between the larger airports.

Usually, also, there are two beams commonly called the east-west beam and the north-south beam. These beams may divide the territory in and about the field into quadrants, the character of which vary with different airports. For the purpose of this description, the quadrants will be considered as four and divided equally by an east-west beam and a north-south beam. The north-west and south-east quadrants off of the beam then would be the "N" zones, and the south-west and north-east quadrants the "A" zones.

2

It will readily be seen that accustoming a pilot to locate himself when he is in the air by means of listening to these radio signals requires considerable experience and training. If this training is effected by actually flying a plane in the air, the pilot not only has to keep his airplane under control, but has to worry about having to ride the beam. It has therefore been the custom in recent years to afford the pilot considerable ground training to accustom him to flying the beam. This is effected by use of a so-called trainer which is of the fixed type and never leaves the ground.

One such trainer is used for teaching blind flying and is known commercially as the Link trainer and is substantially that disclosed in the United States patents to E. A. Link, Jr., No. 2,179,663 of November 14, 1939, and No. 2,119,083 of May 31, 1938. In this trainer the pilot is seated in the cockpit of a device simulating an actual airplane and a hood is placed over his head. Connected to the trainer by a flexible cable is a so-called "crab" which travels over a chart. This crab travels according to the manner in which the trainer is directed and an observer or instructor watches the chart and the crab and sends signals to the trainer, the nature of which is determined by the instructor's observation of the position of the crab on the chart, and which signals are supposed to be of the type the flyer would receive if he were actually in the air and traveling over that part of the terrain represented by the crab on the chart.

Still other devices have been designed to educate the aviator to the art of blind flying, but they all more or less operate on the same general principle.

There are several disadvantages in these prior devices, the greatest of which is the reliance on the human element to inform the pilot as to his location; that is, it is necessary for an instructor to pay exact and close attention to the movement of the trainee as indicated by the crab or other device in order to communicate the proper signals to the trainee. Should the instructor relax his vigilance, he inserts errors into the action of the trainee by not changing his signals at the proper time. This rather than helping the trainee, results to his detriment.

Still another disadvantage of some of these prior devices is the element of cost. The cost of some of these devices is exorbitant and places the same beyond the ken of private ownership. Not only is the cost a considerable item, but the cost of operation is not to be discounted since it

is necessary to have an instructor present at all times and the possibility of a pilot training by himself without assistance is nil.

By the present invention it is possible to design a trainer for blind flying where the cost element is so low as to put the same within the reach of nearly any would-be pilot's pocketbook. Furthermore, the device is such that it lends itself to refinements which thus make it possible to construct devices that have a minimum number of parts and cost, and still retain a large measure of usefulness, or to make the more complex and complete devices having more refinements which aid in the operation of teaching of blind flying and afford a still more realistic effect to the training.

But what is most important even in its simplest form, the human element of the instructor is eliminated. The device is also readily adapted to the operation of the trainers of the aforementioned Link type.

Still further in its simpler forms, it is an excellent educational device adapting itself to various types of games necessitating the exercise of skill, and furnishing amusement, not only for the older children, but for the entire family.

It is, therefore, an object of this invention to provide a device for training aviators in blind flying.

Another object of the invention is to provide a device for instructing aviators in problems of orientation in connection with blind flying.

Another object of the invention is to eliminate the necessity of instructors being present while trainees are learning blind flying.

Another object of the invention is to provide an improved means for sending signals to a trainee during blind flying instructions so that the signals are automatically sent to the trainee.

Another object of the invention is to simulate the signal sent out by a radio range station in and about an airport in a blind flying training device.

Another object of the invention is to provide a device for teaching blind flying that adapts itself to a game of skill and amusement.

Another object of the invention is to provide a device for teaching blind flying which is economical in construction and operation.

Another object of the invention is to provide a device which may be used in conjunction with existing devices to eliminate the error due to the human element in sending the proper signals to trainees in blind flying.

Still other objects of the invention and the invention itself will become more apparent from the following description of some embodiments thereof, which description is illustrated by the accompanying drawings.

