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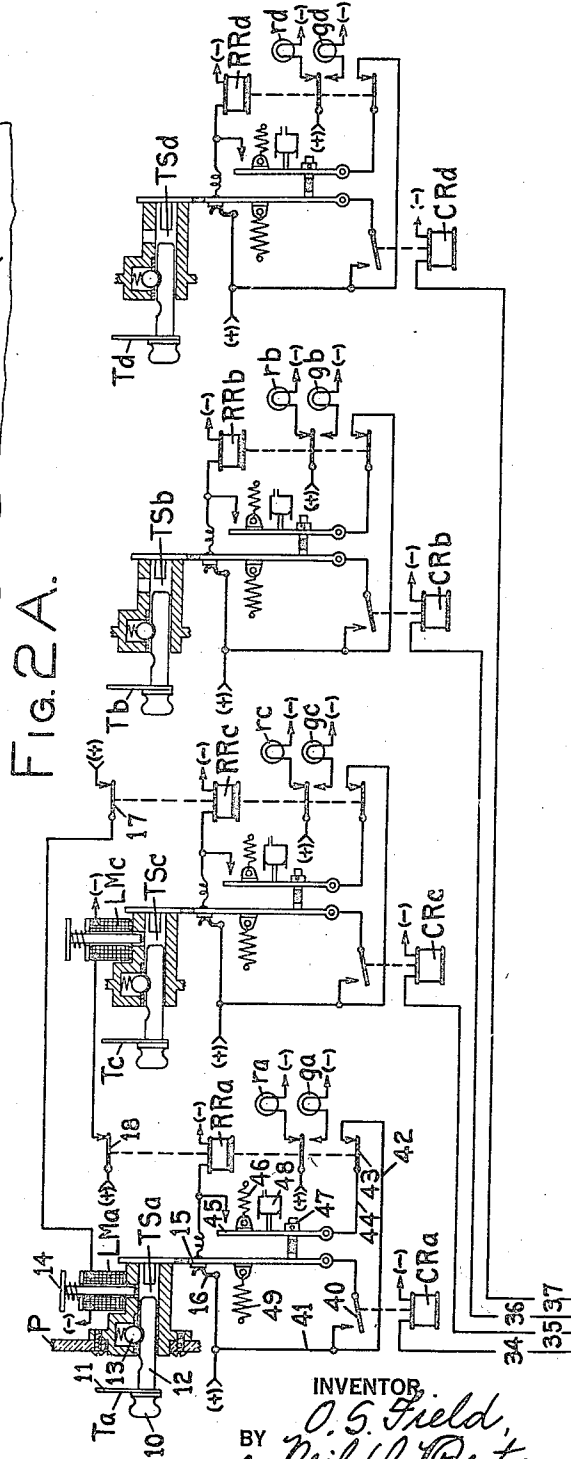
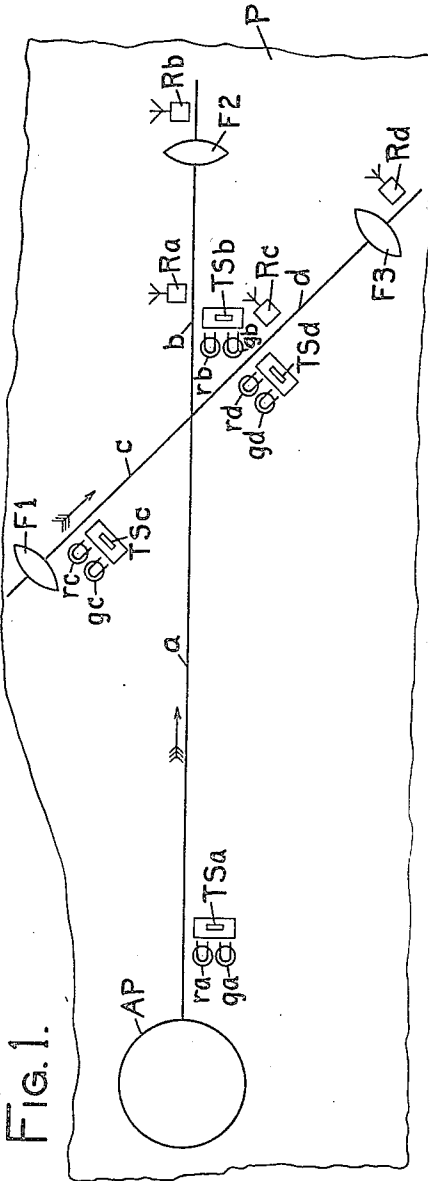
O. S. FIELD

