June 5, 1934. W. D. HAILES 1,961,853

TRAIN CONTROL SYSTEM FOR RAILROADS

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FIG. 1.

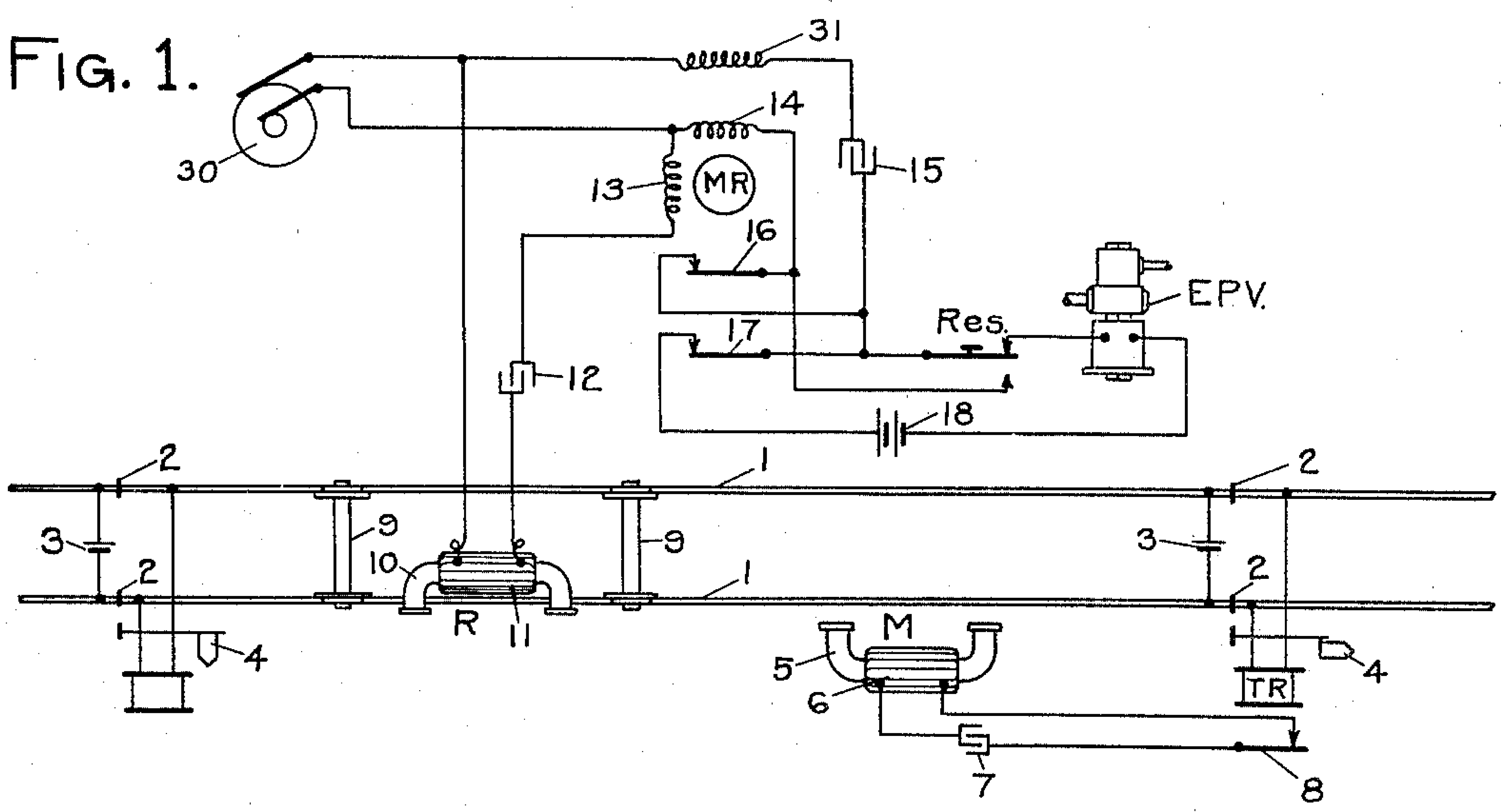


FIG. 2.

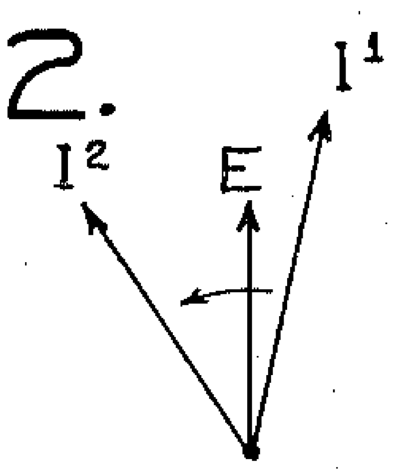


FIG. 3.

