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SYSTEM OF TELEDYNAMIC CONTROL

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Fig. 1.

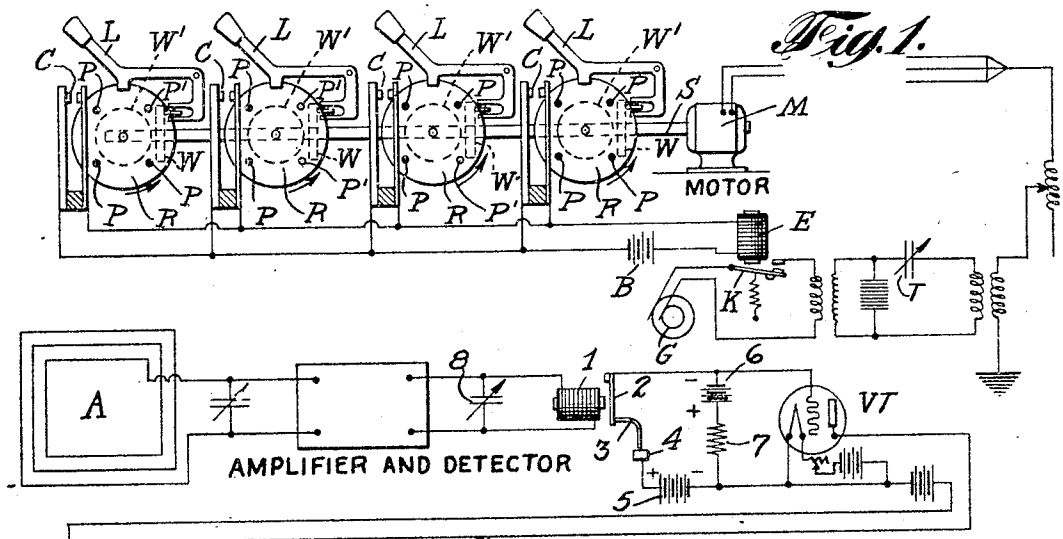
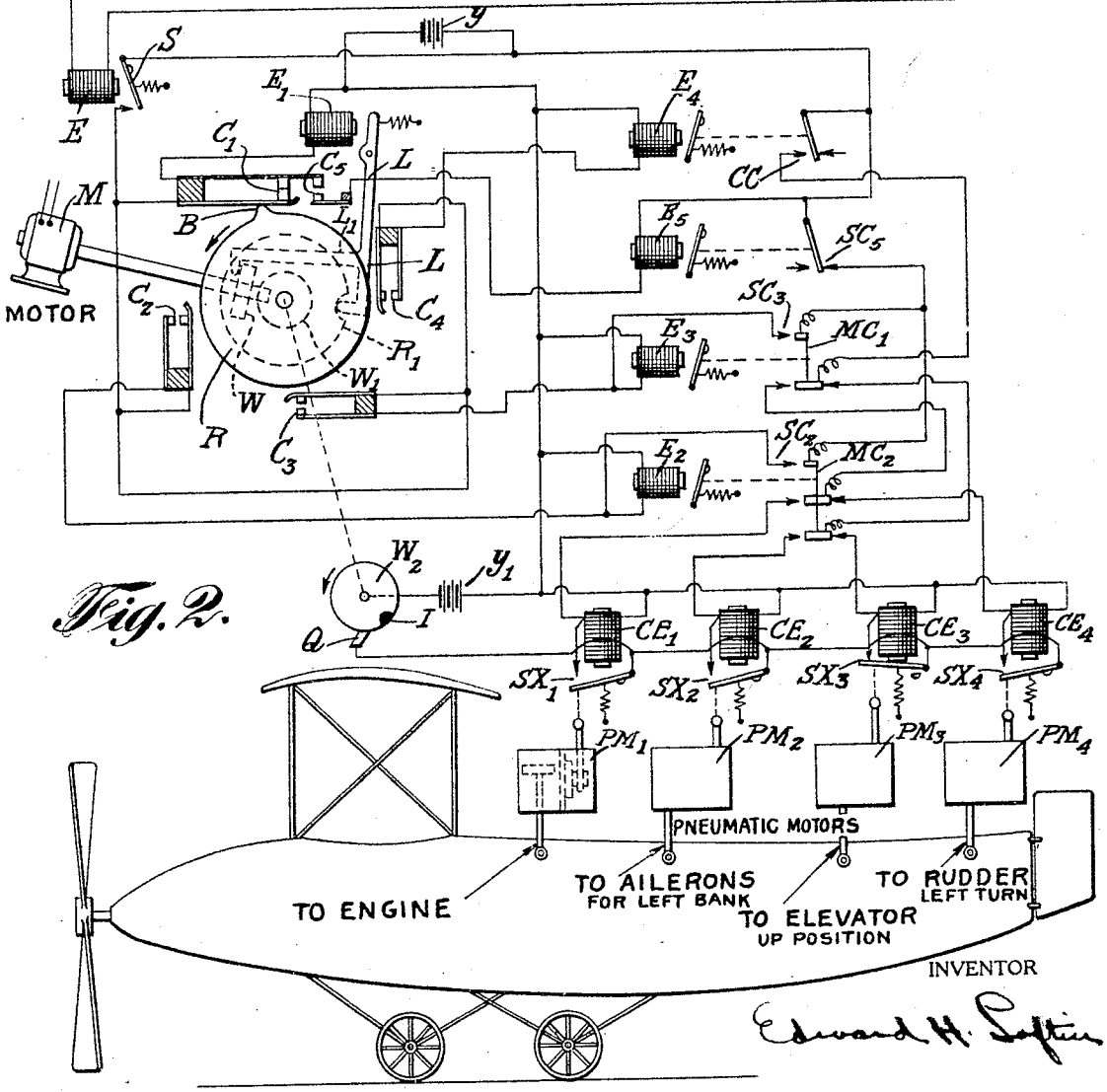


