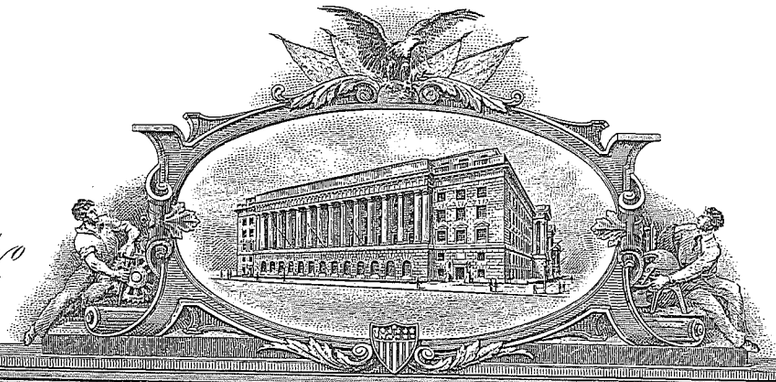

No. 2459150

THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME:

Whereas Carl J. Crane and George V. Holloman, of Dayton, Carl W. Muller, of Osborn, and Raymond K. Stout, of Dayton, Ohio,

PRESENTED TO THE Commissioner of Patents A PETITION PRAYING FOR THE GRANT OF LETTERS PATENT FOR AN ALLEGED NEW AND USEFUL IMPROVEMENT IN

INTERCEPTION TRAINERS,

A DESCRIPTION OF WHICH INVENTION IS CONTAINED IN THE SPECIFICATION OF WHICH A COPY IS HEREUNTO ANNEXED AND MADE A PART HEREOF, AND COMPLIED WITH THE VARIOUS REQUIREMENTS OF LAW IN SUCH CASES MADE AND PROVIDED, AND

Whereas UPON DUE EXAMINATION MADE THE SAID CLAIMANT s are ADJUDGED TO BE JUSTLY ENTITLED TO A PATENT UNDER THE LAW.

NOW THEREFORE THESE Letters Patent ARE TO GRANT UNTO THE SAID

Carl J. Crane, George V. Holloman, Carl W. Muller, and Raymond K. Stout, their heirs OR ASSIGNS

FOR THE TERM OF SEVENTEEN YEARS FROM THE DATE OF THIS GRANT

THE EXCLUSIVE RIGHT TO MAKE, USE AND VEND THE SAID INVENTION THROUGHOUT THE UNITED STATES AND THE TERRITORIES THEREOF. Provided, however, that the said invention may be manufactured and used by or for the Government for governmental purposes without the payment of any royalty thereon.

In testimony whereof I have hereunto set my hand, and caused the seal of the Patent Office to be affixed at the City of Washington this eighteenth day of January, in the year of our Lord one thousand nine hundred and forty-nine, and of the Independence of the United States of America the one hundred and seventy-third.

Attest:

Law Examiner.

Lawrence E. Kingsland
Commissioner of Patents.

Jan. 18, 1949. C. J. CRANE ET AL 2,459,150

INTERCEPTION TRAINER

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FIG. 12.

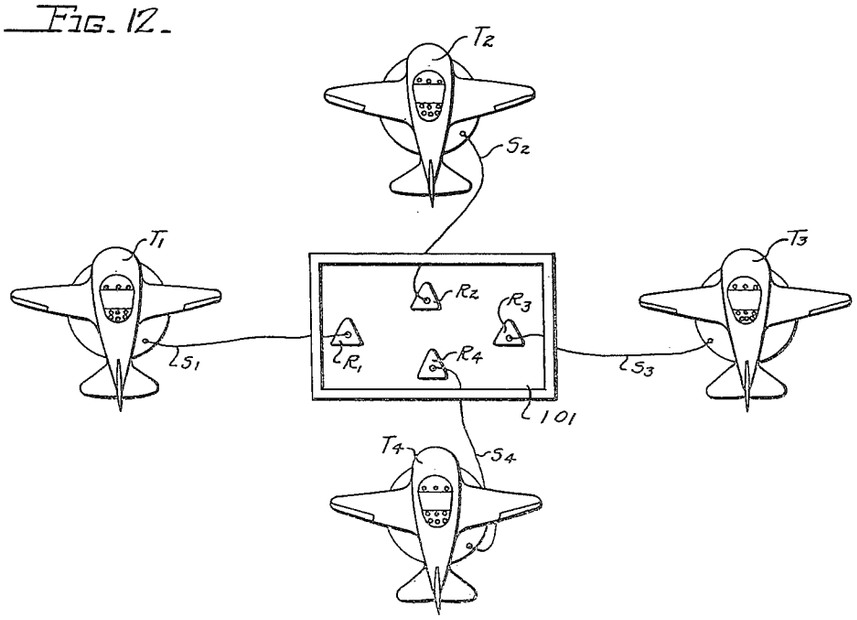
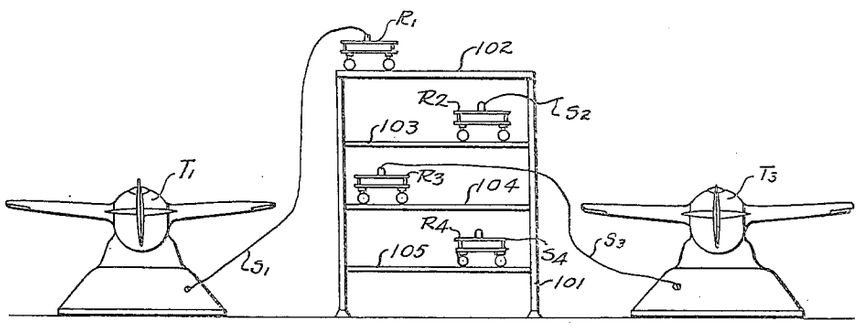


FIG. 13.