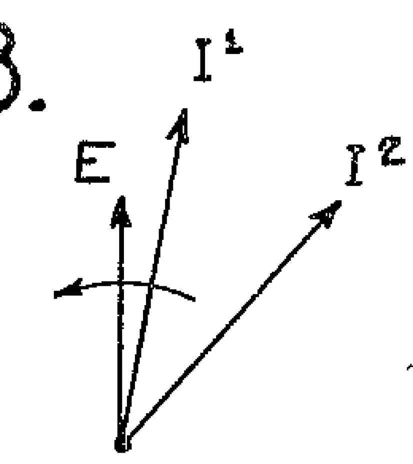
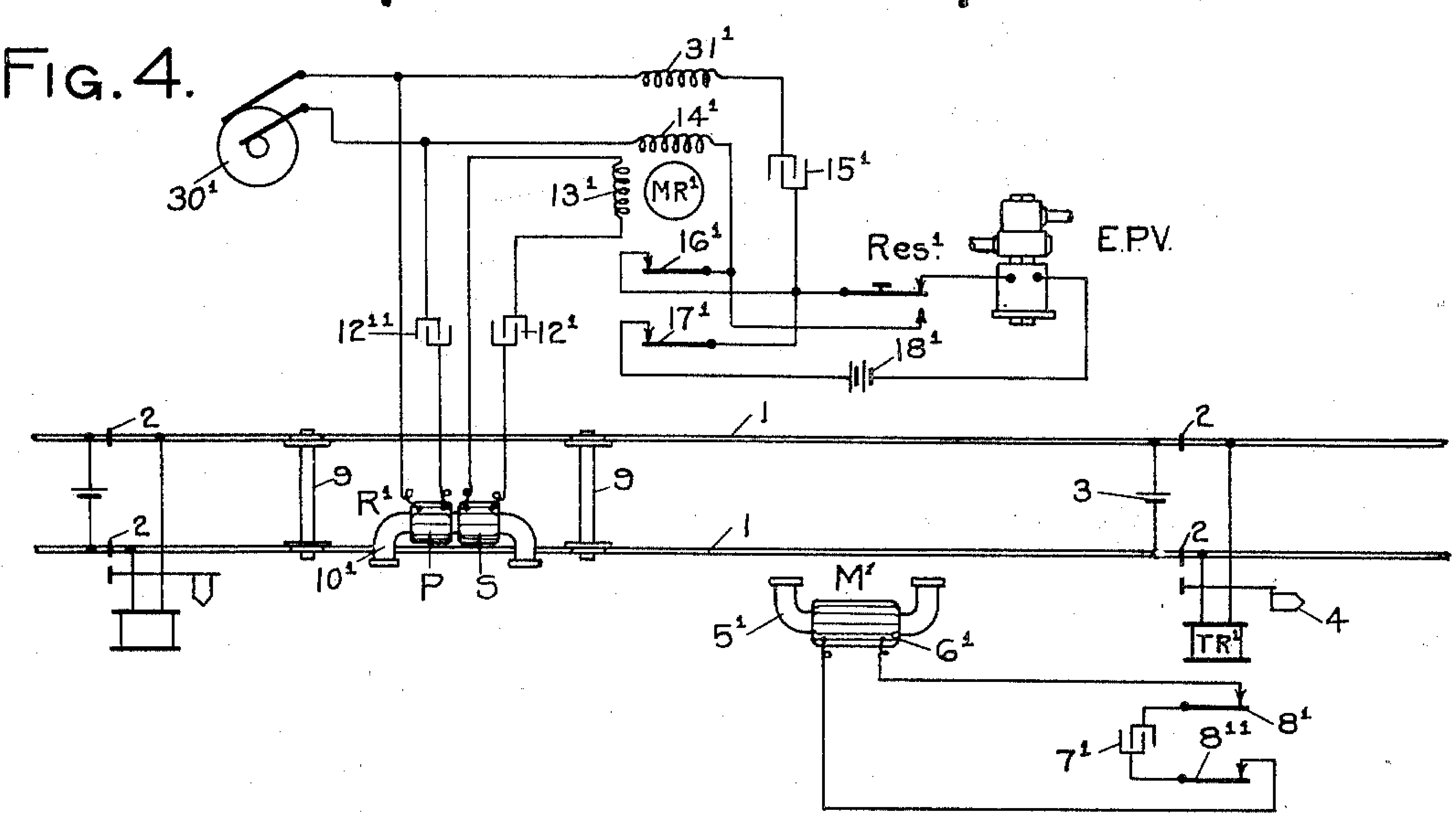


FIG. 4.