In the drawings:

Fig. 1 is a plan view of one form of the apparatus of the invention;

Fig. 2 is a side elevational view thereof;

Fig. 3 is a sectional elevation showing the interior of the device;

Fig. 4 is a vertical section through a signal pickup device;

Fig. 4*a* is a plan view of the top of the pickup device of Fig. 4;

Fig. 5 is an inside view of the upper and lower inner surfaces of one form of the device;

Fig. 6 is a view partly in perspective and partly in plan showing the invention adapted to the so-called "Link trainers";

Fig. 7 is an enlarged view of the recorder used in conjunction with the apparatus of Fig. 6;

Fig. 8 is a diagrammatic view of the electrical system embodied in the invention as shown in Fig. 1;

Fig. 9 is a side elevational view of a circuit breaking cam;

Fig. 10 is a side elevational view of a modified form of a circuit breaker;

Fig. 11 is a diagrammatic view showing the method of distributing the signals;

Fig. 12 is a schematic view of another modification of the invention;

Fig. 13 is a plan view of another modification of the invention, certain of the parts being broken away to disclose the interior;

Fig. 14 is a diagram of another modification of the invention;

Fig. 15 is a plan view of still another modification; and

Fig. 16 is a view taken on the lines 19—19 of Fig. 15.

Referring now to the drawings throughout which like parts have been designated by like reference characters and particularly to Fig. 1.

Briefly, the invention comprises a signal generator which will generate on and off of beam signals so connected to a board or base that the signals are fed to this base in zones simulating the signal zones in and about an airport. That is, there may be the continuous tone indicating a beam designated as an east-west beam and another like signal indicating the north-south beam dividing the board into quadrants, the spaces between the beam being the off-beam signals of the letters N and A. Pickup means is provided associated with the base, which when moved about the base and into the various zones, picks up these signals much in the manner as an airplane would pick up the signals if flying near an airport. These signals are made audible to the operator through a set of phones or loud speaker, and he can thus accustom himself by the signals to directing his plane into the proper channels that will permit him to land his plane at the airport.

One form of the device is shown in Figs. 1 and 2 and contemplates a signal generator indicated generally at 1, powered from the A. C. line and which may be of any form usually an electronic device, connected to the board or base indicated generally at 2 by a flexible multiple conduit 3. A suitable interrupter or timer is provided in the signal generator 1 to break the signal up into A and N signals and these signals are fed to the board as best shown in Fig. 8, all of which will be hereinafter more fully described. A set of ear phones 4 are also connected in the circuit and the volume of the signal may be controlled by the volume control 5 on the signal generator or by a remote volume control 6 stationed conveniently for the operator.

The base comprises an upper flat surface 10 preferably of a hard composition material such as pressed wood upon which may be imprinted a map, as best shown in Fig. 1, illustrating the territory around and adjacent to an airport. The upper board is held in spaced relation from the lower board 11 by sides 12 extending around three edges of the board; the fourth edge remains left open to permit access to the interior.

The undersurface of the upper board 10 and upper surface of the lower board 11, as indicated at 15 and 16 respectively, are provided with a

deposit of conducting material of relatively high resistance, which material is laid onto the boards as best shown in Fig. 5. Fig. 5 shows the top and bottom of the base taken apart and the top board laid over to the right so that it is upside-down. The diagrammatic view in Fig. 8 shows the top and bottom parts in the same position.

The resistance material may be a composition containing carbon, graphite or any other resistance or conductor material having a resistance, which material may be placed on the base by spraying, painting, lithographing or any other suitable manner. It may generally take the form shown in Fig. 5 wherein the boards are divided diametrically by pie-shaped segments passing through the center of the board in such a manner and so positioned that when the two boards are spaced together, the pie-shaped segments, which have no material thereon, are displaced on each board from the other substantially 90°. As best shown in Figs. 8 and 5, the small circular area 18 at the center of the board usually is designated as the airport and in both parts is clear of any conducting material. The base 11 is clear of conducting material from the corner or from a space at 19 extending from the lower left hand corner to the center 18, and from the center 18 to the upper right hand corner, as indicated at 20. This space may vary in width, but I have found that a path subtending an angle of substantially 15° operates very efficiently. The remainder of the board on either side of this wedge-shaped division has applied thereto a compound, as previously described. One compound which I have found to be very useful, being a mixture of finely divided carbon and casein glue.

In the drawings I have shown the greatest concentration of the material extending from a point indicated at 21 to the airport point 18 and increasing in density as it reaches the airport 18. This, however, is not strictly essential, as will hereinafter more fully appear, because the resistance decreases from the airport to the point 21 providing that the conductors for transmitting the signals are connected to the board at 22 and 22*a*, as indicated in Figs. 5 and 8. For instance, the deposit could be of an even nature throughout the surface and the diminishing signal would be obtained merely by the increased resistance of the material with increase in distance from the airport 18. To provide it with portions of increased density, as shown, provides an exaggerated effect which is sometimes useful.

