March 15, 1938. C. J. CRANE 2,110,869

ELECTRICAL SIGNALING APPARATUS

Filed July 12, 1934 2 Sheets-Sheet 1

Fig. 1.

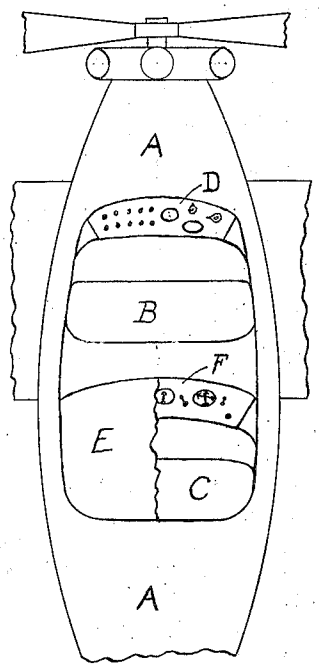


Fig. 2.

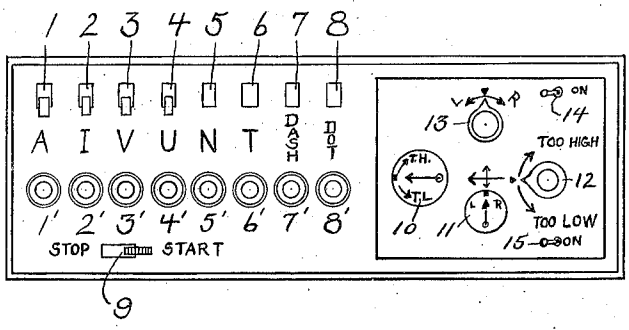
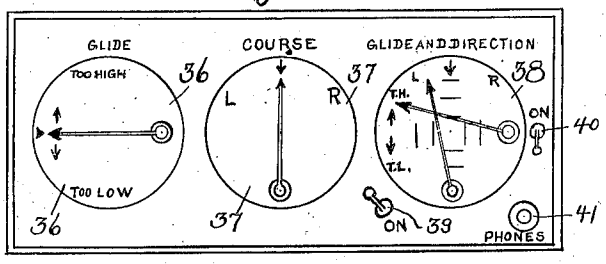


Fig. 3.



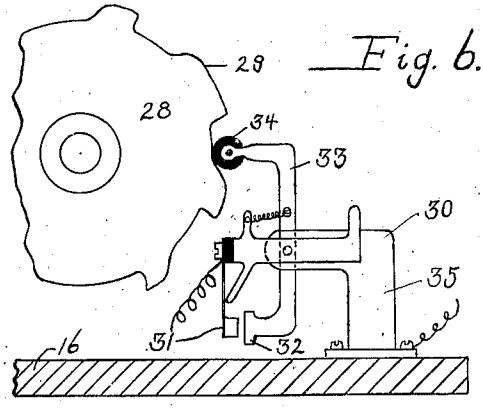


Fig. 6.

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ELECTRICAL SIGNALING APPARATUS

Filed July 12, 1934 2 Sheets-Sheet 2

Fig. 7.

