April 7, 1942. A. W. FISHER 2,279,117

CONTROL APPARATUS

Filed Jan. 31, 1940 3 Sheets-Sheet 1

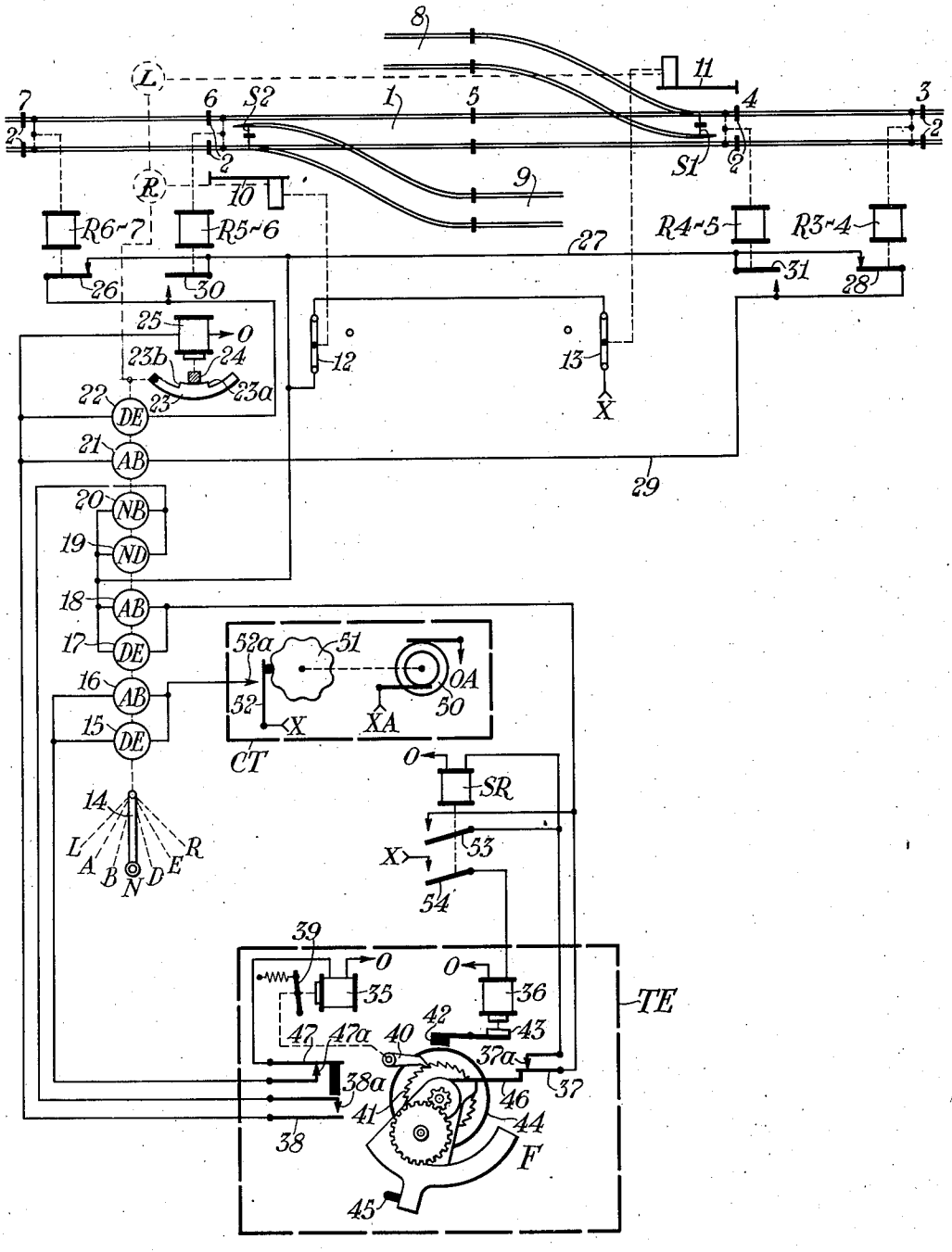


Fig. 1.