W. D. Hailes INVENTOR

BY Neil D. Preston, his ATTORNEY

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FIG. 5.

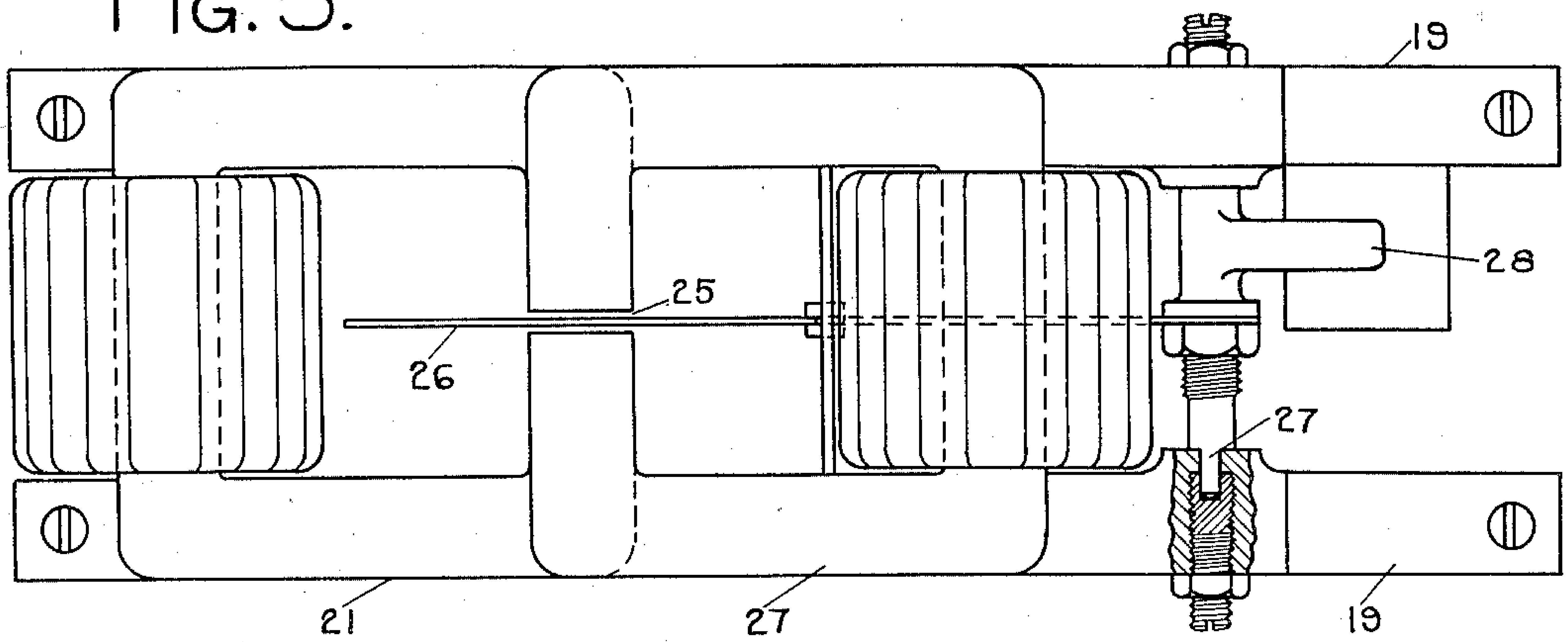


FIG. 6.