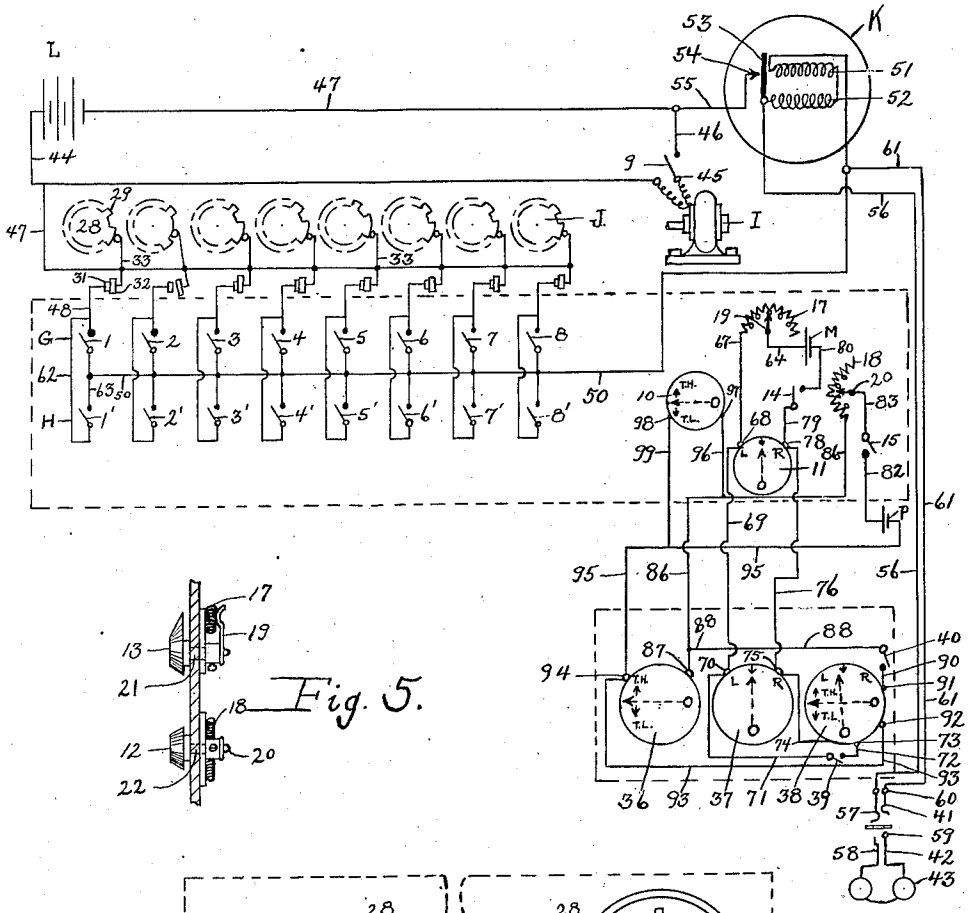


Fig. 5.

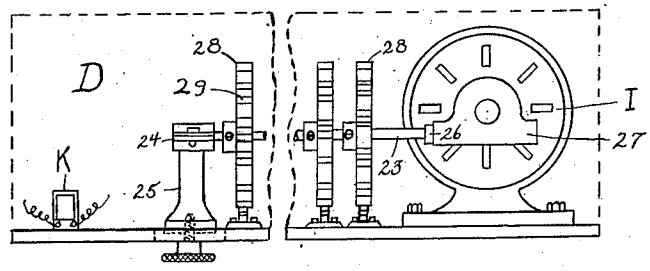


Fig. 4.

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UNITED STATES PATENT OFFICE

2,110,869

ELECTRICAL SIGNALING APPARATUS

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Application July 12, 1934, Serial No. 734,829

10 Claims. (Cl. 35—12)

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

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

This invention generically relates to aerial navigation, more particularly it is directed to an electrical signaling apparatus for making blind landings, through the instrumentality of which, aerial navigators may be familiarized with the technique of making a safe landing under conditions of little or no visibility and in accordance with the signal indications used in radio systems of blind landing aids.

Another object of this invention is to provide an electrical apparatus of the character designated by means of which an aerial navigator may be readily taught to pilot a ship to a safe landing solely by means of visual or aural indications transmitted to him by an instructing pilot, the indications corresponding to those used in connection with the present systems of radio field localizing aids.

Another object of this invention is to provide an arrangement wherein the student pilot is completely enclosed and therefore compelled to rely entirely upon the visual and aural signals transmitted to him by an instructing pilot, the signals and instruments over which they are received simulating in detail those which would be employed if the student pilot were making a blind landing by means of either the radio beacon or leader cable systems now used by certain airports for field localizing purposes.