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INTERCEPTION TRAINER

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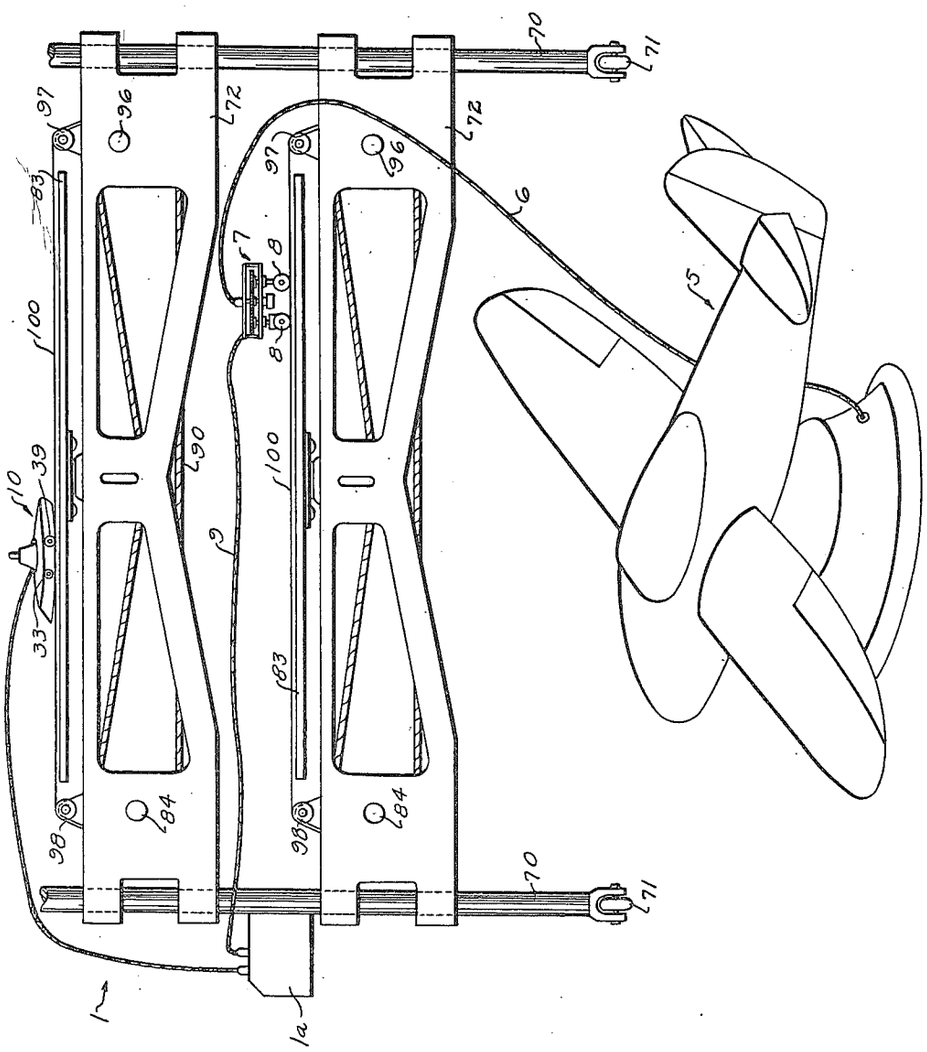

FIG. 11.

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INTERCEPTION TRAINER

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FIG. 9.

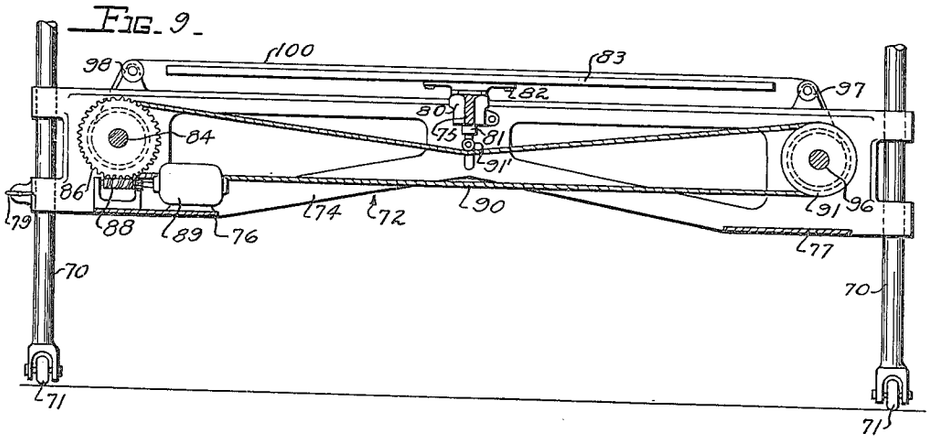
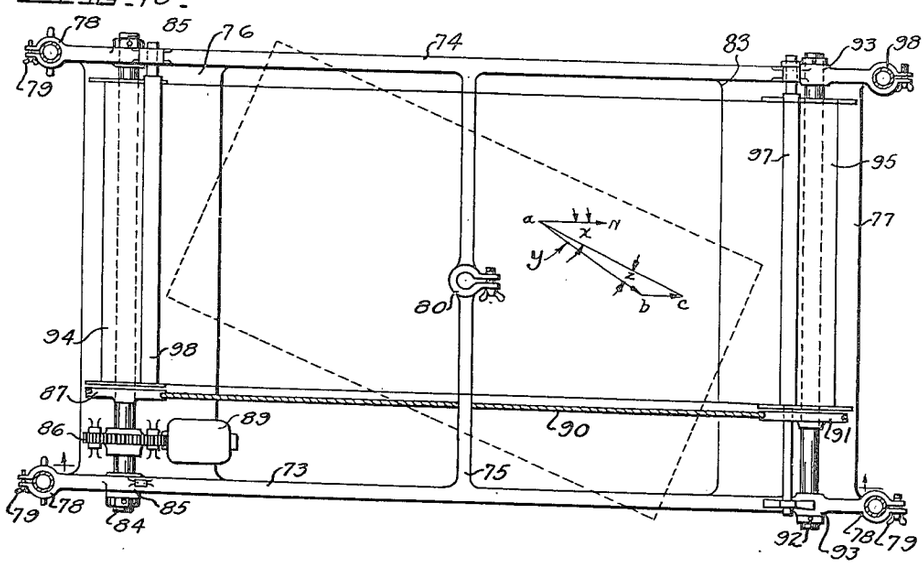


FIG. 10.



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INTERCEPTION TRAINER

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FIG. 6.