2,371,749

AIRPLANE TRAFFIC CONTROLLING SYSTEM

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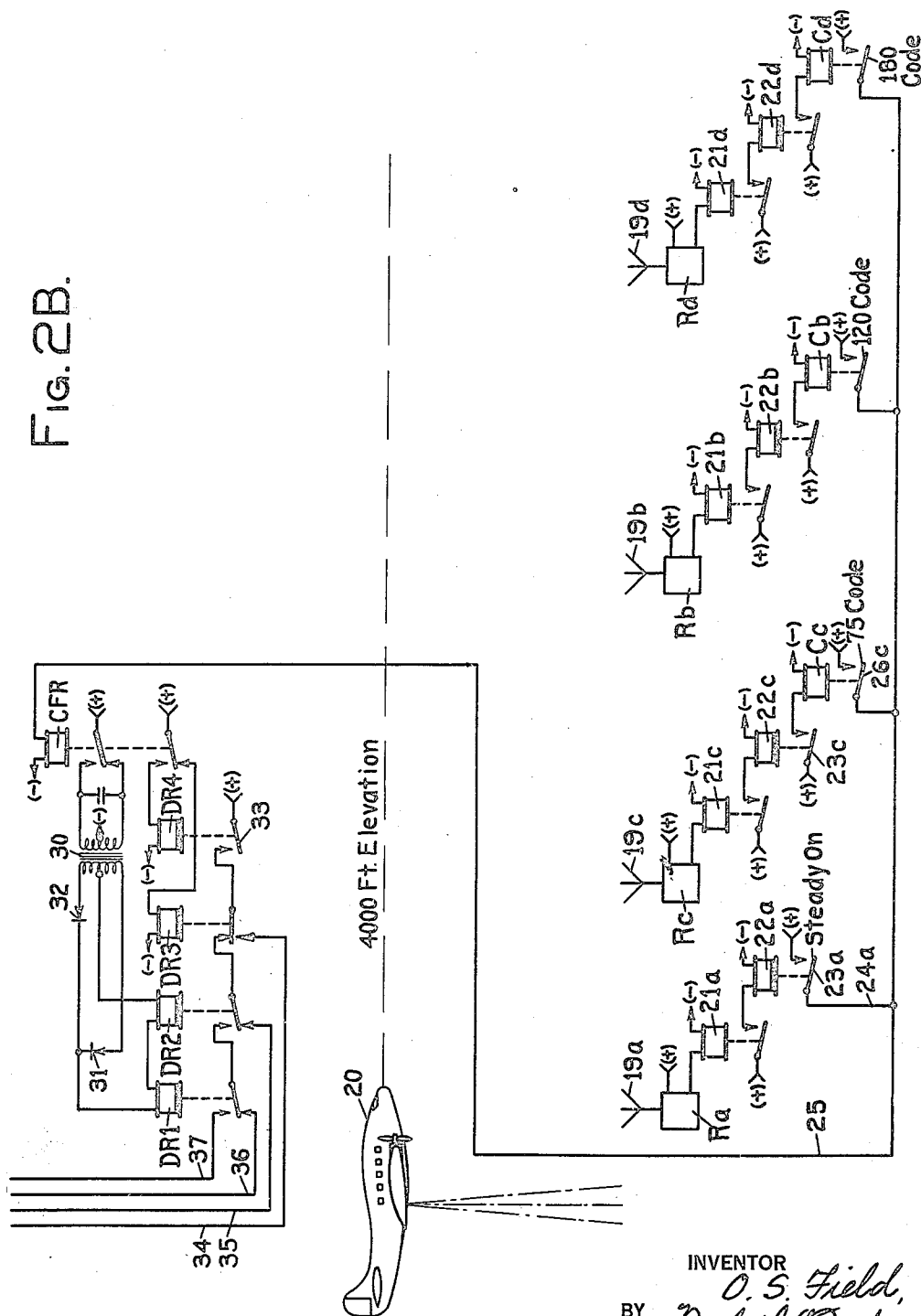