Fig. 2.



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SYSTEM OF TELEDYNAMIC CONTROL

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My invention relates generally to the operation of control devices at a distance with the aid of electrical energy, and particularly to the control of moving vehicles. A particular object of the invention is the selection for operation of any one of a number of controls to the exclusion of others at the will of the controlling operator whereby the distant controlled vehicle may be made to perform in the same manner as if occupied by the operator.

A further object of the invention is to provide a system for the making of quick, independent signals for each control function desired, and to be able to repeat the same signal any number of times in rapid succession to minimize possibilities of interference.

It is one purpose of my invention to provide a simple system of control of distant vehicles, such as airplanes, torpedoes, ships and locomotives, with the aid of electrical signals transmitted in various ways including radio transmission, that is selective, quick and capable of actuating a large number of controls reliably through the use of signals selectively peculiar to each operation, thereby removing many limitations encountered in systems previously suggested.

There has been in use for some time a code system for electrical telegraphy popularly known as the Baudot code, which consists of dividing a predetermined period of time, such as that measured by one revolution of a rotative element at a fixed speed, into a number of time spaced points at which electrical energy may or may not be transmitted in accordance with predetermined code signals. It is therefore apparent that the number of possible code signal combinations with such a system depends upon the number of selected points; for instance, if there are four there are sixteen possible combinations involving energy transmission or no transmission at these points. In practice however, it is customary to use the first and last points as fixed ones of energy transmission in order to use the first one as a starting signal for the receiver and the last one as a signal of actuation or "execution" to the receiver. In practice therefore the number of signal combinations is determined by the number of time points interposed between the first and last points. If there are a total of four, or two interposed points, the number of possible combinations is four; if there are three interposed points the number of combinations is eight; if there are four interposed points the number of combinations is sixteen, and so on, so that any desired number of definite, selective signals may be transmitted with such a system.

To make such a system effective at a receiver it is necessary to have a receiver time element synchronously acting with the time element at the transmitter to render a separate responsive element of the receiver at each one of the time spaced points successively capable of response to the corresponding timed spaced energy transmission, or to remain set in its initial position in case there is no transmission at the point. Thus each timed spaced point of the transmitter determines the one of two possible positions of a synchronously spaced element in a series of such elements at the receiver, with the result that the series of elements can be made to set up a number of combinations of positions corresponding to the number of possible code signal transmissions.

I have found that the code system outlined may be simply and effectively, and most advantageously, employed in a system of teledynamic control, particularly for moving vehicles. The combinations of positions of the synchronously spaced receiving elements are of particular value for completing any one of a plurality of electrical circuits selectively employed to operate the different control functions of a vehicle; or the combinations of positions may be made to control mechanical devices directly actuating the control functions of the vehicle, or actuating them through intermediate devices, such as pneumatic or other forms of motors.