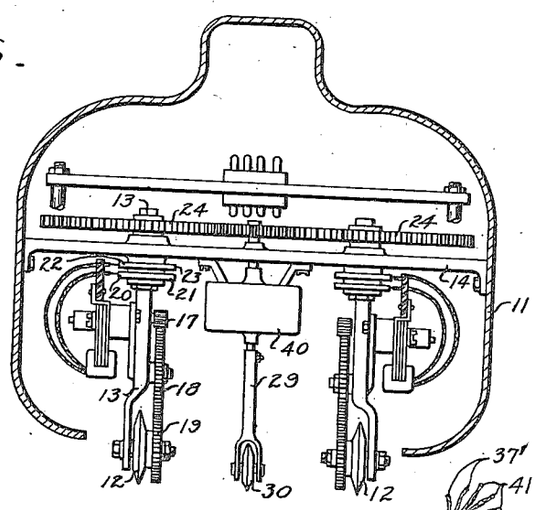
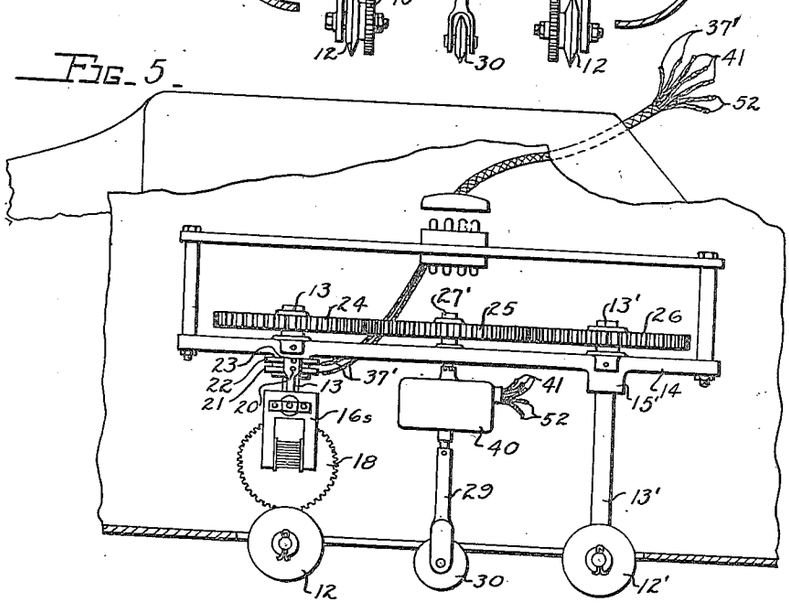


FIG. 5.



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INTERCEPTION TRAINER

Filed Feb. 26, 1940

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FIG. 4

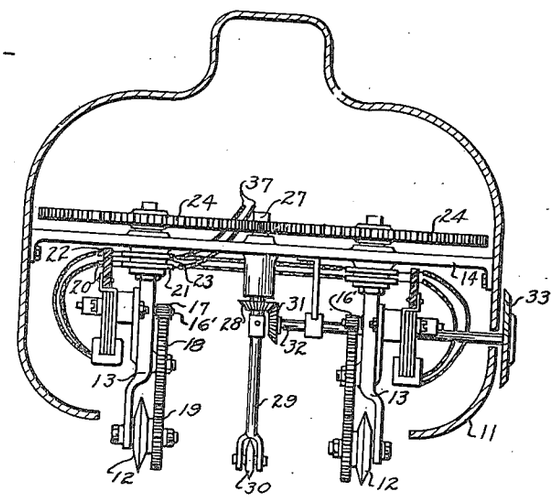
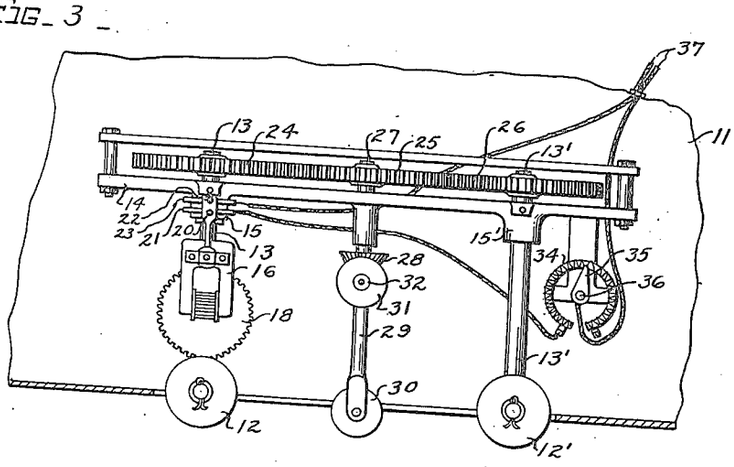


FIG. 3



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INTERCEPTION TRAINER

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FIG. 2.

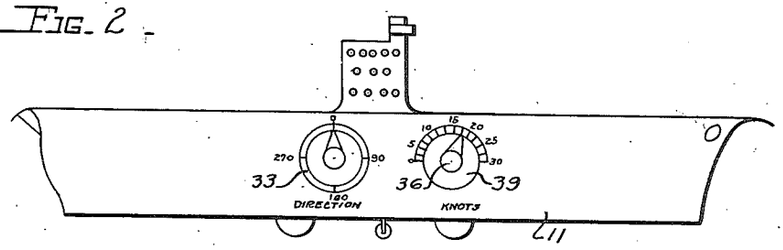


FIG. 8.

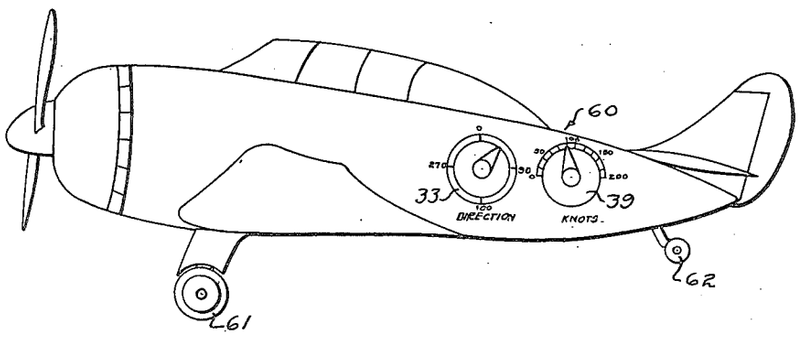
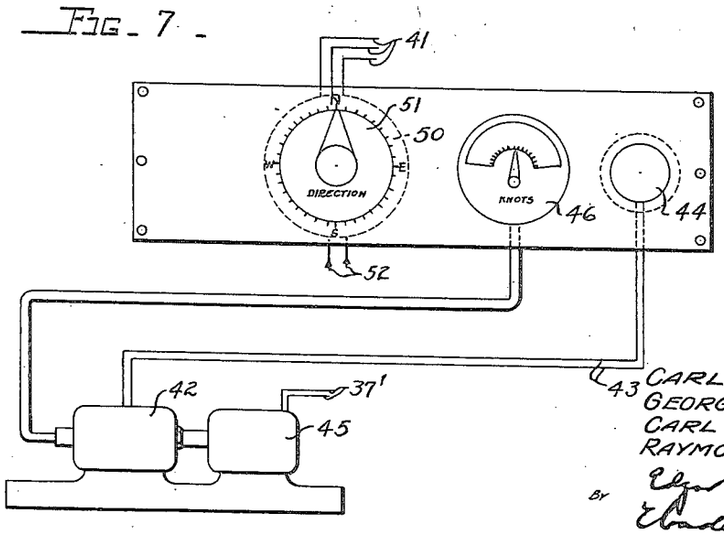


FIG. 7.