Another object of this invention is to provide an electrical signaling apparatus wherein the practice plane has a transmitting station for the instructing pilot, said station being electrically associated with an enclosed receiving station for the student pilot, the two stations being equipped with conventional glideometers and course indicators whereby signals may be transmitted from one station to the other to the end that the student pilot may direct the ship pursuant to the observations of the signaling pilot.

Other objects of this invention are to provide an electrical signaling apparatus wherein the instruments employed simulate those used in the radio beacon and leader cable systems, so that the student may be able to interpret readings of these instruments when occasion demands, and likewise to provide an apparatus of the type specified which is simple, inexpensive, easily installed and effective, to furnish the student pilot with the requisite information for making blind landings by means of the latest developments in radio navigational aids.

With these and other objects in view the invention resides in the novel details of construction and combinations of parts as will be disclosed more fully hereinafter and particularly pointed out in the claims.

The practicability of radio navigational aids, such as the radio beacon or the leader cable system, having been fully demonstrated, particularly with reference to field localization, it is only a question of time when the principal airports will be equipped with one or both of these systems. Therefore, the training course of every student flyer should include some instructions in the application of these systems so that when occasion requires the student will be able to make a blind landing without difficulty. At the present time the installations are limited in number and consequently accessible to but few pilots. To meet this situation the electrical signaling apparatus forming the subject matter of this application has been developed. As this apparatus simulates in every detail the indications visual and aural used by the existing radio systems of blind landing, it will enable the pilot to be thoroughly drilled in the technique of their use, so that when conditions of no visibility demand landing on a field equipped with a radio field localizing system, the pilot will be in a position to make it with perfect safety.

Referring more particularly to the accompanying drawings in which corresponding parts are indicated by similar reference characters:

Fig. 1 is a fragmentary perspective view of an airplane equipped with the instruction arrangement constituting the subject matter of this application;

Fig. 2 is a front elevation of the transmitting panel;

Fig. 3 is a similar view of the receiving panel;

Fig. 4 is a fragmentary rear elevation of the transmitting panel, with parts shown in dotted outline;

Fig. 5 is a fragmentary sectionized detail illustrating the arrangement of the rheostat knob controls;

Fig. 6 is a fragmentary detail of a part of the circuit interrupting mechanism, and

Fig. 7 is a diagrammatic view illustrating the circuit arrangement employed to carry this system into effect.

Briefly stated, this invention comprises a plane adapted to be used for training purposes and equipped with an instructor's transmitting and observation station, and an enclosed student pilot's receiving station, means in connection with the instructor's station for producing aural and visual indications at the receiving station, the aural indications being in the Morse or other suitable code, the visual indication being effected by means of electro-mechanical devices located at both stations and responsive to the control at the transmitting station, the electro-mechanical devices simulating in external appearance the

conventional instruments used in connection with the radio beacon and leader cable systems of blind landing aids.

In the illustrated embodiment characterizing this invention, there is shown an aeroplane A having cockpits B and C adapted to accommodate the instructing and instructed pilots. The dash of the cockpits B is provided with a transmitting panel D on which are mounted a pair of indicating instruments and various audible and visual signal controls.

The cockpit C which is entirely enclosed by a canopy E is provided with a dash mounted receiving panel F equipped with various audible and visual indicating apparatus functioning to convey to the student under instruction the requisite navigational aids for making a safe landing under conditions of no visibility.

For the sake of convenience the cockpits B and C with their transmitting panels D and F will hereinafter be referred to as transmitting and receiving stations B and C respectively and these will now be described in the order mentioned.

Transmitting station

The transmitting panel of station B is provided with two vertically spaced parallel rows of Morse code signaling controls G and H. The upper row of controls G embodies eight keys, designated (1) to (8) inclusive, and are of the type having "off" and "on" positions, that is to say, when any one of the keys is in its "on" position, the code circuit which it controls remains closed, until such key has been actuated to its "off" position.