INVENTOR.
O. S. Field,
BY Neil W. Preston,
ATTORNEY

2,371,749

2 Sheets-Sheet 2

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பு



INVENTOR
O. S. Field,
BY Neil H. Preston,
his ATTORNEY

UNITED STATES PATENT OFFICE

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AIRPLANE TRAFFIC CONTROLLING SYSTEM

Oscar S. Field, Rochester, N. Y., assignor to General Railway Signal Company, Rochester, N. Y.

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8 Claims. (Cl. 177—353)

This invention relates in general to "A. T. C." or airplane traffic controlling systems, and has more particular reference to such systems wherein there is automatic cancellation of routes and sections of routes.

More particularly, the invention provides means for manually establishing a route, and indicating the established route on a panel, together with means controlled by radio energy sent out by a plane following the established route, for initiating controlling means located on the ground at various check points along the route, whereby to automatically cancel a route or portion thereof after it has been traversed.

Further objects, purposes, and characteristic features of this invention will appear as the description progresses, reference being made to the accompanying drawings showing solely by way of example, and in no manner whatsoever in a limiting sense, one form of the invention. In the drawings—

Fig. 1 is a fragmentary plan view of a control panel in accordance with this invention.

Figs. 2A and 2B, when placed one above the other, form a diagrammatic view of circuits, both in the field and in the control office, in accordance with this invention.

Referring now to the drawings, and first to Fig. 1, there is here shown a portion of a control panel P, which may be made of any desired suitable material and which bears representations of airplane routes. In the present case, two routes are shown, separated into sections defined by various check points. For example, one route, comprised of sections *a* and *b*, has the section *a* limited at one end by any suitable marker at airport AP and the other end by the intersection with a conflicting route. The section *b* is limited at one end by this intersection and at the other end by a fan marker F2. The conflicting route is comprised of sections *c* and *d* defined by fan markers F1 and F3 and the route intersection. Only these portions of these two routes have been shown, in order to exemplify the invention, and it is clear that additional routes and portions of routes can be controlled in the same manner as described below in connection with the parts shown.

The panel shows routes assumed to be travelled at a given elevation, such as 4000 feet, and movements are assumed to be in easterly and southerly directions (as shown by arrows) at this elevation, so that no opposing routes need be considered. Other elevations of an even number of thousands of feet will have movement in these same directions, while elevations of the odd numbers of

thousands of feet will be traversed in the opposite directions.

On the panel, at the entrance end to each section, is a token slot or its equivalent, as TS*a* for a token controlling section *a*. Adjacent the token slot are indication lights and merely by way of example, in the present instance, these are shown as two in number, a hold or red light *ra*, and a proceed or green light *ga*, indicating that these two lights are red and green lights indicating the condition of section *a* of route *ab*. In a like manner section *b* has a token slot TS*b* and associated indicating lights *rb* and *gb*.

Also associated with each section of each route is a representation of a radio receiving device, the one associated with section *a* being identified as Ra. This represents a receiving device for automatically cancelling an established route or section of route upon a plane having traversed and passed beyond the same. Thus, the receiver Ra is positioned a suitable distance beyond the exit end of section *a*. The actual device, Ra (Fig. 2B), is on the ground so as to be generally beneath the plane following this route. In like manner the representation of the receiving means for cancelling section *b* is shown beyond the end of section *b* and identified as R*b*.