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INTERCEPTION TRAINER

Filed Feb. 26, 1940 7 Sheets-Sheet 1

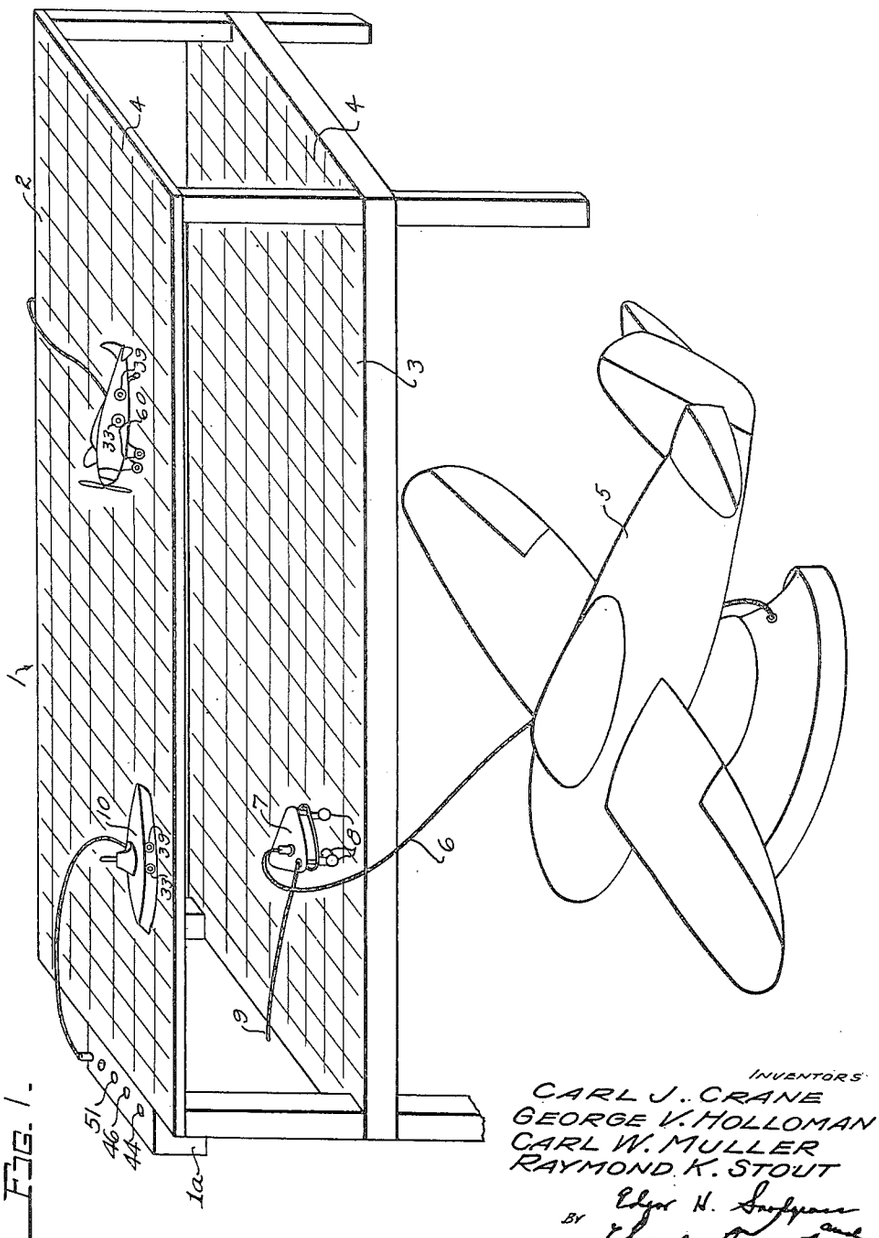

FIG. 1.

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Patented Jan. 18, 1949

2,459,150

UNITED STATES PATENT OFFICE

2,459,150

INTERCEPTION TRAINER

Carl J. Crane and George V. Holloman, Dayton, Carl W. Muller, Osborn, and Raymond K. Stout, Dayton, Ohio

Application February 26, 1940, Serial No. 320,880

6 Claims. (Cl. 35—25)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

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The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to us of any royalty thereon.

This invention relates in general to improvements in auxiliary apparatus used in combination with aviation ground trainers and more particularly relates to a novel arrangement of transparent recorder table surfaces, one of which surfaces supports a simulated air borne or sea borne target propelled at a constant speed and having a controlled direction and another of which surfaces supports a course indicator, or recorder, controlled by the aviation ground trainer, whereby simultaneous observation of the relative position of the recorder and the target permits the solution of interception problems.

At the present time instruction in complicated aviation flight problems is given on aviation ground trainers, such as the well-known "Link" trainer, with a consequent reduction in actual flying time necessary to complete the course of instruction. The structure and operation of such trainers is disclosed in United States Patents Nos. 1,825,462 and 2,099,857, granted to Edwin A. Link, Jr.

It is customary in the operation of aviation ground trainers to use in conjunction therewith, a course indicator, or recorder, which comprises a frame supported by a plurality of rollers, each of the rollers being rotatable about a vertical axis to cause a change in direction of rotation of the rollers. The rollers are mounted on vertical shafts, which are interconnected by gearing to a "selsyn" receiver mounted on the recorder frame. The "selsyn" receiver is electrically connected to a "selsyn" transmitter, driven by the trainer as it rotates about a vertical axis, so that the recorder rollers are always rotated through the same angle as the trainer and the heading of the recorder thus corresponds at any instant with the heading of the trainer. At least two of the supporting rollers of the recorder are driven by small electric motors generally of the synchronous type, so that the speed of the recorder over the map table represents to a definite scale the simulated velocity in flight of the trainer. The speed of the recorder, or course indicator is kept constant, but may be adjusted to any desired value by changing the speed of the generator supplying current to the propulsion motors on the recorder.

Course recorders such as above described generally employ one of the supporting rollers as a marker wheel, which when inked by a felt pad, traces the course of the recorder on the record

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map, though the position of the marker wheel even when not inked serves as a course indicator.