My invention will be best understood by reference to the drawing in which Fig. 1

illustrates the transmitting portion of the system and Fig. 2 illustrates the receiving portion of the system. While I have illustrated the invention in connection with the control of an airplane it is not limited to use with any particular type of vehicle or organization of functions to be controlled While I have illustrated a radio system as the means of electrical energy transmission over distance, it is of course understood that any other means, such as wire transmission may be substituted without departing from the spirit of the invention. Likewise, while I have illustrated the selector system at the receiver of an electrical character, mechanical selector systems are likewise adaptable to the invention, and I do not limit my invention to any particular form.

For the purpose of brevity I have illustrated the system as capable of four code signal combinations to control four functions of an airplane, though any desired number of combinations may be included therein through obvious extensions of the illustrated means. Referring to Fig. 1 the elements R are four rotative elements normally held stationary by the levers L dropping into notches in the rotative elements. These rotative elements are capable of rotation or not through rotary motion derived from a constant speed motor M having friction wheels W rotatably fixed but slidably mounted on the shaft S, adapted to engage friction wheels W′, fixed to the rotative elements R, when the lifting of a lever L shoves, through the bell-crank extension of the lever, the corresponding wheel W into friction driving contact with the corresponding wheel W′. The friction drive will remain effective until the rotative element R completes a revolution where the lever L drops back into the notch. The one revolution of the rotative element R provides a predetermined time period based on the governable speed of the motor M. The one revolution is divided into spaced time points illustrated by the points P, representative of points at which transmission of energy take place, as by inserting a pin to force the spring mounted contact C to closure, and P′, illustrative of the points of no energy transmission as by leaving out the pin so as not to close the contact C.

The rotative elements are illustrated as rotating in an anti-clockwise sense, and the points P are so pinned on all of the elements that the first and last points always effect closure of the contacts C to make the desired starting and execution signals for the receiver, leaving the other two points variable in the matter of contact closure to make the desired signal combinations.

T illustrates in a well-known conventional way an ordinary radio transmitter deriving its energy from the generator G, and transmitting energy on closure of the key K, operated through the electromagnet E when energized by the battery B on closure of the contacts C. Thus, on lifting any one of the levers L a definite time period is started during which the radio transmitter T transmits or does not transmit energy at predetermined time points in the period in accordance with a chosen combination or code signal.

Referring to Fig. 2, A is a suitable collector of radio signals at the receiver, illustrated as tunable through a variable condenser, connected to an indicated amplifier and detector. The amplifier-detector output is indicated as delivered to magnet 1, tunable to low frequencies through a condenser 8, actuating a vibrating armature 2, having mounted thereon a vibratory reed 3, to complete contact on vibration with a contact 4 in the grid circuit of a vacuum tube VT including a battery 5. In shunt to the grid circuit is a battery 6 and a high resistance element 7. The battery 6 has its negative terminal towards the grid of the vacuum tube so that with a properly chosen potential of this battery the plate current is normally reduced to practically zero. When incoming signals energize the magnet 1, the armature 2 and reed 3 close the portion of the grid circuit including the battery 5, which battery has its potential and polarity so chosen as to neutralize the normal grid bias due to the battery 6, thus resulting in a sudden, large flow of plate current to energize the magnet E. The relay system just described is not essential, but is merely illustrated and described in view of its extreme sensitiveness and selectivity for a system of this kind. The type of energy translating system does not form a part of this invention.