Referring now to Fig. 2A and considering the apparatus for section *a*, there is here shown a token Ta, having a button 10 and a body portion 12, the body portion being insertable into the panel token slot TS*a* and being provided with a plate 11. The body portion can be of any suitable size and form, so as to conveniently bear various information about the particular plane being dispatched. The token can assume either one of two different positions, the first where it is inserted in the slot with a plunger portion 12 entering an opening in the panel and retained in place by detent means, such as a spring pressed ball 13. For at times preventing the insertion of plunger 12 fully within the panel and to bring about the second position, there is a lock magnet L*Ma* which when deenergized allows its lock plunger 14 to drop in the path of plunger 12 and prevent its insertion fully into the panel. This lock magnet L*Ma* is shown as energized and hence in unlocking position.

When a token is inserted into the panel its plunger 12 moves a contactor 15 to open contacts 15—16 and break a normally closed obvious circuit for energizing a route relay R*Ra* which controls the establishment of the route through section *a*. When this relay is in picked-up position the red indication light *ra* is energized, while when this relay is deenergized and hence releases

its armature, the red light is deenergized and the green light *ga* is energized.

Thus, as above described, if a dispatcher desires to dispatch a plane, at the 4000 feet elevation, from airport AP along route *ab* he will insert tokens *Ta* and *Tb* in their slots *TSa* and *TSb* and attempt to press them fully into the panel. If the route is not locked up by a conflicting route, or section thereof being already established such as route *cd* in the present case, the tokens can be fully inserted and the two red lights *ra* and *rb* will be extinguished, and the corresponding green light *ga* and *gb* will be energized and hence illuminated. This indicates to the dispatcher that the route is available and is established and reserved for a particular plane.

The plane pilot can then be notified to accept the route and upon reaching the end of each section, which is defined by a recognizable marker, the pilot can communicate with the dispatcher, who can then withdraw the proper token so as to extinguish the green light for that section and re-energize the red light and thus restore the panel to normal in this manual way.

The interlocking referred to above is such that conflicting routes are interlocked so that section *a*, for example, cannot be cleared for plane traffic, if the section *c* is already cleared, and vice versa.

This is accomplished, as shown in Fig. 2A, by carrying the energizing circuit for the lock magnet of each section through the front points of the route relays of all conflicting sections. In the case of the section *a*, the lock magnet *LMa* is energized through a circuit which passes through contact finger 17 and front point of route relay *RRc*. In the same manner the energizing circuit for lock magnet *LMc* is carried through contact finger 18 and front point of relay *RRa*. Thus, conflicting routes cannot be established contemporaneously and danger of collision is avoided. The tokens for the control of sections *b* and *d* need not be equipped with any lock magnet since these two sections do not conflict with each other, or with the sections *a* or *c*. If the direction of travel were opposite to that described above, then these two sections *d* and *b* would be interlocked. Furthermore, should there be other conflicting routes which produce conflict between various sections, these sections would be interlocked by carrying the control for each section through a front point of the route relay of each one of the conflicting sections in a series energizing circuit.

The radio receiving devices, such as *Ra* as referred to above, are positioned a suitable distance beyond the sections they control as indicated by *Ra*, etc., in Fig. 1.

In Fig. 2B these receiving devices are shown in somewhat more detail. Referring to receiving device *Ra*, for example, this device has a receiving antenna 19*a* and is positioned so as to be generally beneath a plane, such as 20, as it is passing thereover in travelling along route *ab*. Each plane is equipped with a sending apparatus which continuously sends out short wave radio energy of perhaps 75 megacycles, by means of a direction antenna so as to cause the energy to be included in a relatively narrow cone and thus to cover a relatively small area on the ground directly beneath the plane. The plane upon having traversed section *a* will be in a position to cause its emitted energy to be received by the antenna 19*a* and thus to cause the receiving device *Ra* which can be of any suitable, desired, well-known form, to energize a relay 21*a* which

in turn causes a receiver relay 22*a* to be energized. This relay 22*a* is of any desired design of slow release relay, so as to remain in energized position perhaps a few seconds after the energy beam from the plane has passed beyond the receiving position. The picking up of relay 22*a* closes a circuit including contact finger 23*a* and front point, wire 24*a*, line wire 25, and a code following relay CFR. Thus, energy is steadily applied through line wire 25 to relay CFR, for perhaps a few seconds, upon a plane having safely cleared section *a*.