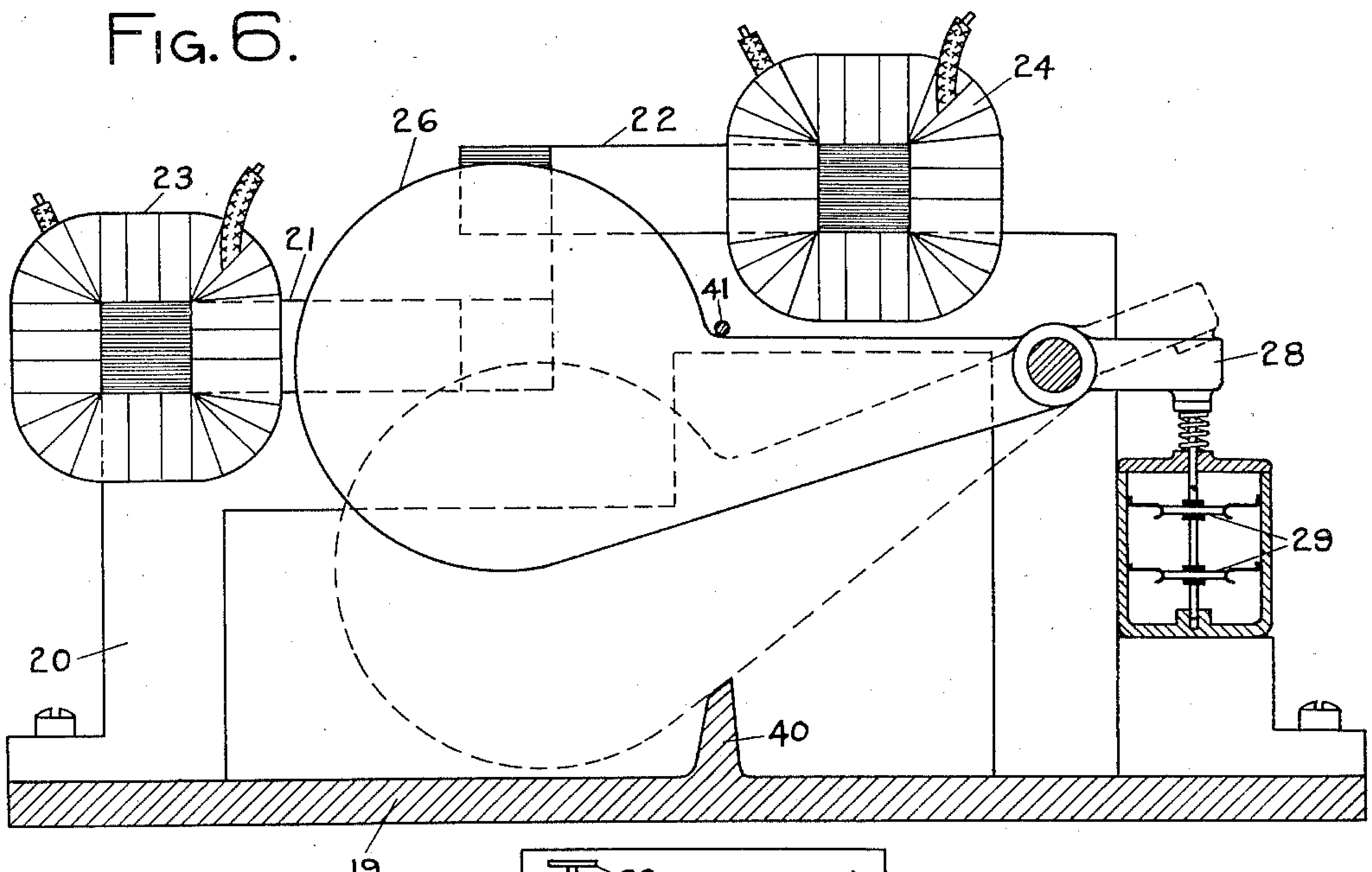
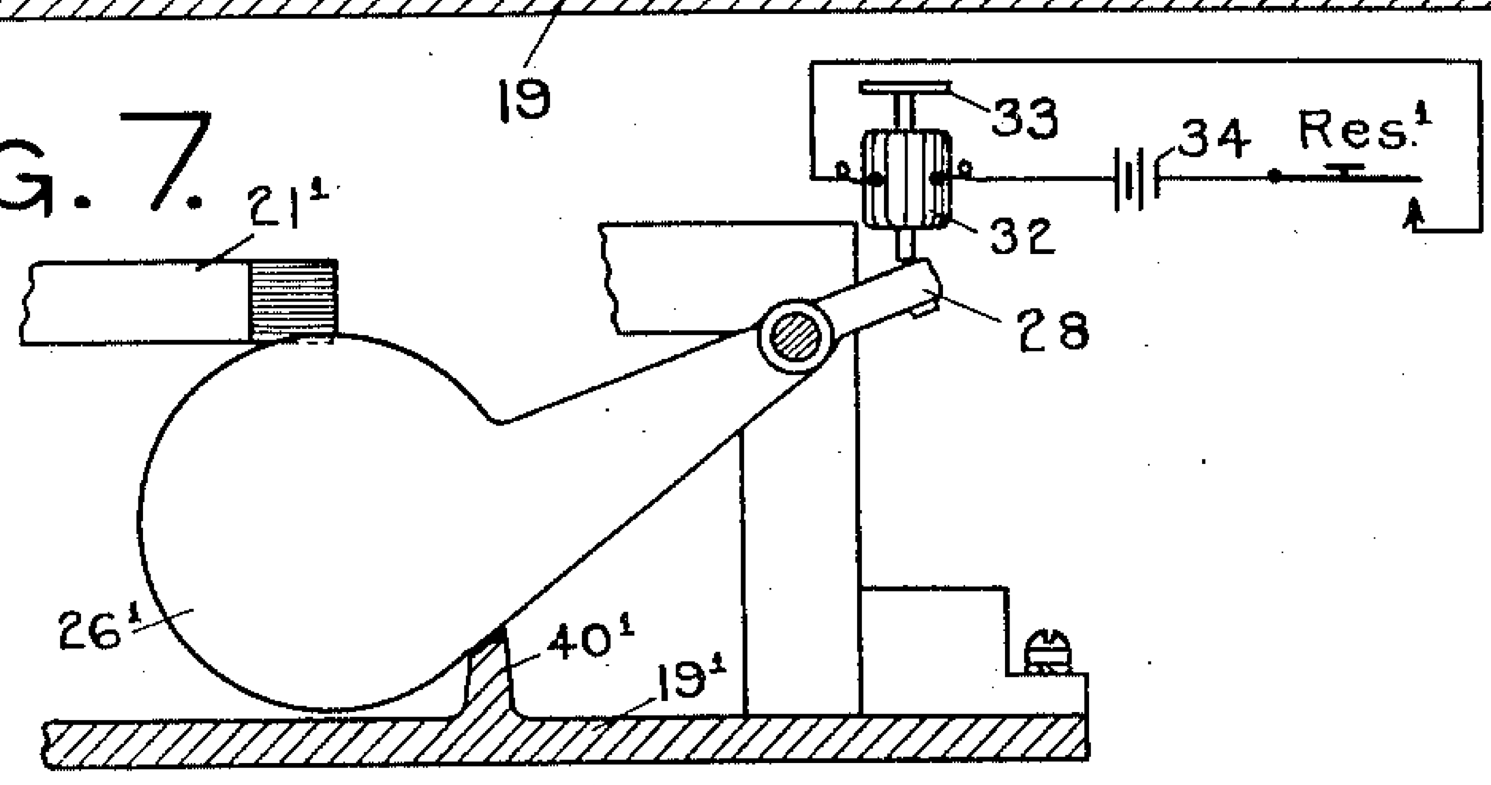