For a more complete description of course recorders suitable for use with aviation ground trainers, preference may be had to United States Patent No. 1,293,747, to Hannibal C. Ford and to United States Patent No. 2,179,663, granted to Edwin A. Link, Jr.

In a course of instruction on the ground trainer, it is desirable to be able to solve interception problems, for example to simulate flight intercepting another aeroplane, or water borne target, knowing the course and speed of the target under either simulated fair weather conditions, or under simulated bad weather conditions, necessitating simulating instrument flight either in whole or in part. A means to render such instruction possible is provided by the invention, in which a record map table is provided with a plurality of record surfaces arranged in a rack in the form of shelves and preferably made of a transparent material such as glass, or one of the well-known transparent plastic materials. The target to be intercepted is placed on one of the surfaces, which has suitable course indicia marked thereon and the target is set into motion with a velocity and under a controlled heading in accordance with the desire of the instructor and the trainer course recorder is placed in operation under the directional control of the trainer and at a velocity proportional to the simulated air velocity of the trainer and starting at a definite point and with a known heading. The instructor then informs the student of the course and simulated velocity of the target, who then must solve the vector problem to intercept the target at the proper point. The movement of the course recorder relative to the target is at all times visible to the instructor and the record trace upon the record surfaces leaves a picture of the completeness of the problem's solution. The simulated trainer flight may be wholly on instruments, or may simulate fair weather flight, the student observing the position of the course recorder relative to the target after simulating flight for a time sufficient to bring the target into view, if the same were in actual flight, so that the resulting solution of the problem becomes apparent.

Since it is essential to take into account the effect of simulated drift, on either the air borne or water borne targets and also the effect of winds on the trainer, the invention provides a means for correctly simulating such effects by means of a device permitting the recorder and

targets to be displaced in a direction and at a velocity proportional to the effect of a simulated air current on the trainer or air borne target and to the effect of water currents on the water borne target.

Analogous to the solution of interception problems is the simulation of control of traffic of a plurality of aircraft operating at different altitudes approaching the same destination and required to proceed to a landing in accordance with their order of arrival and their respective altitudes. Such traffic control problems may be readily solved with the trainer record table used according to the invention, by providing a separate record surface in the form of a shelf for each trainer to be operated and the instructor can then watch the respective recorders and give to each student the proper information as to the conduct of his respective simulated flight, in the same manner that a traffic control director at a large airport conducts the safe landing of a number of aircraft arriving at close intervals of time. It merely requires the supplying of the proper maps and charts in order to convert from one type of problem to another.

It is an object of this invention to provide apparatus for aviation ground training in which a multiple surface record table serves as a support for one or more simulated air borne or water borne targets, each having a controlled velocity and direction on one of said surfaces and one or more course indicators, or recorders, each directionally controlled by a respective ground trainer and operating at a velocity proportional to the simulated flight velocity of the trainer, whereby flight interception problems may be simulated.

A further object of the invention is the provision of a novel trainer table assembly comprising a plurality of superimposed spaced transparent surfaces, each surface having position indicia thereon, whereby the instantaneous relative position of a ground trainer course indicator and a simulated air borne or a water borne target may be observed.

Another object of the invention is the provision of a means to cause a movement of a course indicator for an aviation ground trainer relative to its record surface, in a manner to simulate the effect of a wind acting on said trainer, while in simulated aircraft flight.

A further object of the invention is the provision of a means for affecting the movement of a recorder, simulating in velocity and direction, the movement of an air borne or water borne craft in a manner equivalent to the effect on said craft of an external force such as wind or water currents respectively.

A further object of the invention is the provision of a novel trainer table assembly permitting simultaneous operation of a plurality of aviation ground trainer recorders thereon, whereby simultaneous simulated flights of a plurality of aviation ground trainers may be directed by an instructor.

Other objects of the invention will appear by reference to the specification and the appended drawings forming a part thereof and in which:

Fig. 1 illustrates a trainer record table having superimposed record surfaces, one of which surfaces cooperates with a simulated air or water borne target and another of said surfaces cooperates with a course recorder controlled by an aviation ground trainer;

Fig. 2 illustrates an enlarged view of a simulated water borne target, as employed in the invention;

Fig. 3 illustrates an enlarged view of the device illustrated in Fig. 2, showing the driving mechanism;

Fig. 4 is a vertical cross sectional view of Fig. 3;

Fig. 5 illustrates a simulated water borne target similar to the device of Figs. 2, 3 and 4 modified for use with distant speed and direction controls;

Fig. 6 is a vertical cross sectional view of Fig. 5;

Fig. 7 illustrates the means employed for distantly controlling the speed and direction of the targets illustrated in Figs. 5 and 6;

Fig. 8 illustrates an enlarged view of a simulated air borne target employed in the invention;

Fig. 9 illustrates a vertical section of a modified trainer record table assembly permitting wind or water current drift effects to be simulated;

Fig. 10 is a top plan view of the device of Fig. 9;

Figure 11 is an illustration of two of the trainer record table devices of Figures 9 and 10 superimposed and used to replace the tables of the device of Figure 1.

Fig. 12 is a top plan view illustrating an aviation ground trainer and table array permitting traffic control problems to be solved; and

Fig. 13 is a front elevation showing the arrangement illustrated in Fig. 12.

Referring to Fig. 1, the reference numeral 1 generally indicates a record map table having thereon an upper supporting surface 2 and spaced therefrom and parallel therewith, a lower supporting surface 3 arranged in the form of a shelf. The upper and lower surfaces are preferably made of a transparent material such as glass or any of the transparent synthetic resinous materials where it is desired to use the table for the solution of course interception problems. The upper and lower surfaces 2 and 3 are each ruled with suitable indicia 4, such as lines indicating latitude and longitude, representing a part of the surface of the earth, either land or water and the indicia are ruled so as to be identical when superimposed.

An aviation ground trainer 5 is placed adjacent the trainer record table 1 and is electrically connected through the electric "selsyn" transmission conductors 6 to a course recorder 7, movable over one of the record surfaces and shown, as being the surface 3. The recorder 7 is supported by a plurality of rollers 8, one of which serves as a marker wheel to leave an inked trace of the recorder path on the record surface 3. Generally the recorders are provided with three rollers, two of which are driven by small electric motors (not shown) supplied with current by the conductors 9. The motors drive the recorder 7 over the surface 3 at a constant speed, representing to a predetermined scale, the simulated velocity of flight of the trainer 5. The rollers 8 are mounted on vertical shafts, which are interconnected by gearing with a "selsyn" receiver (not shown), which in turn is connected by the conductors 6 to a "selsyn" transmitter, rotated by the trainer 5 as it changes its heading. The directional heading of the recorder rollers 8 are thus simultaneously rotated in step with the rotation of the trainer and the course taken by the recorder in its movement relative to the surface 3, is thus controlled by the heading of the trainer. The construction of the recorder and its control by the trainer, as before noted, is well-known in the art and the

detail construction of the recorder and its control, therefore, has not been illustrated in the drawings.