Assume again that a plane is travelling along section *c* and upon clearing the section, has had its emitted energy received by receiving antenna 19*c*. This results in relay 21*c* picking up to thereby pick up the slow release receiver relay 22*c* to thereby energize a coder *Cc* through contact finger 23*c*. This coder can be of any desired form and operates to intermittently make and break its front contact by means of its finger 26*c*, a given number of times per minute as, for example, 75 times per minute. This results in the code following relay CFR to operate at the rate of 75 times per minute, so long as the coder is energized.

Each receiver is connected to send energy through the line wire 25 to the code following relay and to send energy of a distinctive character, peculiar to the particular location of the receiver. The coders *Cb* and *Cd* can code, respectively, at the rate of 120 times per minute and 180 times per minute. Thus, code following relay CFR is energized in a distinctive manner, depending upon which particular section has just been traversed, and hence should be cancelled.

In the form here shown and described, four different codes can be applied to line wire 25, namely, intermittent energy coded at the rates of 75, 120, and 180 impulses per minute and current steadily applied. Furthermore, the energy applied by the three coders and relay 22*a* can be either direct or alternating in character, the code following relay CFR being designed to stay in energized position throughout an impulse, even though the impulse, as it will, includes several cycles of alternating current.

The code following relay CFR controls decoding relays DR1, DR2, DR3 and DR4 in a manner similar to that shown and described in the Re-issue Patent No. 19,299, issued June 4, 1935, to W. D. Hailes. With this reference to the Hailes patent, it should be unnecessary to describe in detail the operation of the coding and decoding system. Briefly, the different codes cause the code following relay CFR to operate through the decoding relays and the push-pull type transformer 30 and the rectifiers 31 and 32, to place energy through contact finger 33 and its front point on one or the other of the several wires 34, 35, 36 and 37.

Assume that plane 20 passes over receiver *Ra* and hence that current is steadily applied to code following relay CFR for perhaps several seconds. This relay picks up and stays up whereby to cause the energization of decoding relay DR4 only and thus to place energy through contact 33 and its front point on wire 34. Upon receiving energy coded at the 75 code rate, the decoding relays are so arranged and designed that only the relays DR3 and DR4 are picked up and, hence, energy is placed on the wire 35. In a similar manner with the code rates 120 and 180 in force, respectively, energy is placed on the wires 36 and 37 respectively.

As described above, when a route is established manually, the green light, such as *ga* is energized, and the route relay *RRa* is deenergized, due to the token *Ta* being fully inserted and, hence, having opened and retained open the contacts 16. To cancel the route and restore the indicating lights to the normal red light, the route relay *RRa* must be re-energized.

Assume now that a plane through functioning of the receiver *Ra* has placed energy momentarily on control wire 34 to thereby energize the cancelling relay *CRa* (see Fig. 2A). A circuit for energizing the route relay *RRa* is established which includes contact finger 40 and front point of cancelling relay *CRa* (bridged across contacts 16) to thereby pick up route relay *RRa* and re-energize the red light *ra*. Upon being picked up, route relay *RRa* is stuck up through a circuit including wires 41 and 42, its own contact finger 43 and front point, wire 44, contact 45 and front point, and route relay *RRa*. This stick circuit, as just described, includes contact 45 which is equipped with a spring 46, tending to close it and is withheld from closing by a finger 47, carried by the token operated contact 15. Thus, when the token is fully inserted it allows spring 46 to move contact 45 to the right, to make up its front point. There is a dash pot 48 connected to contact 45 whereby to make the contact slow closing and insure release of the route relay upon insertion of its token.

Should the plane continue upon its course, it eventually passes beyond section *b*, whereby to initiate receiver *Rb* to thus send the 120 code to the decoding device, and thus place energy on wire 36, whereby to momentarily energize cancelling relay *CRb* and cancel this section *b* of the route which has been manually established.

It is contemplated that the dispatcher, before attempting to re-establish a route, which has been established and then automatically cancelled, will remove his tokens from the panel. Upon this removal as, for example, token *Ta*, contacts 15-16 will reclose and contact 45 will open due to action of spring 49. The opening of contact 45 breaks the stick circuit for the route relay, but the closing of contact 15 closes the normal energizing circuit, and to bridge over this transition, the route relays such as *RRa* are made slightly slow release and insure that the route relay shall not momentarily release and flash the red lamp to release.