FIG. 7.



INVENTOR
W. D. Hailes,
BY
Neil D. Preston,
his ATTORNEY

Patented June 5, 1934

1,961,853

UNITED STATES PATENT OFFICE

1,961,853

TRAIN CONTROL SYSTEM FOR RAILROADS

William D. Hailes, Rochester, N. Y., assignor to General Railway Signal Company, Rochester, N. Y.

Application June 13, 1927, Serial No. 198,494

6 Claims. (Cl. 246—63)

This invention relates in general to train control systems, and has more particular reference to an automatic inductive alternating current type of system together with a polyphase relay particularly adapted for use with the system.

In train control systems of the type in question, it is very general to provide car-carried means responsive to trackway conditions to govern train control devices carried on the car. It is also usual to control the car carried responsive device by quantitative effects, that is, for instance, by changes in the quantity of current flowing through such device. It would appear however that a car-carried device responsive to trackway conditions and operated in accordance with qualitative changes, that is, in accordance with the changes in kind, rather than in degree, might be very desirable.

With the above and other considerations in mind, it is proposed, in accordance with the present invention, to provide a train control system employing car-carried apparatus including means responsive to trackway conditions and operated in accordance with changes in kind rather than in degree. More specifically, it is proposed to provide a polyphase two position relay which assumes one or the other of its positions dependent upon the time phase relation between the currents in its phase windings, and to control the time phase relation between the currents by trackway inductors which in turn are controlled in accordance with trackway conditions.

A further object of the present invention is to provide an improved form of polyphase relay particularly adapted for use in the above connection. More specifically, the polyphase relay in accordance with this invention is of the vane type, operated by a shifting field, on the inductive motor principle, and the parts are so arranged that the vane is biased to one position by gravity, by a magnetic blow out effect, and by a positive drive due to a magnetic field shifting in one direction, while the vane is caused to assume its other position by means of a positive torque produced by a field shifting in the opposite direction. This prevents sticking of the vane in its unbiased position and gives the relay a very positive and quick release.

Further objects, purposes and characteristic features will appear as the description progresses, reference being had to the accompanying drawings, showing, solely by way of example, various forms which the invention can assume.

In the drawings:—

Fig. 1 is a schematic representation of a simplified train control system embodying one form of the invention;

Fig. 2 is a diagram showing the relation between voltage and currents in the main relay when in its attracted position;

Fig. 3 is a diagram showing the relation between voltage and currents in the main relay when in its retracted position;

Fig. 4 is a view similar to Fig. 1, embodying a modified form of the invention;

Fig. 5 is a top plan view of a relay in accordance with the present invention;

Fig. 6 is a cross sectional elevation of the relay of Fig. 5, and

Fig. 7 is a fragmentary view of a modified form of relay.