As seen in Fig. 1, a simulated water borne target 10, is adapted to be propelled over the record surface 2 at a velocity proportional to the simulated velocity of a target vessel on the ocean and is adapted to be directionally controlled at the will of the instructor. One form of the simulated water borne target 10 is illustrated in Figs. 2, 3 and 4 in which the target comprises a hull shaped casing 11, supported for movement over a record surface by two pairs of rollers 12 and 12' respectively. As seen in Fig. 2, the casing 11 has two manually controlled knobs thereon, the knob 33, controlling the plane of rotation of the rollers 12 and 12' and the knob 39, controlling the speed setting of a rheostat governing the speed of the driving motors. A suitable scale reading in degrees of rotation and simulated speed in knots is placed adjacent the respective knobs 33 and 39, so that their respective settings may be observed.

As seen in Figs. 3 and 4, the propelling mechanism comprises a frame 14, secured to the casing 11 as by bolts, the frame having enlarged bosses 15 and 15', which serve as bearings for the vertical shafts 13 and 13'. The shafts 13 serve as supports for the rollers 12, which are rotatably mounted on the lower ends of the shafts. Small electric motors 16 are mounted on the shafts 13 and are rotatable therewith. The motors 16 may be of the well-known universal type, which can be energized from any suitable low voltage alternating or direct current source. The shafts 16', of the motors 16, pass through suitable journal openings transverse to the axis of shafts 13 and have pinion gears 17 mounted on the end portions of the shafts. The pinion gears 17 mesh with idler gears 18 rotatably mounted on pivots carried by the shafts 13. The idler gears 18 each mesh with a driving gear 19 secured to each of the rollers 12 and rotatable therewith. The motors 16 each have secured thereto a pair of brushes 20 and 22, which contact the respective slip rings 21 and 23 mounted on the bosses 15. The slip rings are connected in parallel by a pair of conductors 37 to a power source (not shown). Each motor 16, when energized from the power source, will drive a respective roller 12 through the medium of pinion gear 17, idler gear 18 and driving gear 19, at a speed proportional to the motor speed. The motor speed is adjusted to give a desired speed of translation to the target 10 by means of a variable resistance 34, inserted in series with one of the conductors 37. The resistance 34 may be varied by rotation of the arm 35 by the shaft 36. The shaft 36 carries the manual adjustment knob 39, as seen in Fig. 2, so that the speed of the driving motors 16 may be set at any desired value by rotation of the knob 39. The motors 16 preferably are provided with built in reduction gearing, so that the normal speed of the shafts 16' will be a desired small number of revolutions per minute.

Upon their upper ends, the shafts 13, each carry a gear 24, which mesh with a gear 25, rotatably mounted on the upper end of the shaft 27, rotatably mounted in frame 14. The vertical shafts 13' are rotatably mounted in the bosses 15' and the rollers 12' are rotatably mounted on pivots carried by the lower ends of the shafts 13'. At their upper ends, the shafts 13' are each provided with a gear 26, meshing with the gear 25. The shaft 27 carries a bevel gear 28 adjacent its

lower end and the gear 28 meshes with a bevel gear 31, mounted on the inner end of the shaft 32. The shaft 32 is suitably supported by the frame 14 and at its outer end carries the knob 33. Rotation of the knob 33 causes rotation of gears 31 and 28, shaft 27, gear 25 and gears 24 and 26. Rotation of gears 24 and 26, causes the plane of rotation of rollers 12 and 12' to be rotated in equal angular increments. The knob 33 thus serves as a means to alter the heading of the target 10 at the will of the instructor.

A vertical shaft 29 is secured to the lower end of the shaft 27 and is coaxial therewith. The shaft 29 terminates in a fork in which the marker roller 30 is rotatably mounted. The roller, when inked by an ink saturated felt, will trace the recorder path on a record sheet and is rotatable in unison with the rollers 12 and 12' by the knob 33.

The target 10 is placed in operation by the instructor by aligning the target roller planes with a line on the table surface 2 and then rotating the knob 33 until the desired heading is obtained. The knob 39 is set to operate the motors 16 at the desired speed to give a velocity of translation having a definite ratio to the simulated velocity of a water borne craft and the motors are then energized by connecting the conductors 37 to the power source through a suitable switch (not shown).

Figs. 5, 6 and 7 illustrate a modified form of driving and control mechanism for the target 10, illustrated in Fig. 2, and similar parts are given the same reference numerals as in Figs. 2, 3 and 4. The construction, as seen in Figs. 5 and 6, differs from the driving mechanism illustrated in Figs. 3 and 4, in that the electric motors 16 are replaced by synchronous motors 16_s which are adapted to run at a speed determined by the frequency of the alternating current supply for the motors, but the driving mechanism to the rollers 12 otherwise remains the same. The shaft 27 for the gear 25 is replaced by the rotor shaft 27' of a "selsyn" receiver 40, mounted on the recorder frame 14. The gear 25 is thus rotated in unison with the rotor of the "selsyn" receiver 40. The shaft 29 and marker roller 30 are mounted on the lower end of the shaft 27' of the "selsyn" receiver 40 in the same manner as illustrated in Figs. 3 and 4. The "selsyn" receiver is adapted to be connected to a "selsyn" transmitter by means of the conductors 41 and the motors 16_s are adapted to be connected to a controlled frequency alternating current supply, by means of conductors 37'. Rotation of the rotor of the "selsyn" receiver 40 thus controls the azimuth heading of the target 10 in the same manner as the manual control knob 33 and the speed of motors 16_s, and hence the velocity of the target can be controlled by control of the frequency of the alternating current supply for the motors.