It can be seen upon inserting a token fully into the panel that the holding circuit for the route relay through contact 16 is broken but a stick circuit is established by the closing of contact 45 on its front point. If this stick circuit were established before the route relay releases, the route relay would not release even though the token were fully inserted. Hence, contact 45 is made slow to make up its front point due to the dash pot 48, and is made considerably slower than the release time, for example, of relay *RRa*.

The control means for each of the sections is identical, except with regard to the interlocking as referred to above, and like parts have been given like reference numbers with exponents distinctive of the route section connected therewith.

With the above system, the dispatcher can insert tokens and establish a route, as designated by green lights, and then may busy himself with other affairs after having dispatched a plane over the route. The plane on traversing the sections of the route will automatically cancel the sections and make them available for further use and un-

lock other sections. This feature not only saves constant scrutiny of the dispatching panel by the dispatcher, but prevents any erroneous cancellation of the route as might well occur if controlled by radio notification by the plane pilot of his position to the dispatcher as by a loud speaker, for example, or ear phones, and either the pilot is confused as to his location or the dispatcher misunderstands, or both.

The above rather specific description of one form of the present invention is given solely by way of example and is not intended, in any manner whatsoever, in a limiting sense. It is to be understood that various modifications, adaptations and alterations may be applied to meet the requirements of practice, without in any manner departing from the spirit or scope of the invention, except as limited by the scope of the appended claims.

Having described my invention, I now claim:

1. In an airplane traffic control system for use with a well defined route, a control panel bearing a representation of an air route, a normally inactive proceed and a normally active stop indicator on the panel, manual means movable from a stop to a proceed position for changing the proceed indicator from inactive to active and the stop indicator from active to inactive, cancelling means located beneath the route and remote from the panel and responsive to radiant energy of a predetermined frequency transmitted from a plane following the route and then only when passing approximately over said cancelling means to make the then active proceed indicator inactive and the then inactive stop indicator active, and means preventing any temporary change in the indicators upon moving of the manual means from the proceed to the stop position subsequently to operation of said stop indicator to its active and said proceed indicator to its inactive condition by the associated cancelling means.

2. In an airplane traffic control system comprising a well defined air route divided into a plurality of sections by check points, a control panel bearing a representation of the route and its sections, an indicator for each section on the panel and having a normal aspect, a manual control means for each section movable from a normal to an operated position whereby to change its indicator aspect, a receiver on the ground remote from the panel and adjacent each route section and each responsive to radiant energy transmitted from a plane, a plane carried directional radio transmitter tuned to the receivers whereby a receiver can respond only when a transmitter is passing over it, means with each receiver to produce coded energy of a character distinctive of its particular section, a single line circuit, and decoding means in the line circuit and distinctively responsive to the coded energies of the receivers to respectively change the aspects of the indicators of the respective sections to normal.

3. In airplane traffic control systems, a plurality of conflicting well defined air routes divided into sections by marker points, a control panel bearing a representation of the routes and sections, a stop and proceed indicator on the panel for each section, a manual controller for each indicator movable to stop and proceed positions to put its indicator respectively at stop and proceed, lock means for each controller effective to prevent the controller being moved to proceed position so long as the indicator of any conflicting section is at proceed, a tuned radio receiver remote from the panel on the ground and posi-

tioned adjacent each section, a single line circuit connecting all of the receivers with the panel location, a carried radio transmitter having directional characteristics and tuned to all the receivers whereby each receiver can be activated only by radio energy transmitted from a transmitter and then only when the transmitter is substantially directly above it, a coder for each receiver placed into operation upon its receiver being activated to place energy on the line circuit and code it distinctively with respect to its location, decoding means in the line circuit and at the panel location and responsive to energy on the line circuit to selectively change the indicators to stop in accordance with the code on the line circuit.