As previously stated, the upper board is formed in the same manner except that the various zones are 90° offset when the boards are placed in the proper position, the signal being connected to the upper board at 23—23*a* as indicated in Figs. 5 and 8. It will appear, therefore, that when the boards are in their proper position, the point of greatest density of resistance material on the upper board, falls exactly opposite the completely non-conducting portion of the lower board, and vice versa. Pickup means 25 is provided for reciprocation inside of the base and in contact with the resistance material to pick up the signals placed on the boards. This, as best shown in Figs. 3 and 4, comprises a pickup base member 25 preferably made of some heavy material to give it stability, and which may be of circular form.

The pickup base member is provided with a coupling 26 held thereon by screws 27 in which is journaled a crankshaft 28. Although I have designated the crankshaft 28 as being journaled in the coupling 26, it will be very obvious that the crankshaft does not necessarily have to rotate in the coupling since the coupling and the base 25 may rotate with the crankshaft without having any particular effect upon its operation. The upper end of the shaft is coupled to an upper member 30 by a coupling 31. In this instance, the coupling 31 and the member 30, and the shaft 28, are rigidly connected together, so that rotation of the shaft is communicated through the coupling to the member 30. The member 30 in this instance is not necessarily circular, as the member 31, but preferably is a bar magnet, which is of the permanent magnet type, many types of which are now on the market and available.

The member 25 is provided with an axial opening 32 to receive a carbon brush assembly 33, which extends and is held resiliently in engagement with the bottom surface 16 by a spring 34. The upper member 30 is provided with a similar brush 35 disposed in a socket 36 through the magnet, and held in spring-pressed relation by a spring 37 against the upper surface 15. Electrical contact is communicated from the surfaces 15 and 16 to the crankshaft and to the crank arm 38. The whole assembly, hereinafter referred to as a "pickup" is movable about between the upper and lower base portions by the control means and adapted to pick up signals that are fed into the base at points 22—23 from the material deposited on the base portions.

As best shown in Figs. 1 to 4 inclusive, the control means comprises an operating handle 40 which may be a semi-circular element, patterned generally after the elevator and aileron controls for an airplane, secured to a base 41 which is hollow and contains therein a compass card 42, which is connected to a castor 43. The castor 43 furnishes a support for the control, and has its pintle connected to the compass card. The castor rolls on the table 44 when the control is moved, and operates in a well known manner to rotate its pintle when the direction of movement is changed. When the castor rotates on its pintle the compass card moves also and indicates to the operator in which direction he is traveling. The pickup assembly is connected to a rod 45, the end of which is bifurcated at 46, Fig. 3, and has removably secured therein by pins 47, a connecting linkage for connecting the rod to the pickup. The connecting linkage comprises a flat portion 48 for insertion in the bifurcated end of the rod, secured by pins 47. From the flat portion extend upper and lower branches 49 and an intermediate branch 50. The branches 49 and 50 are provided with aligned apertures through which is disposed the crank pin 38*a*. The intermediate branch 50 has a portion 50*a* which extends beyond the center line of the crankshaft and has connected thereto an electrical conductor 51.

The operator normally takes his position with the control handle 40 disposed between him and the base, the whole assembly being placed on a suitable bench or table 44. It will thus be seen that if the operator is moving the device toward him, or to the left as viewed in Fig. 2, the crank pin 38*a* is then closer to the operator than the shaft 28 and the magnet with its north and south poles will have the north pole pointing toward the operator, as also indicated in Fig. 4, and the castor 43 will be pointing away from the operator, as shown in Fig. 2. Movement of the control device is preferably done in parallel lines; that is, the connecting rod 45 is maintained in a north and south direction at all times so that

the movement of the pickup is exactly the same amount of movement of the control handle 40, whether it be toward any point of the compass. I contemplate the use of a linkage which will prevent the movement of the control rod in any direction other than in parallel lines such as is illustrated in Fig. 13.

Disposed on the upper surface of the base is a miniature airplane 55, best shown in Figs. 2 and 3, the base of which comprises a permanent bar magnet 56 having north and south poles, as indicated. The attraction of the magnet member 30 for the magnet 56 on the airplane is sufficient, so that when the pickup member is moved about underneath on the board, the airplane follows, remaining directly above. That is, the south pole of the pickup magnet attracts the north polt of the airplane magnet, which north pole may be the nose of the plane, and the south end the tail. The plane then, if traveling in the direction indicated in Fig. 2, is headed south. If the control 40 and the rod 45 should be moved laterally to the left, as shown in Fig. 1, the caster 43 will then taken the position 90° clockwise from that shown, the compass card will read the compass direction in which it is heading; in this instance being west, and the nose of the plane will point west, because the crankarm is also rotated clockwise 90° rotating the magnet 30 therewith. The pickup can thus be moved about between the upper and lower parts of the base and no matter where or in what direction it is moved, the airplane will always be headed in the direction of travel and closely follow the position of the pickup.