The distant control mechanism for controlling the "selsyn" receiver and the frequency of the alternating current supply for motors 16_s, is illustrated in Fig. 7, in which the reference numeral 42 indicates a variable speed electric motor supplied with direct current by conductors 43 and controlled by a variable resistance 44, which may for example be connected in series with the armature and field for a series wound motor, or connected in the armature circuit of a shunt wound motor. The motor 42, is connected to drive a small alternator 45, which supplies current to the conductors 37' at a frequency proportional to the speed of rotation of the motor

42. The speed of rotation of the motor 42 is indicated by a tachometer 46, which can be calibrated to read in knots, equivalent to the simulated velocity of the target 10. The translational velocity of the target 10 can then be controlled by the instructor by adjustment of the rheostat 44, which will control the speed of motor 42 and the frequency of the current generated by the alternator 45, which in turn controls the speed of the synchronous driving motors 16s. The motors 16s may be purchased with built in gear reductions similar to that above described with reference to the universal motors 16, thus permitting the target to be driven at a very slow speed.

The "selsyn" receiver 40 (Figure 5) is connected by the leads 41 to a "selsyn" transmitter 50, the rotor of which can be revolved by the knob 51, so that the directional heading of the target 10 may be controlled by rotating the knob 51. The stator windings of the "selsyn" receiver 40 and the "selsyn" transmitter are supplied by a constant frequency source of alternating current (not shown) connected to leads 52. The "selsyn" control knob 51 and the rheostat 44 serve to respectively maintain the heading and velocity of the target 10, as desired by the instructor. The motor generator set and the "selsyn" control may be placed in the cabinet indicated by the reference character 1a (Fig. 1) placed adjacent the instructor's position, on the side of the record table frame.

Fig. 8 illustrates the simulated air borne target 60 which may be used in interception problems in the same manner as the simulated sea borne target 10. The target 60 has the outline of an aeroplane and is supported on rollers 61, which are adapted to be driven and directionally controlled in the same manner as above described with reference to Figs. 2 to 7 inclusive. A small castered roller 62 is used as a marker wheel similar in function to the roller 30 of the device illustrated in Figs. 2 to 7, inclusive. The target 60 may be manually controlled by course and speed control knobs 33 and 39, in the same manner as illustrated in Figs. 3 and 4, or the target may be distantly controlled in the manner illustrated in Figs. 5 to 7 inclusive.

An interception problem is solved by the instructor setting either one or more targets 10, or 60, into operation on the surface 2, of table 1, with a desired heading and with a velocity proportional to the simulated air velocity, or water velocity, of the target craft to be represented. The trainer 5 is then placed in operation with the recorder 7 parallel to the heading of the trainer and the course and simulated velocity of the target is given to the student aurally. The student must then solve a vector problem to obtain the proper course to simulate, in order to intercept the target 10 or 60. The instructor, being in telephonic communication with the student, can at any time alter the speed and direction of the target and informing the student of the change, add additional elements to the problem. The simulated trainer flight may be made to represent the flying in fair weather, or flying by instruments in bad weather. Where the table surfaces are made of transparent material, the indicia on the surfaces 2 and 3, permit the instructor to watch all phases in the solution of the problem and the record traces left on the surfaces by the inked marker wheels, serve as a means to visualize the solution of the problem and any errors therein caused by improper simulated flight by the student in the trainer.

In the solution of interception problems as above described, it is important to be able to introduce the effect of simulated winds acting on both the trainer and the simulated air borne target, or in the case of the simulated water borne target, the effect of currents or other factors causing drift. A means to simulate such air or water current effects is illustrated in Figs. 9 and 10, in which the numeral 70 indicates each of four tubular vertical supports, each provided with rollers 71, pivotally mounted on the lower ends thereof and adapted to be in rolling contact with the surface of a floor. The rollers 71 may be provided with suitable brake devices (not shown) to retain the supports in a fixed position on the floor. The supports 70 are retained in spaced relation and serve to support a light metal transverse frame generally indicated by the numeral 72. The frame 72 comprises transverse side rails 73 and 74, spaced by the centrally disposed crosstie 75 and the plate members 76 and 77, placed at the respective ends of the frame. The side rails 73 terminate at each end in spaced enlarged bosses 78, which serve as guides in which the vertical tubular supports 70 are placed. The bosses 78 are provided with clamping screws 79 so that the frame 72 may be adjusted vertically on the supports 70. The crosstie 75 is provided with an enlarged boss 80 which serves as a guide and clamping means for the vertical shaft 81 which carries a flange 82 at its outer end, to which is secured the record table 83, which may have a transparent record surface such as above described with reference to surfaces 2 and 3 of the device of Fig. 1. At one end of the frame 72, a roll shaft 84 is rotatably mounted transverse to the frame axis, by bearing bosses 85, formed in the frame members 73 and 74. The roll shaft 84 has a worm wheel 86 and a pulley 87 mounted thereon, adjacent the frame member 73. The worm wheel 86 is driven by a worm 88 mounted in suitable bearings carried by the plate 76. The worm 88 is driven by a reversible adjustable speed electric motor 89, also mounted on the plate 76. A flexible endless belt 90 passes over the pulley 87 over an adjustable idler pulley 91', onto a pulley 91, secured to a second roll shaft 92, mounted transversely to the frames 73 and 74, in bearing bosses 93. A spool or drum 94 is secured on the shaft 84 and a similar spool or drum 95 is secured to the shaft 92. A roller 97 is rotatably mounted on the frames 73 and 74 transversely thereof, adjacent the drum 95 and the mounting made adjustable longitudinally by means not shown, and a similar roll 98 is mounted transversely of frames 73 and 74 adjacent the drum 94. The outer peripheral surface of the rolls 97 and 98 are tangent with the plane of the upper surface of the table 83 or slightly above the said table surface. A transparent endless belt 100 passes over the drums 94 and 95 and rollers 97 and 98 and passes over the surface of the table 83 in contact therewith.

When the motor 89 is energized to rotate in one direction, the worm 88 will drive the worm gear 86, which will turn shaft 84 and pulley 87. The pulley 87, by means of belt 90, drives pulley 91 and shaft 92. The shafts 84 and 92 respectively rotate the drums 94 and 95, causing the endless transparent belt 100 to move in one direction relative to the surface of table 83. Reversal of motor 89 will drive the belt 100 in the opposite direction. The outline of table 83 is shown in dotted lines in Fig. 10 for simplicity, but it will be evident that the transparent belt 100 may

move in a plane having any desired angle relative to the longitudinal axis of the table surface 83, by either rotating the table relative to the frame 72 or preferably rotating the frame 72, by means of rollers 71 about the axis of the vertical shaft 81 relative to the table 83.