Referring to the drawings, and more particularly to Fig. 1, a stretch of trackway is shown comprising track rails 1, divided into signalling blocks by means of insulating joints 2, in the usual manner, each block being supplied with a track battery 3, a wayside signal 4, and a track relay TR.

At the entrance to each block is positioned an inductor M, comprising a core 5 of magnetic material, preferably laminated, carrying a winding 6, connected to a condenser 7, and a contact finger 8, of the track relay controlled by traffic conditions in the block at the entrance to which the inductor is placed. There have been shown but two controls for the inductor circuit, namely, danger and clear, corresponding to the track relay TR in retracted and attracted positions respectively. It is obvious, however, that any usual three position control can be employed, by means of using line relays in conjunction with the track relays, in a manner, as for example, shown in Patent 1,604,098 to W. K. Howe of October 19, 1926. The various control devices and circuits for the wayside signals 4, have not been shown or described, as this is quite unnecessary for a thorough understanding of the present invention.

Carried on the car, represented diagrammatically by wheels and axles 9, is a receiver R, which is similar in construction to the inductor M, and includes a magnetic core 10, carrying a winding 11, the winding being connected in series with a condenser 12, and the control phase winding 13, of a main relay MR. The main relay MR has a local phase winding 14, which is connected in series with a condenser 15, and a contact finger 16 and front contact of the main relay to constitute a stick circuit. Both the local and the control phase windings are connected directly across a source of energy 30, shown as an alternator, and the constants of the circuits including these two phase windings are so chosen as to normally give a leading current I^2 for the control phase 13, and a lagging current I^1 for the local phase 14, an inductive reactance 31, being included in the local phase winding circuit for purposes of adjustment.

Controlled by a contact finger 17 of the relay MR, is a train control device EPV, which may assume various forms according to requirements and conditions, but which in the present instance is shown as an electromagnetic device which is normally electrically energized, and which on de-energization is initiated to give an automatic brake application, or to apply any other desired restrictive condition upon train movement. The energizing circuit for the control device EPV, includes a battery 18, and a reset contactor *Res.*

Referring now to Fig. 4, a slightly modified form of the invention is shown, wherein the inductor M differs from the inductor M of Fig. 1 by having its condenser 7^1 positioned between two contact fingers 8^1 and 8^{11} of the track relay TR^1, this arrangement being advantageous, as will appear below.

The car carried apparatus of Fig. 4 also differs slightly from that shown in Fig. 1, in that the control phase winding 13^1, of relay MR^1, is fed from the secondary S, of a transformer placed on the receiver core 10^1, having a primary winding P which is fed directly from the source of energy 30^1. Thus the control phase winding 13^1 of the main relay is not fed directly from the source of energy 30^1, as in Fig. 1, but is fed indirectly therefrom through a transformer carried on the receiver core 10^1, and this form is advantageous for reasons which will appear below.

The operation of the apparatus thus far described, will now be discussed in some detail. The various parts have been shown in the drawings in their normal positions and conditions, that is, the positions and conditions which exist under travel in clear territory. As shown, the train control device EPV is energized from the battery 18, and thus the train is free to proceed without restriction. The relay MR is designed to be picked up, as shown in Fig. 1, when the control phase current I^2 leads the local phase current I^1, as shown diagrammatically in Fig. 2. That is, the circuits including the local and control phases, are so arranged that the local phase current I^1 lags its voltage E, by a slight angle, while the control phase current I^2 leads this voltage E by a considerable angle.

The main relay MR, is so designed that it will assume its retracted position when the relation of the two phase currents is reversed, so that, if the control phase circuit be changed to draw a strongly lagging current, while the local phase circuit is held constant, then the control phase current I^2, will lag the local phase current I^1, as shown in Fig. 3, and as a result relay MR will assume its retracted position, to de-energize EPV, and give an automatic brake application.

The inductor M, it will be noted, is arranged so that when track relay TR is de-energized, which corresponds to danger conditions, or if a three aspect signal system be used, corresponds to both danger and caution conditions, the effect of the receiver passing over the inductor is to decrease the reluctance of the magnetic circuit through the receiver R, to thus increase the inductance of the electric circuit including control phase winding 13, thus to give a lagging current through such control phase, (Fig. 3). On the other hand, if the track relay TR be energized, to thus close the circuit including the inductor winding 6, and the condenser 7, the effect of the receiver passing over the inductor, is to maintain the control phase current a leading one, or possibly even to make it more leading, the condenser 7 in the inductor circuit being so chosen as to give the inductor circuit a leading characteristic. Under such conditions, the passage of a receiver over a closed circuited inductor, that is, an inductor at the entrance to a clear block, does not materially affect relay MR, and no brake application results, while under caution and danger conditions, EPV becomes de-energized.