For purposes of training, an opaque screen is provided, indicated at 61, supported by a base 62 and having an opening 63, to permit free movement of the rod 45 therethrough, and still to screen the board and the airplane from the operator.

The signal generating means, as best illustrated diagrammatically in Fig. 8, may include a vacuum tube oscillator, although very obviously any kind of high frequency audio tone generating means such as a buzzer may be substituted, which generates a note of approximately 800 c. p. s. The oscillator in Fig. 8 is designated OSC. and the output level is regulated by the volume control shown diagrammatically at 6. As previously stated this may be a dual control, one on the oscillator and one remotely controlled by the operator. The output of the oscillator is fed through the leads 66 and 67, the lead 67 connecting directly with one of the ear phone leads and the other ear phone lead 51 connected to the pickup 25; the other lead 66 goes to a circuit-breaker comprising a motor 69 connected to gear reduction drive 70 and thence to a suitable circuit-breaker rotor 71.

The rotor 71 is designed to take the continuous signal off of the line 66 and split it up into N and A code signals and distribute them through the lines 72 and 73 to the base 11 and top 13 respectively. This is best illustrated in Figs. 8 to 11 inclusive. As appears most clearly in Fig. 9, the rotor which may rotate clockwise is provided with a cam surface on its side adjacent its periphery comprising alternately raised and low portions, 71*a* being a high portion extending around one-third of the periphery of the cam and flush with the side thereof; this is followed immediately by a low portion 71*b* extending one-sixth of the periphery of the cam and this being followed by a second but smaller high portion 71*c* also extending one-sixth of the periphery of the cam; and lastly a low portion 71*d* extending the remainder or one-third of the periphery of the cam. The conductor 66 is provided with a cam contacting brush 66*a* which presses and rides upon the high spots 71*a* and 71*c* of the cam. Since 71*a* precedes 71*c* and is larger than 71*c*, it will be seen that this is adapted to provide the dash-dot signal and is larger than 71*c*. The signal from the line 66 therefore goes through the brush 66*a*, thence through the cam 71 which is connected by the sliding contact 72*a* to the conductor 72. The conductor branches at 72*b* into two lines which are connected through the variable resistances 74 to the conductors 75 and 75*a*, which conductors connect to the points 22 and 22*a* on the board 11. The volume controls or resistances 74 permit the signal fed in either section of the base to be increased or attenuated at will. When the contact arm 66*a* rides off of the high spot of the cam 71*a* to the low spot 71*b*, this arm then contacts with the contact arm 73*a* which is connected to the line 73. At this time neither one of the arms 66 or 73*a* are in contact with the cam, and a current flows from the line 66 through the arm 66*a* to the contact 73*a* and thence to the line 73. Here it divides into the branches 73*b* and is sent through the lines 73*b*, through the variable resistances 76, and the lines 77 and 77*a* to the top board 15 where it connects to the conducting material at 23 and 23*a*. By reference to the diagram in Fig. 11 it will be noted that the signals N and A are alternately put out into the two lines 72 and 73 from the line 66 to which a continuous signal is furnished by the cam 71. That is the dash goes onto the line 72 followed by the dot onto the line 73, and in turn is followed by the dot into the line 72 to complete the N, and then there is a space in the line 72 while the dash of the A is being put into the line 73 which is followed by a space in the line 73 while the dash of the next N is being put onto the line 72 etc. It is to be noted that the cam 71 in Fig. 11 follows the cam design of Fig. 10 rather than that of Figs. 8 and 9. The function is the same in either instance. Fig. 10 shows a slightly modified cam 71' where the cam surfaces for making the dots and dashes or on the periphery instead of on the side. In this instance the contact member 66*a* swings back and forth between the contact carrying arm 72*a* and 73*a*. The signals are, however, placed onto the lines the same as in the other device. Very obviously other expedients could be used for the circuit breaker, but the two described are relatively simple and economical in construction.

In operation, the oscillator being turned on, the operator places the head phones over his ears so that he can hear the signals, and takes his position behind the control member 40, grasping the same with his hands. He then adjusts the volume control to provide a suitable volume. In the initial stage of the training in order to accustom himself to flying the beam, he can operate the device and at the same time, observe the actions of the airplane on the top of the base. The object, of course, is the same as in actual practice, namely, for the operator to get onto the proper beam and land his plane at the airport. With the N signals being fed into the bottom board at 22 and 22*a*, and the A signals being into the top boad at 23 and 23*a*,