The lower row of signaling controls H contains eight keys designated (1') to (8') inclusive. These are of the push-button type and are arranged in vertical alignment with those in the row above, as clearly shown in Fig. 2 of the drawings. Each pair of vertically aligned keys controls the same Morse code signal, for instance keys 1 and 1' are adapted to close circuits determining the transmission of Morse signal A, keys 2 and 2' code signal I, etc., as will be readily understood without further discussion. The lower row of keys is to be used when the instructing pilot wishes to sound a selected signal for a very short period, by merely pushing the button controlling the desired signal. Beneath the lower row G of signaling keys there is positioned a starting switch (9) by means of which certain of the electro-responsive components of the system may be placed in circuit with a suitable source of electro-motive force.

To the right of the signaling keys G and H are mounted a pair of ordinary volt meters, the dials of which have been replaced with dials corresponding to those of a standard glideometer (10) and course indicator (11) used in the radio beacon and leader cable systems of radio navigational aids. Symmetrically disposed with respect to the indicators (10) and (11) are two rheostat knobs (12) and (13) respectively, which control the readings of the several indicating apparatus utilized by this apparatus. Switches (14) and (15) located above and below rheostat knob (12) function to open and close the signaling circuits of indicators (10) and (11).

A base (16) extends from the rear of panel D and supports motor I, code signaling interrupter J and audible signaling device K. On the rear of the panel D are mounted rheostat coils (17) and (18) adapted to be engaged by the contact arms (19) and (20) respectively, carried by shafts (21) and (22) of the rheostat control knobs (13) and (12) respectively. Code signaling interrupter, in the instant disclosure, consists of a horizontally disposed shaft (23) journaled at one end in bearing (24) carried by the adjustable bracket (25). At its other end it is mounted in bearing (26) of gear housing (27) attached to the motor I. Gear housing (27) contains a gear mechanism, not shown, by means of which the drive will be transmitted from motor I to the shaft (23).

Removably keyed to shaft (23) are a plurality of Morse code discs (28), in the present instance eight, corresponding to the number of keys on the transmitting panel. The peripheries of these discs are provided with projections (29) which are arranged so as to produce the desired Morse code signal. Each of the discs (28) coacts with a circuit interrupter (30) which embodies a stationary contact (31) and a movable contact (32), the latter being formed at the lower extremity of a pivoted bracket (33).

The upper extremity of bracket (33) is provided with a follower roller (34) adapted to travel the periphery of the disc (28). Bracket (33) is pivotally mounted intermediate its ends on the support (35) mounted on base (16) as clearly shown in Fig. 6 of the drawings.

By this construction it is apparent as the several discs are rotated the movable contacts (32) will be actuated to open and close the circuits in which they are included, to produce a predetermined Morse code signal.

Receiving station

The receiving panel F of station C mounts a trio of volt meters having dials simulating a glideometer (36), a course indicator (37) and a combination glide and course indicator (38), all of which correspond in external appearance to the instruments used in the radio beacon and leader cable system of blind landing aids. On panel F are also arranged two switches (39) and (40), controlling the circuits of indicators (37) and (38) and a telephone jack (41) for plug (42) of head set (43).

With this installation at station C, the student pilot will be able to direct the course of the ship entirely by means of the instrument readings and code signals transmitted to him from transmitting station B by the instructing pilot.

Let it be assumed the pilot under instruction is to receive a course in the use of the leader cable system of radio navigational aids to blind landing. According to this system the requisite directions for making a safe landing under conditions of no visibility are provided by means of magnetic fields and Morse code signals. These signals are interpreted on the plane by means of a course indicator, and a device responsive to the Morse code signals.