The receiver includes a rotative element R, adapted to be driven at the same angular velocity as the rotative elements of the transmitter through a governable speed motor M, having a friction wheel W rotatably fixed and slidably mounted on the shaft of the motor so as to be pressed into friction driving contact with the wheel W′, fixed to the rotative element. A lever L is adapted to engage a notch in a rim R′ fixed to the rotative element, and an arm L′ of the lever is adapted to press the wheel W into friction driving engagement with the wheel W′ when the lever L is raised from the notch, thereby starting the rotative element to measure a time period the same as that measured at the transmitter. The rotative element has a cam B which in the stop position holds the contact C_1 closed, and in its rotation successively closes the contacts C_2, C_3, C_4, and C_5. When a signal is started at the transmitter as previously described

the first time spaced point always causes energy to be transmitted, resulting in the receiving magnet E closing the switch S. Since the contact C_1 is closed, current flows from the battery Y through the switch S and contact C_1 to energize the magnet E_1 actuating the lever L to raise it from the notch of the rim R' and pull the wheel W into friction driving contact, thus starting the rotative element R. As soon as the cam B leaves the spring contact C_1 contact is opened, thus deenergizing the magnet E_1 during the rest of the revolution, but since the lever L rides on the surface of the rim R', friction driving contact of wheel W is maintained until the lever drops in the notch at the end of the revolution. The opening of the contact C_1 does not close contact C_5 until cam B strikes this spring contact.

As soon as the transmitter ceases transmitting energy after the passage of the first time spaced point the switch S opens. The contacts C_2, C_3 and C_4 are so spaced in time with respect to the motion of the cam B as to be successively closed in synchronism with the passage of the time spaced points at the transmitter by the transmitter contacts. If, when the cam B has closed the contact C_2 the transmitter sends an impulse to close the switch S, current can flow from the battery Y through switch S and contact C_2 to energize the magnet E_2; and if no impulse is transmitted the closure of C_2 at the specified moment results in no action. In the same way magnet E_3 is or is not energized.

The magnets E_2 and E_3 control the position of the multiple contact elements MC_2 and MC_1 respectively, and the settings of these two multiple contact elements determines through which one of the four control magnets CE_1, CE_2, CE_3 and CE_4 current will flow from the battery Y when the circuit closing contact CC is closed at the time the actuating or execution signal is received. When magnets E_2 or E_3 are energized they remain so through the office of stick circuits contacts SC_2, SC_3 and SC_5 permitting stick circuit energizing current to flow through the magnets until magnet E_5 is actuated to clear out the system preparatory to receiving the next signal.

The positions of the multiple contacts MC_2 and MC_1 having been determined during the closure of contacts C_2 and C_3 by cam B, the cam next closes contact C_4, and at this time point there is always a transmission of energy from the transmitter as an execution signal, so that switch S is closed at the same time and allows energizing magnet E_4 to close circuit closing contact CC, thereby energizing the control magnet which has been selected by the multiple contacts MC_1 and MC_2. The control magnets are provided with stick circuits energized through battery Y, and contacts SX_1, SX_2, SX_3 and SX_4 whereby a selected control magnet remains energized until a new and different signal is made.

To provide for opening the stick circuits of the control magnets when a different signal is made, so that an old applied control goes out of action, the stick circuits have included in series therewith a contact breaker actuated in synchronism with the rotative element R, which may be a wheel W_2 mounted on the same shaft as the rotative element R as indicated by the broken line connection. A brush Q contacts with the surface of the wheel, which surface is interrupted by an insulating segment I, so located that it is under the brush at the moment closing circuit contact CC is closed, and so proportioned that the stick circuit will remain broken for a time period less than the closure of contact CC. Therefore, if a new signal is made, the wheel will interrupt the stick circuit long enough for the old signal to go out of action, but not sufficiently long to prevent taking up and sticking the new signal.

When the cam B closes contact C_5 magnet E_5 is energized, opening stick circuit contact SC_5 to release magnets E_2 and E_3 from stick circuit energizing, and thus clear the selector system for the next signal.

The magnets CE_1, CE_2, CE_3 and CE_4 control the valves of pneumatic motors PM_1, PM_2, PM_3 and PM_4 or other suitable intermediate devices, associated with the various control functions of the airplane as indicated in Fig. 2. Pneumatic motor PM_3 is illustrated as actuated by magnet CE_3.

In the transmission of electrical signals difficulty is often had due to interference from false signals such as atmospheric electrical disturbances and other stations in radio work, and induction from power lines and the like in wire work. When interference is had it is the practice among operators to repeat each word of a message two or three times, depending upon the character of the interference, to make certain of correct transmission. The system of teledynamic control I have illustrated and described provides for quick transmission of the selective signals as well as rapid repetition. Apparatus capable of sending a succession of signals at the rate of three or four per second is easily within practical design limits. Such rapid repetition of a fixed, desired signal makes certain instantaneous and absolute control over the vehicle under all reasonable conditions of interference.