and the plane in the position shown in Fig. 1, he will be receiving an A signal; this being because the lower part of the pickup is positioned as shown in Fig. 1 and in Fig. 5 as is indicated by the dotted lines at A, on the base 11 and A on the lower surface 15 of the upper board 10 (Fig. 5). In this position the pickup receives the greatest signal from the A distributing zone because it is closest to the most dense low resistance carbon zone on the upper base portion 16 and receives hardly no signal from the N distribution zone because it is in a thin high resistance carbon zone, and also because it is partially overlapping the zone 19 where there is no carbon and no conducted signal. A relatively strong A signal is therefore heard. This can also be better understood by reference to Fig. 11, where the oscillator is shown connected to 66 and the cam causes the signal components to be alternately distributed to the lines 72 and 73 as previously mentioned. 15 and 16 represent the resistance of the upper and lower boards between which the pickup 25 moves. In the position A the pickup is receiving more signal from the line 73, and in position B the signal from both lines balances furnishing a continuous tone, while in position C the signal is stronger from line 72, and N is heard. Should the plane be moved to the position B, indicated by the dotted circle on Fig. 1, the pickup is then disposed, as can best be seen in Fig. 5, by the corresponding dotted circle B, in a zone where the signal is picked up in equal intensity from both the upper and lower conducting surfaces. Since the signals are equal in intensity, and since they are interlocked as best shown in Fig. 11, the signal represents a single continuous tone. This corresponds to the north-south beam on the map. If the plane then continues east across the map to the position C, as indicated by the dotted circles on Figs. 1 and 5; the lower part of the pickup, as indicated on Fig. 5, is in the N zone of greatest signal distribution density, while the upper part, as indicated on the upper board 10 of Fig. 5, is in the zone 19 where no signal is picked up, and therefore the operator receives an N signal in the head phone. He knows then that he has gone from an A zone across the beam to N zone. As a matter of fact, the actual manner in which the flyer would be trained to handle this device would be considerably different, since in all probability, after he had got onto the beam he would merely turn to the right or left to see whether he was traveling towards the airport, or away from the airport which would be indicated by an increase or decrease in signal strength because the pickup would approach or travel away from the contacts 22 or 23 where the signal was fed into the boards, and having determined which direction the signal was coming from, he would merely cross the beam slightly until he picked up the N signal, and then get back onto the beam and stay on the beam until he arrived directly over the center of the airport, indicated by open space 18, where there is no material and where once he reaches that spot there would be a complete cessation of signal. 18 in this instance represents the position of the range station. In actual flying he would probably, if the station was arranged as shown in Fig. 1 with the station west of the airport, approach the airport from the west, and when he arrived over the station or point of no signal, start his glide, which would bring him down through the bad conditions until he was able to land his plane.

The figure of the drawing happens to depict the Cleveland Airport, but the boards can be arranged to depict any airport, and in most instances, it is possible to use the same base construction, and merely substitute different sectional maps for the different airports. These maps may be held in position by suitable clips.

In event that an airport should be selected where the beams do not run directly north and south or east and west, then the beams can be swung by changing the resistances 74 and 76 in the N and A legs from the distributor. For instance, taking the N leg as in Fig. 8, if the resistance in the lines 75 and 75*a* is decreased, while the resistance in the lines 77 and 77*a* is increased, it will have a tendency to widen the N zone and narrow the A zone. It will also be seen that if the one of the resistances 74 in the legs 75 and 75*a* is increased, and the other decreased. while in the other the lines 77 and 77*a* the resistances 76 are likewise increased and decreased, there will be a tendency to shift the beams, depending upon the amount of change of the resistance, a considerable number of compass degrees.

After the operator has accustomed himself to the operation, and what happens by observing the same visually, the screen 63 is interposed between him and the board, after which the board may be moved relative to the operator and the screen, the operator holding the control handle 40 steady while the moving is being accomplished. By moving the board around, the pickup and the plane on top of the board is placed in any zone that the instructor so desires. The operator then does not know where the pickup and plane are, and therefore has to orient himself entirely by the sound of the signals.

In Fig. 6 I have shown another modification. Here the oscillator 1 is connected to the base 2 in the usual manner. The trainee, however, takes his position in a trainer 80 which may be of the aforementioned Link type, and wherein the hood is placed over the cockpit, as is common practice. The Link trainer is connected through a flexible conduit 81 through the side of the base to a crab which operates between the top and bottom boards of the base. The crab may be constructed substantially as shown in the aforementioned Patent No. 2,179,663, and per se, forms no particular part of the present invention other than as is particularly pointed out hereinafter. Movements of the crab between the board from the Link trainer are accomplished in the manner well known and described in that patent. However, in previous devices it was necessary for an instructor to watch the movements of the crab and transmit to the trainee signals indicative of his position as shown by the crab on the chart. In the present instance, however, the crab may be provided with a pair of pickup members constituting brushes riding on the surfaces 16 and 15 of the base, which brushes pick up signals from the base in exactly the same manner as the manually operated pickup previously described. The upper pickup may have associated with it the bar magnet 30, and a small airplane 87 travels about the upper surface indicating the position of the crab between the boards in a manner exactly similar to the device shown in Fig. 3.