4. In airway traffic control systems; in combination; a control panel bearing the representation of an air route; an outlying ground location substantially directly below the air route represented; an indicator having clear and stop aspects; a manual controller on the panel movable to clear and stop positions to control the indicator to display, respectively, its clear and stop aspect; a radio receiver at said ground location and tuned to a particular frequency; an airplane borne radio sender, tuned to emit energy only of said particular frequency and constructed to transmit energy only substantially vertically downwardly; communication means interconnecting the panel and the receiver; and automatic control means at the panel and responsive to the receipt of radio energy by the receiver to change the indicator aspect to stop, if at that time it is at clear, even though the manual controller is then assuming its clear position.

5. In airway traffic control systems, in combination, a slow release signal control relay, a manually movable controller positionable in normal and reverse positions, an energizing circuit for the relay closed when the controller is at normal and open when the controller is at reverse, a stick circuit for the relay including its own front contact and a contact closed only a measured time after the controller has reached reverse position and open when the controller is in normal position, a normally deenergized reset relay, a pick-up circuit for the control relay closed when the reset relay assumes its energized position, and means for energizing the reset relay.

6. In airway traffic control systems, in combination, a slow release signal control relay, a manually movable controller positionable in normal and reverse positions, an energizing circuit for the relay closed when the controller is at normal and open when the controller is at reverse, a stick circuit for the relay including its own front contact and a contact closed only a measured time after the controller has reached reverse position and open when the controller is in normal position, a normally deenergized reset relay, a pick-up circuit for the control relay closed when the reset relay assumes its energized position, and means for energizing the reset relay, said control relay having a release time shorter than said measured time but longer than the time normally required for manual movement of the controller from reverse to normal position.

7. In an airway traffic control system, a central office; a control panel in said office bearing the representations of air routes, a plurality of outlying ground locations located substantially below the air routes, an indicator on said panel for each location and capable of manifesting airplane traffic conditions for such location, manu-

ally operable means for controlling said indicators, a single line circuit connecting said office and said locations, coding means at each location for creating a code characteristic of that location and each connected to said line circuit, decoding means at said office and connected to said line circuit and including electro-responsive means for each of said locations actuated when a code corresponding to the code for that location is transmitted to said central office, means controlled by each electro-responsive means for controlling its associated indicator, radio receiving means for each location responsive to radio energy of a particular carrier frequency and which when active causes its associated coding means to apply a code identifying that location to said line circuit, and an airplane carried radio transmitter including a directional antenna for each airplane flying over said routes each of which transmits substantially continuously a downwardly directed radio beam of said carrier frequency directed through a sufficiently narrow angle such that a particular ground located receiver will only respond while the transmitter carrier airplane is substantially directly over the location including that receiver, to thereby cause the coding means for that location to manifest the presence of an airplane by being rendered active and transmitting a code identifying that location over said line circuit to said central office to in turn through the medium of said decoding means and the electro-responsive means for that location control the indicator associated with that electro-responsive means.

8. In an airway traffic control system, a central office, a control panel in said office bearing the representations of conflicting air routes, a plurality of outlying ground locations located substantially below the air routes, an indicator capable of manifesting airplane traffic conditions on said panel for each location, means for interlocking the indicators for different routes at a location common to two routes, a single line circuit connecting said office and said locations, coding means at each location for creating a code characteristic of that location and each connected to said line circuit, decoding means at said office and connected to said line circuit and including electro-responsive means for each of said locations actuated when a code corresponding to the code for that location is transmitted to said central office, means controlled by each electro-responsive means for controlling its associated indicator, radio receiving means for each location responsive to radio energy of a particular carrier frequency and which when active causes its associated coding means to apply a code identifying that location to said line circuit, and an airplane carried radio transmitter including a directional antenna for each airplane flying over said routes each of which transmits substantially continuously a downwardly directed radio beam of said carrier frequency directed through a sufficiently narrow angle such that a particular ground located receiver will only respond while the transmitter carrier airplane is substantially directly over the location including that receiver, to thereby cause the coding means for that location to be rendered active and transmit a code identifying that location over said line circuit to in turn through the medium of the decoding means at said office and the associated electro-responsive means for that location control the associated indicator and manifest an airplane movement over that location.

OSCAR S. FIELD.