Having described and illustrated my invention, I claim:

1. In a vehicle control system, a traffic medium, a vehicle traveling within said medium, automatic means for producing in said medium a code of abrupt electrical current

changes at predetermined recurrent intervals, a receiver on said vehicle responsive to said abrupt electrical current changes comprising a relay responsive to an individual abrupt current change and vehicle control means governed by said relay.

2. In a vehicle control system, means for controlling the movement of a vehicle in a traffic medium comprising stationary transmitting apparatus for recurrently impressing a predetermined series of time-spaced electrical impulses on the traffic medium, vehicle carried means for inductively receiving said impulses, and vehicle carried apparatus operated synchronously with said transmitting apparatus for responding to said impulses.

3. In a vehicle control system, means for controlling the movement of a vehicle in a traffic medium comprising stationary transmitting apparatus for recurrently impressing one of a plurality of predetermined series of time-spaced energy impulses on the traffic medium, each of said series of impulses representing a given control, means for receiving said impulses on the vehicle, and vehicle means operated synchronously with said stationary transmitting apparatus for responding to said impulses.

4. In a vehicle control system, means for controlling the movement of a vehicle in a traffic medium comprising stationary transmitting apparatus for recurrently impressing a predetermined series of time-spaced electrical impulses on the traffic medium, vehicle carried means for receiving said impulses and rotary vehicle apparatus responsive to said impulses, said rotary apparatus being continuously rotated while said impulses are being transmitted.

5. In a vehicle control system, means for controlling the movement of a vehicle in a traffic medium comprising stationary transmitting apparatus for recurrently impressing a predetermined series of time-spaced electrical impulses on the traffic medium, vehicle carried means for receiving said impulses and rotary vehicle apparatus responsive to said impulses, said rotary apparatus being continuously rotated and periodically synchronized with said transmitting apparatus while said impulses are being transmitted.

6. In a vehicle control system, means for controlling the operation of a vehicle in a traffic medium comprising stationary transmitting apparatus including a plurality of rotary commutators, each capable of automatically and recurrently impressing a different predetermined series of time-spaced impulses of electrical energy on the traffic medium, means for selectively operating said commutators continuously, vehicle carried apparatus for receiving said impulses, and vehicle apparatus for controlling the operation of the vehicle, said control apparatus including a rotary device initiated by one of said impulses and continuously rotated in synchronism with one of said commutators so long as said impulses are received.

7. In a vehicle control system, means for controlling the operation of a vehicle in a traffic medium comprising stationary transmitting apparatus including a plurality of rotary contact closers, each driven continuously when initiated, and acting to impress a distinctive recurrent series of time-spaced electrical impulses on the traffic medium, means for selectively initiating said contact closers, vehicle carried apparatus for receiving said impulses and vehicle apparatus for controlling the progress of the vehicle including rotary means initiated by one of said impulses and continuously driven in synchronism with said rotary contact closers so long as said impulses are received, and a contact closed by said rotary means for energizing a relay if an impulse is received when said contact is closed.

8. In a vehicle control system, means for controlling the operation of a vehicle in a traffic medium comprising stationary transmitting apparatus including a plurality of rotary contact closers, each driven continuously when initiated, and acting to impress a distinctive recurrent series of time-spaced electrical impulses on the traffic medium, means for selectively initiating said contact closers, vehicle carried apparatus for receiving said impulses and vehicle apparatus for controlling the progress of the vehicle including rotary means initiated by one of said impulses and continuously driven in synchronism with said rotary contact closers so long as said impulses are received, a plurality of contacts successively closed at predetermined time spaced intervals by said rotary means, relays controlled by said contacts and energized if said impulses are received when said contacts are closed, and means acting on the controls of the vehicle and operated in accordance with the energization of said relays.

9. In a vehicle control system, the combination with a traffic medium, a vehicle traveling on said traffic medium, remotely located apparatus for producing in said medium a series of distinctive electro-magnetic impulses at recurrent intervals, a relay on said vehicle responsive to a separate impulse, apparatus distinctively responsive to the spaced relation of the impulses in a series, and vehicle control means controlled by said apparatus.