It will thus be seen that the human element of an instructor whose attention might waver momentarily and thus provide the wrong signals to the trainee, is completely eliminated because his position is relayed to him automatically by the

pickup on the crab between the upper and lower portions of the base. The airplane 87 travels over the top surface and follows the crab in the same manner that the airplane 55 of Fig. 3 follows the manually operated pickup.

As best shown in Fig. 7, a modified airplane 87 may be provided with an inkpencil 94 having a reservoir for receiving ink, and a stylus 95 for tracing a path on the chart such as is indicated at 96 in Fig. 6. This inkpencil does not necessarily have to be at the tail, but can be at the nose where the propeller is shown, but in either event, inks the path of travel taken by the airplane over the chart. As best shown, the chart is a removable sectional map held in place by clips 97.

In operation the trainee gets into the trainer, the hood is closed down over him, the instructor either opens up the base and positions the crab where he wants it manually, or reaches in with a suitable pole and moves the crab around to the proper position, starts the oscillator going, indicates to the pilot that he is now on his own, and the pilot works out his problem of orientation without further instructions from the instructor. It is thus possible for one instructor to supervise a considerable number of trainees and he can tell about the problem of each trainee by the course 96 traced on the respective chart. The pilots being trained have the signals relayed to them more realistically than they would if they were relying on the judgment of an instructor to manually see that the signals were sent according to what, in his opinion, would be the type of signals that would be received if the operator was in a particular zone.

Although I have not specifically shown it, it is contemplated that an addition in the oscillator setup be provided whereby the "on" and "off" beam signals are interrupted periodically during which period the station call letters are sent, as is the actual practice with the regular range stations.

In Fig. 12 I have shown another modification of my invention wherein a dirigible motor driven pickup is provided which operates in a manner substantially the same as that described for Fig. 6. That is, the pickup will be motor driven to travel at a certain speed variable between certain limits simulating the top and cruising speeds of an airpane. The pickup is provided with brush type pickups and signals are communicated to the operator by means of the head phones 4. The oscillator 1 is connected to the board in a manner previously described to furnish the signals in the N and A zones. A screen 63 is also provided to screen the board from the operator and the airplane operating on the top of the board may have the ink stylus 94—95 as shown in Fig. 7. Connected to the board by a cable 150 is a control box 151 which is provided with a control 152 simulating a throttle whereby the speed of the airplane can be increased or decreased, as previously mentioned. This control may be eliminated in some instances and the pickup constantly driven at one predetermined speed. At 153 I have provided a stick similar to that employed in the control of an airplane for enabling the operator to bank to the right or to the left, and the operation of which when moved to the left or right as indicated in the dotted lines will cause the airplane 87 to train to the left or right.

It will be seen that this device operates in a manner quite similar to that of Fig. 6 except that the so-called "Link" trainer is eliminated.

In Fig. 13 I have shown another modification of my invention. Here, instead of the upper and lower boards being provided with a carbon deposit as in the manner of the previous figures, I have provided prepared surfaces which are both disposed in the same plane which may be the base. The manner of deposition of the material may be the same as that described, the pickup arm, however, comprises the contact portions 100 and 101 held in a spaced relation from each other by a beam 102. The zones of resistance material are indicated by 111 and 110, each being divided by the pie-shaped segments 119—120 and 119*a* and 120*a* respectively; those on the part 110 being displaced 90° relative to those on the part 111. Signals are fed to the zones 111 and 110 respectively at the points 122—122*a* and 123—123*a* in the same manner as that illustrated in the preceding figures. The pickup 100—101 is shown in the position where the letter A is being picked up. The position of the airplane is indicated by a continuation of the rod 45 which extends beyond the beam 102 and carries on its end a magnet to attract an airplane 55 disposed on a chart similar to that previously described. The connection to the magnet may be through a member similar to the pickup shown in Fig. 3, except in this instance no brushes may be used because the signal is picked up by the pickup 100—101; the magnet in this instance is preferably directively moved by a castor and pintle.

In this embodiment I have shown a linkage which causes the controls to be moved in parallelism with the base. In the form shown it comprises a saddle 130 securely connected to the rod 45 and extending down through an elongated slot 131 of a yoke 132. The saddle 130 is of sufficient length so that it cannot turn in the slot 131 and can only slide longitudinally therein. The ends of the yoke 132 are provided with extensions 133 which carry at their extremities guide tubes 134 slidably journalled on rods 135 connected to the inner and far side of the base and in closely spaced parallelism with the sides. A suitably constructed pantograph mechanism could be substituted and a similar result accomplished, as will readily be recognized. The operation of the device is substantially the same as that shown for Fig. 1.