In the event a caution or danger signal be passed, and an automatic brake application be incurred, relay MR will not again pick up, after passing the active inductor, since the energizing circuit for its local phase winding 14, is broken at contact finger 16 and front contact of relay MR. It is thus necessary, in order to relieve the train of the brake application, to have recourse to the reset contactor *Res,* which is positioned to be operable only when the train is stationary, as, for example, by making it accessible only from the ground. Upon operation of the reset contactor, an energizing circuit is closed for the local phase winding 14 which includes the contactor *Res* and back point thereof and which circuit shunts out contact finger 16 and its front contact, to thereby pick up relay MR, which, after once picked up, stays up due to the normal energization thereof under conditions as indicated in Fig. 2. The reset contactor *Res,* is protected against misuse by arranging it to break the normally energizing circuit for EPV at contactor *Res* and its front contact, when operated for reset purposes, thus preventing its being tied down, for example, in its resetting position.

The operation of the modified arrangement shown in Fig. 4, is identical with that described above in connection with Fig. 1. In Fig 4, however, by having the control phase winding 13^1 fed through the secondary of a transformer on the receiver R^1, if the primary P should be accidentally shorted out from the energizing source 30^1, winding 13^1 would be deprived of any current, and as a result, a brake application would be incurred. In the case of Fig. 1, however, shorting out of winding 11 of receiver R, would not take current off of the control phase winding 13.

Again, with the modified form of inductor M^1, shown in Fig. 4, in order to connect the winding 6^1 and condenser 7^1 in a closed series circuit, both contact fingers 8^1 and 8^{11}, must be in attracted position, whereby a single short across one of these fingers can not operate to change over the circuit of inductor M^1 from a lagging to a leading one, but two such shorts would be necessary. In the form shown in Fig. 1, if a short should occur connecting the contact finger 8 with its front contact, the circuit of inductor M^1 would then be a capacity circuit having a leading characteristic, which might result in a false clear indication upon entrance into a danger block.

It will thus be seen, that the form shown in Fig. 4 is more dependable, and less subject to errors due to shorting and the like, than the form shown in Fig. 1.

It should be clear from the above description that one of the essential features of this invention is to provide trackway means, controlled in accordance with traffic conditions ahead, to exert an influence on a car-carried circuit, namely the circuit including the control phase winding 13 of the main relay, which, under clear traffic conditions does not materially change the power factor of such car carried circuit, but which under caution and danger conditions does change such power factor so as to relatively reverse the time phase relation between the currents flowing in the two phase windings of the main relay.

There is shown, in Figs. 5 and 6, a relay which is particularly adapted for use in the train control system described above. This relay comprises a base 19 having side brackets 20 connected thereto and supporting control and local phase cores 21 and 22 carrying control and local phase windings 23 and 24. The cores, as shown, are provided with slots 25 positioned on a vertical line, through which a vane 26, adjustably pivoted at 27, can operate in accordance with the energization of the two phase windings. The vane 26 has an operating heel 28 which controls contacts 29. As shown, the cores 21 and 22 are arranged one above the other and when their respective windings are supplied with current which is displaced in phase a proper amount, preferably as nearly 90° as possible, a shifting magnetic field is produced which positively drives the vane 26, either upwardly or downwardly, depending upon the relative time phase relation between the two currents in question, the vane being driven on the well known induction motor principle. Stops 40 and 41 are provided for limiting the vane in its lower and upper, that is retracted and attracted, positions.

When the two phase windings of the relay illustrated in Figs. 5 and 6 are supplied with currents as diagrammatically indicated in Fig. 2, the vane 26 is moved to, and retained in, its upper or attracted position as shown. Upon conditions changing to cause the two phase currents to take the relative positions shown in Fig. 3, the drive torque on the vane 26 is reversed in direction and the vane is moved to, and retained in, its lower or retracted position, as indicated in dotted lines in Fig. 6, the contacts 29 being closed with the vane in its upper position, and open with the vane in its lower position. In connection with the operation of this relay, it should be noted that the vane is so arranged relatively to the cores 21 and 22 that it is constantly urged downwardly by a magnetic blow out effect. In the position shown in Fig. 6, the magnetic blow out effect is produced by core 22, while as soon as the vane gets below the upper edge of core 21, such effect is continued by the core 21, and operates to hold the vane in its lower position. Thus the vane 26 is constantly urged to its retracted or lower position by gravity, and when the windings 23 and 24 are energized, by a magnetic blow out torque. Also, when the phase currents bear the relation shown in Fig. 3, there is a positive drive torque in a counter-clockwise direction. On the other hand, when these phase currents bear the relation shown in Fig. 2, there is a drive torque in a clockwise direction which raises the vane to its attracted or upper position by overcoming gravity and the magnetic blow out effect. Thus the relay can be operated from one position to the other without any change in the amount of the currents flowing through its windings, but merely by a change in their relative time phase relation, to thus give a more dependable, more positive, and quicker acting relay, than is now available.