To instruct in the use of the foregoing system by means of the electrical signaling apparatus for making blind landings, forming the subject matter of this application, the instructing pilot at station B closes the starting switch (9) on the transmitting panel D. This completes a circuit from the source of electro-motive force L through conductor (44), motor I, conductor (45), switch (9), conductor (46), conductor (47) back to source L and starts the motor I.

Completion of the circuit of motor I, starts the interrupter J and rotates the several code discs (28) for a purpose hereinafter to appear. After the interrupter J has been placed in operation, if the instructor desires to indicate to the student pilot at station C, the zonal position of

the ship, characterized for instance by the Morse code signal A, then key (1) of row G is moved to its "on" position. This completes a circuit from the electrical source L, conductor (44), bracket (33) of circuit breaker (30), movable contact (32), fixed contact (31), conductor (48), switch (1), conductor (49), conductor (50), buzzer coils (51) and (52), movable armature (53), contact (54), conductor (55), conductor (47) to source L, and sounds the buzzer K.

As the discs (28) of interrupter J rotate, the buzzer circuit, just described, will be interrupted in accordance with the projections on the periphery of the discs (28) to produce the Morse code signal. This signal is received in head set (43) of the student pilot at receiving station C via conductor (56), contact (57) of jack (41), at receiving station C, contact (58) of plug (42), head set (43), contact (59) of plug (42), contact (60) of jack (41) and conductor (61). The signal thus produced will continue to sound in the head set of the student pilot until the instructor opens key (1) at the transmitting station, as will be readily undersood without further discussion.

Under some conditions it may be desirable to produce a signal for a very short period, in which event, instead of operating key (1) to transmit the code signal A, the instructing pilot depresses the button of switch (1') in row H. This completes a circuit from electrical source L, conductor (44), conductor (47), bracket (33), contacts (32)(31), conductor (48), conductor (62), push button (1'), conductor (63), conductor (50), buzzer coils (51)(52), movable armature (53), stationary contact (54), conductor (55), conductor (47), to the electrical source, and likewise sounds the buzzer K.

The remaining Morse code signals indicated on the panel D as I—V—U—N—T dash-dot are produced at the transmitting station in the same manner as that described in connection with the code signal A. Further discussion with respect to the circuits of the several keys controlling these signals is therefore deemed unnecessary.

When the instruction pilot observes that the student pilot is to the right or left of the prescribed course, he transmits this information by causing a corresponding deflection of the course indicator pointer at the receiving station C. To accomplish this switch (14) on the transmitting panel is closed, which completes a circuit from the source of electro-motive force M through conductor (64), rheostat contact arm (19), resistance (17), conductor (67), terminal (68) of course indicator (11) on the transmitting panel, conductor (69), terminal (70) of the course indicator on the receiving panel, conductor (71), switch (39) (assumed to be closed), conductor (72), terminal (73) of the indicator (38), conductor (74), terminal 75 of course indicator (37), conductor (76), terminal (78) of course indicator (11) on the transmitting panel, conductor (79), switch (14), conductor (80) to the electrical source M.

By this circuit arrangement movement of the rheostat control knob (13) on the transmitting panel to the right or left will vary the resistance in the circuit to increase or decrease the current flow through the volt meters forming the course indicators (11) and (37), thereby causing deflection of their pointers to the right or left as the case might be. As the student pilot corrects his course from the transmitted observations of the instructor, the pointer of the course indicator is gradually returned to its vertical position by the instructor and the student is thus informed that the ship is again on the proper course.

Having outlined the procedure to be followed when instructing a student pilot in the use of the leader cable system, the radio beacon or Bureau of Standards System will now be referred to. This system provides course and position indication by means of a main radio beacon, landing field runway direction by means of a localizing beacon and longitudinal position, that is approached along the runway by means of a marker beacon.

On the aeroplane three instruments are employed namely, a reed indicator, a glideometer and a course runway localizing indicator. The reed indicator furnishes information as to the landing field runway direction, the glideometer, location of the place with respect to the gliding path, while the course runway localizer designates any deviation to the right or left of the runway beacon course.