I also contemplate eliminating the top board and leaving the mechanism all exposed. In this instance, the chart would also be mounted on the bottom board, and the magnets for moving the airplane could be eliminated since the airplane would be connected directly to the castor-pintle. This parallel linkage just described can also be applied to the device of Fig. 1.

Although I have shown and described my invention as operating with a relatively high resistance conducting material such as a mixture of carbon deposited as described, I also contemplate using other types of means for distributing the signal, which can be either inductively or capacitively arranged.

Fig. 14 shows an arrangement for inductive coupling. In this instance, the oscillator 1 is connected through the lines 72, 73, and 66 to the coil forms 173—173*a* and 172—172*a*. The signal is put into these forms in the same manner as it is put into the carbon or resistance type, except that in this instance they are closed circuits. The signal is picked up by a pickup coil 125 which may be moved about in the same

manner as the pickup of the previously described pickup. A suitable amplifier may be provided for boosting the signals in the head phones 4, should it be necessary.

In Fig. 15 I have shown an arrangement for accomplishing the objects of my invention capacitively. In this instance the signal is fed to metallic plates 273 and 273a and 272 and 272a. These plates are formed in plan view in the manner shown in Fig. 15 and are dished, as best shown in the elevational section of Fig. 16. The plates are held, being spaced from each other by dielectric partitions 201 and 202 which are parallel to each other. The pickup may comprise a pair of plates of circular formation 203 which slide between the dielectric plates 201 and 202 and vary in their capacitive relation to the plates 273 and 272 according to their position relative thereto. The signals are fed to the plates in substantially the same manner as previously described for the inductive coupling and are picked up by the pickup 203.

It will thus be seen that I have provided a device that will enable an unexperienced person to soon accustom himself to flying on a radio beam. The expense of operation is practically negligible and at the same time the results of the operation more nearly simulate the actual conditions encountered on a radio beam than devices heretofore known. It will also be apparent to those who use the device how it may not only be used as a most practical training device, but also lends itself to various forms of entertainment for both the old and young, besides increasing the interest in aviation.

It will also be apparent that the device lends itself to various degrees of perfection, making it possible to construct inexpensive devices furnishing very satisfactory operation such as described in Fig. 1, to the more expensive devices containing the motor drive pickup. It will also be clear that there is no chance for the error that might be otherwise injected into its operation as is possible where an instructor must use his judgment as to the type of signal that the trainee should be receiving.

Although I have shown permanent magnets in the miniature airplane and pickup, it is quite practical to substitute an electromagnet in the pickup; in this event the airplane could be partially of magnetic material so that only the nose, for instance, was magnetic and the crank mechanism for the pickup could be eliminated.

In the inductively arranged setup it may also be desirable to insert iron cores in the signal coil. Obviously, the loudspeaker or head phones could have substituted therefor a visual indicator, shou'd it be desired.

Having thus described my invention and some embodiments thereof, I am aware that numerous and extensive departures may be made by me therefrom without departing from the spirit and scope of the invention.

I claim:

1. An apparatus for teaching blind flying including a signal generator adapted to generate signals corresponding to the radio signals broadcast by an airport radio range station, a base comprising a pair of vertically spaced upper and lower members, the opposite surfaces between the upper and lower members in said base having deposited thereon a conducting material having a predetermined resistance and arranged in zones, means connecting said signal generator to said conducting material, and pickup means disposed between and movable between said upper and lower members and in electrical contact with said resistance material and adapted to pick up signals from said material, and means connected to pickup to render said signals audible.

2. An apparatus for teaching blind flying including a signal generator adapted to generate signals corresponding to the radio signals broadcast by a radio range station for guiding airplanes, a base comprising a pair of vertically spaced upper and lower members, the upper surface of said base adapted to support a map depicting a portion of the terrain over which an airplane may travel, the opposite surfaces between said upper and lower members in said base having deposited thereon a conducting material having a predetermined resistance and arranged in zones, means connecting said signal generator to said conducting material, and pickup means disposed between and movable between said upper and lower members and in electrical contact with said resistance material adapted to pick up signals from said material, which signals vary according to the position of the pickup relative to the resistance material on the upper and lower members and from the point of connection of the signal generator to said conducting material.