It is assumed that the clockwise drive torque in vane 26, is sufficient to overcome the effect of gravity or the blow out effect due to core 21, whereby to cause the vane to move to its attracted position when the currents assume the relation of Fig. 2.

However, if it be desired to have a more positively de-energized type of device the stop 40 can be made lower, as 40′ in Fig. 7, in which case the clockwise drive torque is not sufficient to overcome the blow out effect plus gravity holding the same in its lower position.

This condition is cared for by having a D. C. operated plunger 33, actuated by a coil 32 energized by a battery 34 only when the contactor Res^1 is depressed. The plunger 33 presses, when actuated, against heel 28^1 of vane 26^1, to move the vane to a point where the normal pick up torque becomes effective.

No attempt has been made in the drawings to show the particular structure which is to be used in practice, the drawings being primarily to show the invention in a form which will facilitate a ready understanding of the same.

The above rather specific description of one form of the invention is given solely by way of example, and is not intended, in any manner whatsoever, in a limiting sense. Obviously, the invention can assume many different physical forms, and is susceptible of numerous modifications, and all such forms and modifications are intended to be included by this application, as come within the scope of the appended claims.

Having described my invention, I now claim:—

1. In a train control system, a wayside inductor, a car-carried receiver, a brake applying device, a two element relay for controlling said device, a local phase winding for the relay connected across a source of energy, a control phase winding for the relay energized by said source of energy and in series with said receiver, traffic controlled means for said inductor, said inductor at times operating to rotate the current vector of said control phase from one side to the other of that of said local phase by changing the circuit of said control phase from capacitative to inductive.

2. In a train control system, a wayside inductor, a car-carried receiver, a brake applying device, a polyphase relay for controlling said device, a local phase winding for the relay constantly energized by being connected across a source of energy, a control phase winding for the relay constantly energized by said source of energy and in series with said receiver, and means for displacing the local and control phase currents in time phase, without materially reducing their magnitudes, by rotating the current vector of one phase relatively to that of the other, said inductor operating to at times reverse the relation of the phases of said currents by making a change, in kind, in the resulting electrical characteristics of the energizing circuit for the control phase.

3. In a train control system, a wayside inductor, a car-carried receiver, a brake applying device, a two element relay for controlling said device, a local phase winding for the relay connected across a source of energy, a control phase winding for the relay energized by said source of energy and in series with said receiver, traffic controlled means for said inductor, said inductor operating to rotate the current vector of said control phase, without materially decreasing it in magnitude, from one side to the other of that of said local

phase, by changing the resulting electrical characteristics of the circuit of one of said phases, in kind, as distinguished from degree.

4. In a train control system, a wayside inductor, a car-carried receiver, a brake applying device, a polyphase relay for controlling said device, a local phase winding for the relay constantly energized by being connected across a source of energy, a control phase winding for the relay constantly energized by said source of energy and in series with said receiver, said inductor operating to displace the local and control phase currents in time phase, without materially decreasing their magnitudes, by rotating the current vector of one phase relatively to the other, by changing the circuit of the control phase winding from a capacitative to an inductive circuit, so as to at times reverse the relation of the phases of said currents.

5. In a train control system, a wayside inductor, a car-carried receiver, a brake applying device, a polyphase relay for controlling said device, a local phase winding for the relay connected across a source of energy, a winding on the receiver connected across said source of energy, a control phase winding for the relay inductively related to the receiver winding, and means whereby said inductor changes, in kind, the electrical characteristics of the circuit including said control phase winding to thereby rotate its current vector, without materially decreasing its magnitude, from one side to the other of the current vector of said local phase winding in accordance with traffic conditions ahead.

6. In a train control system, in combination, a wayside inductor, a car-carried receiver, a relay having two energizing windings connected in circuits which are normally of different electrical characteristics, one being inductive and the other capacitative and means whereby cooperation between the inductor and the receiver makes the said circuits of the same kind of electrical characteristics.

WILLIAM D. HAILES.