In the operation of the cross wind simulating device, the trainer recorder 7, serving as an indicator, is placed on the belt 100 and the belt set in motion at a velocity proportional to the velocity of the wind to be simulated and having the longitudinal axis of the belt 100, making the desired angle relative to the longitudinal axis of the table 83. The belt 100 will then bodily displace the recorder 7 in a direction and at a velocity equivalent to the effect of a wind acting on the simulated air borne trainer. The student must then correct the heading of the trainer by an amount equal to the drift angle and as indicated in Fig. 10, if line B—C represents in length to a certain scale, the velocity and direction of the wind and A—C represents the true course to be traversed relative to a suitable chart placed on the record surface 83, having a heading of angle x, then line A—B, which represents the simulated air speed of the trainer, is the course which must be steered, to compensate for the effect of the wind component B—C and the trainer heading and similarly the heading of the recorder must be changed to angle y, which equals the sum of angle x and angle z, the drift angle. No matter what the angle between the axis of the belt 100 and the longitudinal axis of the table, the effect of wind will be correctly applied to the recorder in the same manner as the wind would affect the flight of an aeroplane, simulated by the trainer 5. When employing the wind simulating device above described the position of the course indicator marker wheel relative to a suitable chart placed on the table 83 beneath the belt 100, serves to visually indicate to the instructor the position of the flight trainer in its assumed flight and the instructor gives the student the corresponding positional signal. The course indicator thus leaves no actual record on the chart of table 83.

To utilize the device of Figs. 9 and 10, in the solution of interception problems as in Fig. 1, two or more of the frame and table assemblies 72—83, are superimposed in the manner illustrated in Figure 11, parts in common with Figure 1 having the same reference numerals. If a water borne target is to be operated on the upper assembly table, its table may be rotated relative to the belt 100, so that the effect on a target 10, will simulate the effect of a water current, while the belt 100 on the lower table may be arranged to simulate the effect of a wind acting on the trainer during the interception problem. With such an arrangement the course of the target will be referred to the position indicia on the lower table surface only, the chart to be used being placed thereon. In a similar manner the effect of wind on both the trainer and the air borne target 60 may be simulated. The operation of the assembly of Figure 11 is otherwise identical to the operation of the device of Figure 1 described above.

It is to be understood that transparent tables 83 are not essential where continuous observation of the target and trainer recorder courses is not required and in such a case the tables may be of any desired material suitable for the intended purpose. The wind simulator as noted is generally applicable to ground trainer instruction and is not limited in use to interception problems.

As seen in Figs. 12 and 13, a variation of the apparatus shown in Fig. 1 is used to simulate air traffic control problems and the numeral 101 represents a record table similar to the table 1, illustrated in Fig. 1. The table 101 has a plurality of surfaces 102, 103, 104 and 105, in superimposed spaced relation and preferably made of transparent material similar to the surfaces 2 and 3, of the device of Fig. 1. The table surfaces each serve as a support for an aviation ground trainer course recorder R_1, R_2, R_3 and R_4 respectively. Each course recorder is connected by an electric conductor S_1, S_2, S_3 or S_4 respectively, to a corresponding flight trainer T_1, T_2, T_3 or T_4 respectively, to be directionally controlled thereby. The trainers are grouped around the table and each is assumed to be flying at a different altitude from the other trainers. The course recorders are placed in operation tracing the course of the simulated trainer flights, which are to end at a predetermined point common to all the trainers. The instructor has telephonic communication with each trainer and as the course recorders approach the predetermined destination, the instructor may then give individual instructions as to the conduct of the flight of each trainer, so that a simulated landing can be made by each trainer in a prescribed manner, dependent on the assumed altitude of the particular trainer. The instructor can watch all of the recorders and their positions relative to the assumed landing destination and thus has complete control over the directional information to be given in the solution of the problem.

While preferred embodiments of the invention have been illustrated in the drawings, it is apparent that other modifications can be made falling within the scope of the invention as defined by the appended claims.

We claim:

1. In an aviation ground training system, an aviation ground trainer for simulating aircraft flight, a pair of superimposed reference surfaces arranged in parallel spaced relation and at least one of said surfaces being formed of a transparent material, a course indicator associated with one of said surfaces and adapted to have a translatory movement relative thereto at a velocity proportional to an assumed velocity of said trainer and directionally controlled by said trainer, a target object simulating a land, air or water borne craft associated with the other of said surfaces and movable relative thereto at a velocity proportional to the supposed velocity of the craft to be represented and having a controlled directional heading, the said surfaces being arranged such that the instant course of said target object relative to the instant course of said course indicator is at all times apparent by visual observation through said transparent surface.

2. The structure as claimed in claim 1, in which each of said surfaces have corresponding positional indicia thereon.

3. In an aviation ground training system, a plurality of aviation ground trainers for simulating the flight of aircraft, a first reference surface, a plurality of transparent reference surfaces superimposed and in parallel spaced relation with respect to each other and with respect to said first reference surface, a plurality of course indicators, each associated with one of said reference surfaces and adapted to have a motion relative to said one surface with a velocity proportional to

an assumed velocity of one of said trainers and directionally controlled thereby and reference indicia on at least said first reference surface, whereby the instant course of each of said course indicators relative to a point on said first reference surface is at all times apparent by visual observation through said transparent surfaces.

4. A wind simulating device for use with aviation ground trainers comprising, a course indicator movable relative to a stationary chart on a supporting table surface at a velocity proportional to an assumed velocity in flight of an aviation ground trainer and having an instant heading equivalent to the heading of said trainer, a movable surface contacting said chart and having its plane of motion at any desired angle relative to the longitudinal axis of the table surface, said movable surface having a velocity proportional to the velocity of an assumed wind and a direction equivalent thereto, said course indicator being movable on said movable surface and displaced therewith in a manner to simulate the effect of an assumed wind acting on said trainer.

5. In an aviation ground trainer assembly for simulating flight interception problems, an aviation flight trainer for simulating the flight of an aircraft, a course indicator adapted to have a translatory motion proportional to an assumed velocity in flight of said trainer and directionally controlled thereby, a first movable surface having a motion equivalent to the direction and proportional to the velocity of an assumed wind, said surface supporting said course indicator for movement thereon, a target object having a controllable velocity and heading representing a target craft, a second movable surface for supporting said target object and said second movable surface having a velocity proportional to the velocity of an assumed current of the supporting medium acting on said target object and having a direction equivalent thereto, said surfaces being superimposed and in parallel spaced relation, the

upper one of said surfaces being composed of a transparent material whereby the instant position of said course indicator relative to said target object is at all times apparent by visual observation through said transparent surface.

6. The structure as claimed in claim 4, in which said movable surface is a belt driven at a constant speed by an adjustable speed power means.

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