10. In a system for controlling vehicles in motion, the combination with a traffic medium, a vehicle traveling on said traffic medium, apparatus located remotely to said vehicle for producing in said medium current changes reproduced at recurrent in-

tervals, relays on said vehicle distinctively responsive to the quantity of current transmitted during each period determined by said intervals, and vehicle control means controlled by said relays.

11. Vehicle control means for controlling vehicles movable on a traffic medium comprising, stationary control means for producing in said medium a distinctive group of electro-magnetic impulses, a vehicle movable on said medium, apparatus carried by and controlling said vehicle distinctively responsive to such group of impulses, said stationary control means being constructed and including apparatus whereby it may be kept in operation continuously and thereby transmit said group of impulses at equally spaced recurrent intervals.

12. Vehicle control means for controlling vehicles movable on a traffic medium comprising, stationary control means for producing in said medium a distinctive series of electro-magnetic impulses, a vehicle movable on said medium, apparatus carried by and controlling said vehicle distinctively actuated by such group of impulses, said stationary control means being constructed and including apparatus whereby it may be kept in operation continuously and thereby transmit said series of impulses at equally spaced recurrent intervals, whereby said apparatus is actuated repeatedly and renders it continuously responsive to the flow of electro-magnetic energy from said control means.

13. The method of controlling a moving vehicle, from a stationary control point, which consists in transmitting to said vehicle from said control point at closely spaced recurrent intervals, a series of impulses having distinctive characteristics of spacing, in detecting these impulses on a moving vehicle, and in using the detected impulses for effecting a predetermined control of the vehicle so long as said impulses are received recurrently.

14. The method of controlling a moving vehicle from a stationary control point, which consists in transmitting to said vehicle from said control point at closely spaced recurrent intervals a series of impulses having distinctive characteristics of spacing, in detecting these impulses on a moving vehicle, in amplifying said impulses, and in using the detected impulses for effecting a predetermined control of the vehicle so long as said impulses are received recurrently.

15. The method of controlling an airplane, which consists in transmitting radio impulses to such plane, and in controlling said plane by said impulses.

16. Vehicle carried apparatus responsive to control impulses transmitted inductively from stationary impulse transmitting apparatus comprising, a normally stationary device on a vehicle having a tendency when initiated to complete a cycle of operation and which is initiated upon the reception of a control impulse, means distinctively responsive to subsequent impulses received by said apparatus, during the cycle of operation of said device, and means for controlling said vehicle by said means.

17. Vehicle carried apparatus responsive to control impulses transmitted inductively from stationary impulse transmitting apparatus comprising, a normally stationary device on a vehicle having a tendency when initiated to complete a cycle of operation and which is initiated upon the reception of a control impulse, stick relay means distinctively responsive to subsequent impulses received by said apparatus during the cycle of operation of said device, means for controlling said vehicle by said means, and means for restoring said stick relay means to normal.

18. Vehicle carried apparatus responsive to control impulses transmitted inductively from stationary impulse transmitting apparatus comprising, a normally stationary device on a vehicle having a tendency when initiated to complete a cycle of operation and which is initiated upon the reception of a control impulse, a plurality of stick relays one or more of which are selectively picked up and stuck up in response to the reception of control impulses during the cycle of operation of said device, means responsive in accordance with the number of stick relays that are in their energized condition near the end of such cycle, and vehicle control means controlled by said means.

19. Vehicle carried apparatus responsive to control impulses transmitted inductively from stationary impulse transmitting apparatus comprising, a normally stationary device on a vehicle having a tendency when initiated to complete a cycle of operation and which is initiated upon the reception of a control impulse, a plurality of stick relays one or more of which are selectively picked up and stuck up in response to the reception of control impulses during the cycle of operation of said device, means responsive in accordance with the number of stick relays that are in their energized condition near the end of such cycle, vehicle control means controlled by said means, and means for dropping said stick relays at the end of such cycle.

20. Vehicle carried apparatus responsive to control impulses transmitted inductively from stationary apparatus comprising, a relay responsive separately to each impulse, a group of stick relays one or more of which are picked up and stuck up in accordance with the characteristic relation of successive impulses, another group of stick relays one

of which is picked up and stuck up in accordance with the particular relays of the first group assuming the energized condition at the time, means for again dropping said stick relays, and vehicle control means controlled by said another group of stick relays.

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