3. A device of the class described comprising a base constituting upper and lower spaced members, conducting material of high resistance disposed on the opposed inner faces of said base, said conducting material substantially covering said surface except for an intermediate point that is free from conducting material at a place adapted to simulate a radio range station, the material on each of said opposed faces of said base being divided into two or more conducting sections by spaces free from conducting material in zones extending from said intermediate points across the conducting material and said space converging toward said intermediate point, said dividing spaces that are free from conducting material being offset on each face of said base relative to the other, a signal generator adapted to generate interlocking code characters, connectors connecting each of said conducting areas at the edge of the place simulating the radio range station to said signal generator, and resistance means interposed in each of said connectors to said conducting zones and controllable to control the intensity of signals fed to said zones, pickup means movable between the inner faces of said base portion and having means to pick up signals from said conducting surfaces, and means for directing the travel of said pickup between said surfaces, and means disposed on the surface of said base operable by said pickup to indicate the path traveled by the pickup.

4. A device useful for training aviators in blind flying, comprising a signal generator for generating code characters such as are broadcast from a radio range station for guiding an airplane, a base formed to simulate an airport and the surrounding territory and comprising a flat upper surface adapted to receive a sectional map, a lower portion for said base spaced vertically from the upper portion to provide an unrestricted passageway therebetween, the upper and lower horizontal walls of said base having deposited thereon in a predetermined pattern a conducting material having a high resistance, said surfaces being substantially covered with said material and each of said walls having a path free from said material extending from the edge of the base to a portion on the base selected to simulate an airport, the

sides of said path diverging from each other away from the simulated airport, the said paths on said walls being displaced circumferentially from each other on opposite walls, said signal generator being electrically connected to said deposits to feed a signal of one type to the material on one wall and a signal of another type to the material on the other wall; and pickup means movable between the upper and lower horizontal walls and having contacts for electrical engagement with the surfaces of said walls for picking up the signals fed thereto and means connected to said pickup to render said signal audible.

5. A device of the class described comprising a hollow base, conducting material of high resistance disposed on the opposed inner faces of said base, said conducting material on each face of said base being divided into two or more conducting sections by spaces free from conducting material, an intermediate enlarged space between said conducting materials, said dividing spaces that are free from conducting material being offset on each wall of said base relative to each other, a signal generator adapted to generate interlocking code characters and connectors connecting each of said conducting areas at the edge of said enlarged space to said signal generator and resistance means interposed in each of said connectors to said conducting zones to control the intensity of signals fed to said zones, pickup means movable between the inner faces of said base portion and having means to pick up signals from said conducting surfaces, and means connected to said pickup and operable outside of said base to direct the movement of the pickup between said surfaces, and means to simulate a miniature airplane disposed on the surface of said base and having a magnet, a second magnet carried by said pickup and operable to cause the airplane to move with the pickup.

6. A device of the class described comprising a base constituting upper and lower spaced members, conducting material of high resistance disposed on the opposed inner faces of said base, said conducting material substantially covering said surface except for an intermediate point that is free from conducting material at a place adapted to simulate a radio range station, the material on each of said opposed faces of said base being divided into two or more conducting sections by spaces free from conducting material in zones extending from said intermediate points across the conducting material and said space converging toward said intermediate point, said dividing spaces that are free from conducting material being offset on each face of said base relative to the other, a signal generator adapted to generate interlocking code characters, connectors connecting each of said conducting areas at the edge of the place simulating the radio range station to said signal generator, and resistance means interposed in each of said connectors to said conducting zones to control the intensity of signals fed to said zones, pickup means movable between the inner faces of said base portion and having means to pick up signals from said conducting surfaces and means disposed outside of said base and connected to said pickup and having a compass card for indicating the direction of travel of the pickup for directing said travel of the pickup between said surfaces, and a miniature airplane disposed on the surface of said base and having magnetic means magnetically attracted by a magnetic means carried to said pickup to indicate the path traveled by the pickup.

7. A device useful in the teaching of blind flying comprising a signal generator, a motor driven circuit breaker for breaking up the signal from said generator into code characters connected to the signal generator, a base, a pair of surfaces on said base having a conductive resistance material coated thereon, each of said surfaces having a zone of non-conducting material dividing each one of said pair of surfaces into spaced conducting zones, said non-conducting zones comprising an intermediate area for simulating a radio range station and diverging areas extending therefrom, the non-conducting spaces of each of said surfaces being radially displaced relative to the intermediate non-conducting zone, and pickup means having brushes for traveling on said surfaces, a rod connected thereto and extending beyond said base adapted to be moved by an operator, and a linkage connecting said rod to said base to direct the movement of said rod along parallel lines, and means connected to said pickup to render signals picked up by said pickup from said conductive material intelligible.

LLOYD R. SUSDORF.

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