By the signaling apparatus forming the subject matter of this application, Morse code signals are substituted for the signals of the reed indicator, otherwise the instruments employed are the same in appearance as those used in the radio beacon system. The course indicator and glideometer are sometimes combined into a single instrument, and as it is advisable to familiarize the student with the use of this instrument it is simulated by the combination instrument designated (38) on panel F of the receiving station.

To furnish instruction in the use of the radio beacon system just referred to, the instructing pilot closes switches (14) and (15) on the transmitting panel at station B and the student pilot closes switches (39) and (40) on the receiving panel at station C.

Switch (14) on the receiving panel completes a circuit from the source of electro-motive force M through conductor (64), rheostat arm (19), resistance (17), conductor (67), terminal (68) of course indicator (11), conductor (69), terminal (70) of course indicator (37), conductor (71), switch (39) which is assumed to be closed, conductor (72), terminal (73) of the combination instrument (38), conductor (74), terminal (75) of course indicator (37), conductor (76), terminal (78) of course indicator (11), conductor (79), switch (14) and conductor (80) to source M.

Switch (15) on the transmitting panel and switches (39) and (40) on the receiving panel, complete a circuit as follows: From source of electro-motive force P, conductor (82), switch (15), conductor (83), contact arm (20), resistance (18), conductor (86), terminal (87) of glideometer (36), conductor (88), switch (40), conductor (90), terminal (91) of combination indicator (38), terminal (92) of said instrument, conductor (93), terminal (94), glidometer (36), conductor (95) to source P.

Switch (15), also completes the circuit to wit: Source P, conductor (82), switch (15), conductor (83), arm (84) of rheostat resistance (85), conductor (86), conductor (96), terminal (97) of the glideometer (10) on the transmitting panel, terminal (98) of glideometer (10), conductor (99) to conductor (95) and thence to the source of electro-motive force P. By means of the foregoing circuits, rotary movement of the rheostat knobs (12) and (13) on the transmitting panel will produce a corresponding movement of the pointers on the several instruments involved in the instant system of instruction for making blind landings.

The circuits of the several indicators having been closed, the instructor by rotating rheostat knob (12) at station B in the direction of the arrows, will indicate to the student pilot by deflection of the glideometer points, that the ship is too high or too low with respect to the gliding path. Likewise by suitably rotating rheostat knob (13) on the transmitting panel, the instructing pilot will cause the deflection of the pointers of the course localizers thereby informing the student pilot that the ship is to the right or to the left of its proper course. By means of the combination indicator (38), the instructing pilot by rotating rheostat knob (12) will inform the student pilot that the ship is left or right of the prescribed course and above or below the proper gliding path as will be readily understood without further discussion.

Manifestly, with this arrangement the observations of the instructing pilot transmitted from station B to the receiving station C will enable the student pilot to direct the course of the ship entirely by the readings on the instruments, just as would be the case if a blind landing were being made by means of either the radio beacon or leader cable systems.

Conclusion

In conclusion, it is apparent this signaling apparatus will enable a pilot to be thoroughly drilled in the use of either the radio beacon or leader cable systems to the end that when weather conditions demand, the pilots so instructed will be fully qualified to make a blind landing with perfect safety regardless of the type of installation used by the airport on which the landing must be made.

Having described my invention, what I claim as new and wish to secure by Letters Patent is:

1. An electrical signaling apparatus for producing in a training plane the signals used in making blind landings with the prevailing types of radio navigational aids, comprising a receiving station adapted to be carried by the plane, and consisting of a code signal receiver and a plurality of indicating instruments, each of said instruments simulating in external appearance one of those adapted to be used in connection with the prevailing type of radio navigational aids, and embodying a pointer, an electro-responsive means connected with and controlling the movement of the pointer, said means being responsive to variations in current strength, a transmitter station adapted to be carried by the plane, a receiver circuit and a series of instrument circuits extending between and electrically interconnecting the respective stations, the receiver circuit including said code signal receiver, the instrument circuits including the electro-responsive means associated with the indicating instruments, an electro-mechanical means at the transmitting station for producing code signals, said electro-mechanical means embodying a series to make and break contacts and a plurality of code wheels cooperating with said contacts, each wheel producing a different code signal, variable resistances at the transmitting station and included in the instrument circuits for varying the current strength thereof, and selectively operating the pointers of said instruments, means for placing any desired contact in the receiver circuit simultaneously with and independently of the operation of the pointers of said instruments and means for energizing said circuits.

2. An electrical signaling apparatus for producing in a training plane the signals used in making blind landings with the prevailing types of radio navigational aids, comprising a receiving station adapted to be carried by the plane, and consisting of a code signal receiver, a trio of instruments in the nature of a glideometer, course indicator and a combination of these two, each of said instruments simulating in external appearance one of those adapted to be used in connection with the prevailing type of radio navigational aids, and embodying a pointer, an electro-responsive means connected with and controlling the movement of the pointer, said means being responsive to variations in current strength, a transmitter station adapted to be carried by the plane, a receiver circuit and a series of instrument circuits extending between and electrically interconnecting the respective stations, the receiver circuit including said code signal receiver, the instrument circuits including the electro-responsive means associated with the indicating instruments, an electro-mechanical means at the transmitting station for producing code signals, said electro-mechanical means embodying a series of make and break contacts and a plurality of code wheels cooperating with said contacts, each wheel producing a different code signal, variable resistances at the transmitting station and included in the instrument circuits for varying the current strength thereof, and selectively operating the pointers of said instruments, means for placing any desired contact in the receiver circuit simultaneously with and independently of the operation of the pointers of said instruments and means for energizing said circuits.

3. An electrical signaling apparatus for producing in a training plane, the signals used in making blind landings with the prevailing types of radio navigational aids, comprising a receiving station adapted to be carried by the plane and consisting of a code signaling receiver and a plurality of indicating instruments, each of said instruments simulating in external appearance one of those adapted to be used in connection with the prevailing types of navigational aids and embodying a pointer, an electro-responsive means connected with and controlling the movement of the pointer, said means being responsive to variations in current strength, a transmitting station adapted to be carried by the plane, a receiver circuit, a series of instrument circuits extending betwen and electrically connecting the respective stations, the receiver station including a code signal receiver, the instrument circuits including the electro-responsive means associated with each of said instruments, variable resistances at the transmitting station and included in the instrument circuits for varying the current strength of said circuits to operate said instrument pointers, electro-mechanical means at the transmitting station for producing code signals, said means including a plurality of rotatably mounted code discs peripherally notched in accordance with a predetermined code signal, and a series of circuit breakers included in the receiver circuit, each circuit breaker embodying a stationary and a movable contact, the movable contacts cooperating with the peripheries of said code discs, manually operable means for placing any desired circuit breaker in the receiver circuit simultaneously with and independently of the operation of said instrument pointers and means for energizing said circuits.

4. An electrical signaling apparatus for repro-

ducing in a training plane the signals adapted to be used in making blind landings with the prevailing types of radio navigational aids, comprising a receiving station adapted to be located in the plane and consisting of an audible signal responsive device and a plurality of signaling instruments, said instruments simulating in external appearance those used in connection with the prevailing types of radio navigational aids and each embodying a pointer, an electro-responsive means connected with and controlling the movement of the pointer, said means being responsive to variations in current strength, a transmitting station adapted to be carried by the plane, an audible signal circuit and a series of instrument circuits extending between and electrically interconnecting the respective stations, the audible signal circuit including the audible signal responsive device, the instrument circuits including said instruments, variable resistance at the transmitter station and included in the instrument circuits for varying the current strength of said circuits and selectively operating the pointers of said instruments, electro-mechanical means at the transmitting station for producing different code signals, means for including any desired code signal in the audible signal circuit simultaneously with and independently of the actuation of the pointers of said signaling instrument and means for energizing said circuits.

5. An apparatus for instruction and training in flying by radio comprising a trainer controllable as to direction, means in said trainer for receiving signals simulating radio signals broadcast to aeroplanes in actual flight, means for creating and transmitting such signals to said receiving means in accordance with observed compass position of said trainer, and means on said creating and transmitting means for varying the intensity of such signals.

6. An apparatus for instruction and training in flying by radio, comprising a trainer controllable as to direction, means in said trainer for receiving signals simulating radio signals broadcast to airplanes in actual flight, said means comprising an indicating instrument including a movable pointer and means responsive to variations in signal intensity for operating said pointer, means for creating and transmitting signals to said receiving means in accordance with the observed compass position of said trainer and means on said creating and transmitting means for varying the intensity of said signals to effect selective operation of the pointer on said indicating instrument.

7. An apparatus for instructing and training in flying by radio, comprising a trainer controllable as to direction, means in said trainer for receiving signals simulating radio signals broadcast to airplanes in actual flight, said means including a code receiver and an indicating instrument including a pointer, and means responsive to variations in signal intensity for operating said pointer, means for creating and transmitting said signals to said receiving means in accordance with the observed compass position of said trainer, said means including an apparatus for producing signals in code adapted to be received by said code receiver, and means on said creating and transmitting means for varying the intensity of said signals to effect selective operation of the pointer on said indicating instrument.

8. An apparatus for instructing and training in flying by radio, comprising a trainer controllable as to direction, means in said trainer for receiving signals simulating radio signals broadcast to airplanes in actual flight, said means including a code signal receiver and an indicating instrument including a movable pointer and means responsive to variations in signal intensity for operating said pointer, said indicating instrument simulating in external oppearance one of those used in connection with the prevailing types of radio navigational aids, means for creating and transmitting signals to said receiving means in accordance with the observed compass position of said trainer, said means including an apparatus for producing signals in code adapted to be received by said code receiver, and means on said creating and transmitting means for varying the intensity of said signals to effect selective operation of the pointer on said indicating instrument.

9. An apparatus for instructing and training in flying by radio, comprising a trainer controllable as to direction, means in said trainer for receiving signals simulating radio signals broadcast to airplanes in actual flight, said means comprising a code signal receiver and an indicating instrument including a movable pointer, and means responsive to variations in signal intensity for operating said pointer, said instrument simulating in external appearance one of those used in connection with the prevailing types of radio navigational aids, means for creating and transmitting said signals to said receiving means in accordance with the observed compass position of said trainer, said means comprising an apparatus for producing signals in code and manually controlled means in connection with said apparatus for selecting a desired code signal, means on said creating and transmitting means for varying the intensity of said signals to effect selective operation of the pointer on said indicating instrument.

10. An electrical signaling apparatus for producing in a training plane the signals used in making blind landings with the prevailing types of radio navigational aids, comprising a receiving station carried by the plane and consisting of a code signal receiver and an indicating instrument, the latter including a pointer, an electro-responsive means connected with and controlling the movement of the pointer, said means being responsive to variations in current strength, a transmitter station carried by the plane, a receiver and an instrument circuit extending between and electrically interconnecting the respective stations, the receiving circuit including said code signal receiver, the instrument circuit including the electro-responsive means associated with the indicating instrument, and electro-mechanical means at the transmitting station for producing code signals, said electro-mechanical means embodying a series of make and break contacts, and a plurality of code wheels cooperating with said contacts, each wheel producing a different code signal, means for placing any desired contact in the receiver circuit, variable resistance at the transmitter station and included in the instrument circuit for varying the current strength thereof and selectively operating the pointer of said instrument, and means for energizing said circuits.

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