INVENTOR
Arthur W. Fisher
BY
HIS ATTORNEY

April 7, 1942. A. W. FISHER 2,279,117

CONTROL APPARATUS

Filed Jan. 31, 1940 3 Sheets-Sheet 2

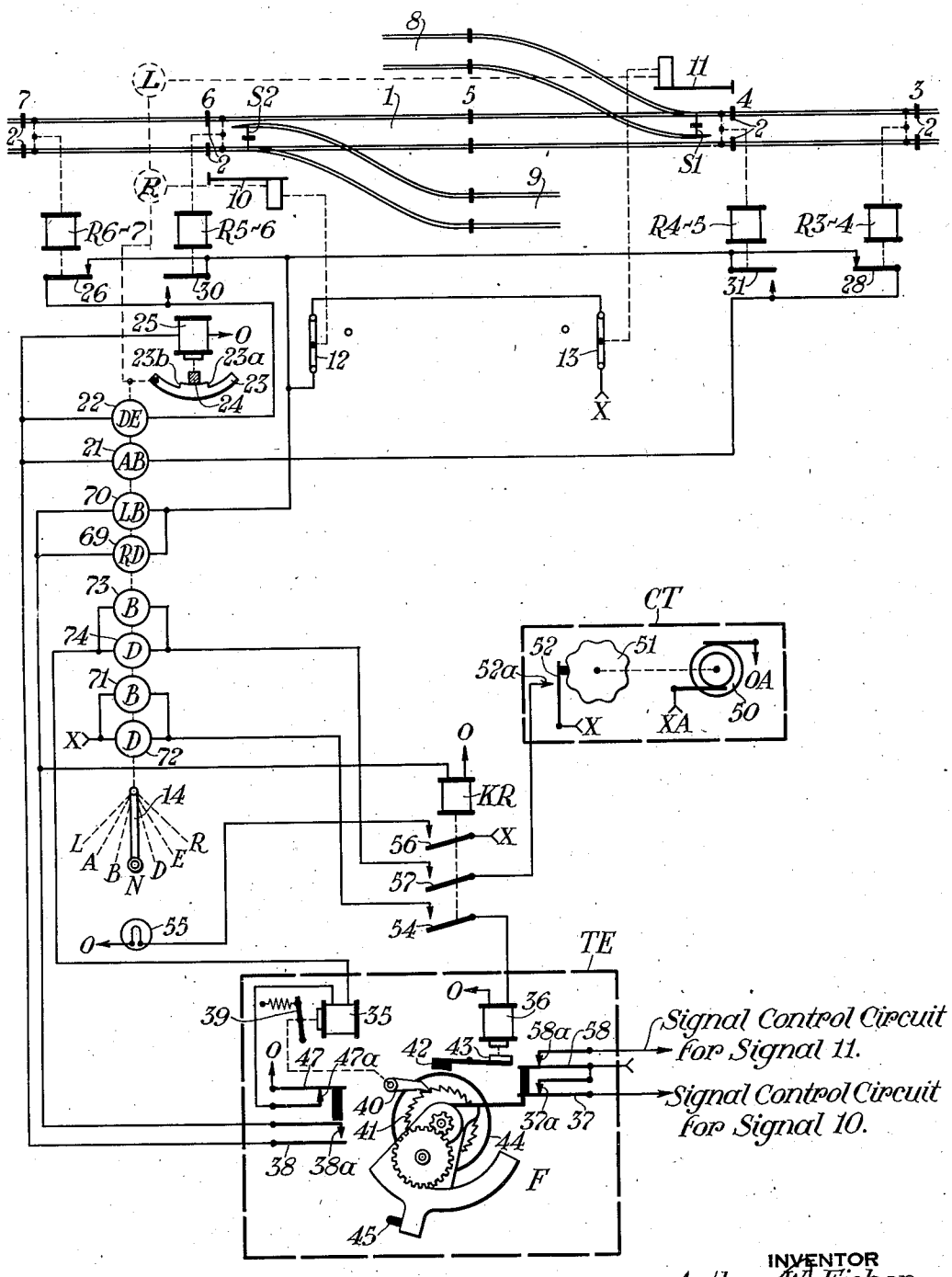


Fig. 2.

INVENTOR
Arthur W. Fisher.
BY
HIS ATTORNEY

April 7, 1942. A. W. FISHER 2,279,117

CONTROL APPARATUS

Filed Jan. 31, 1940 3 Sheets-Sheet 3

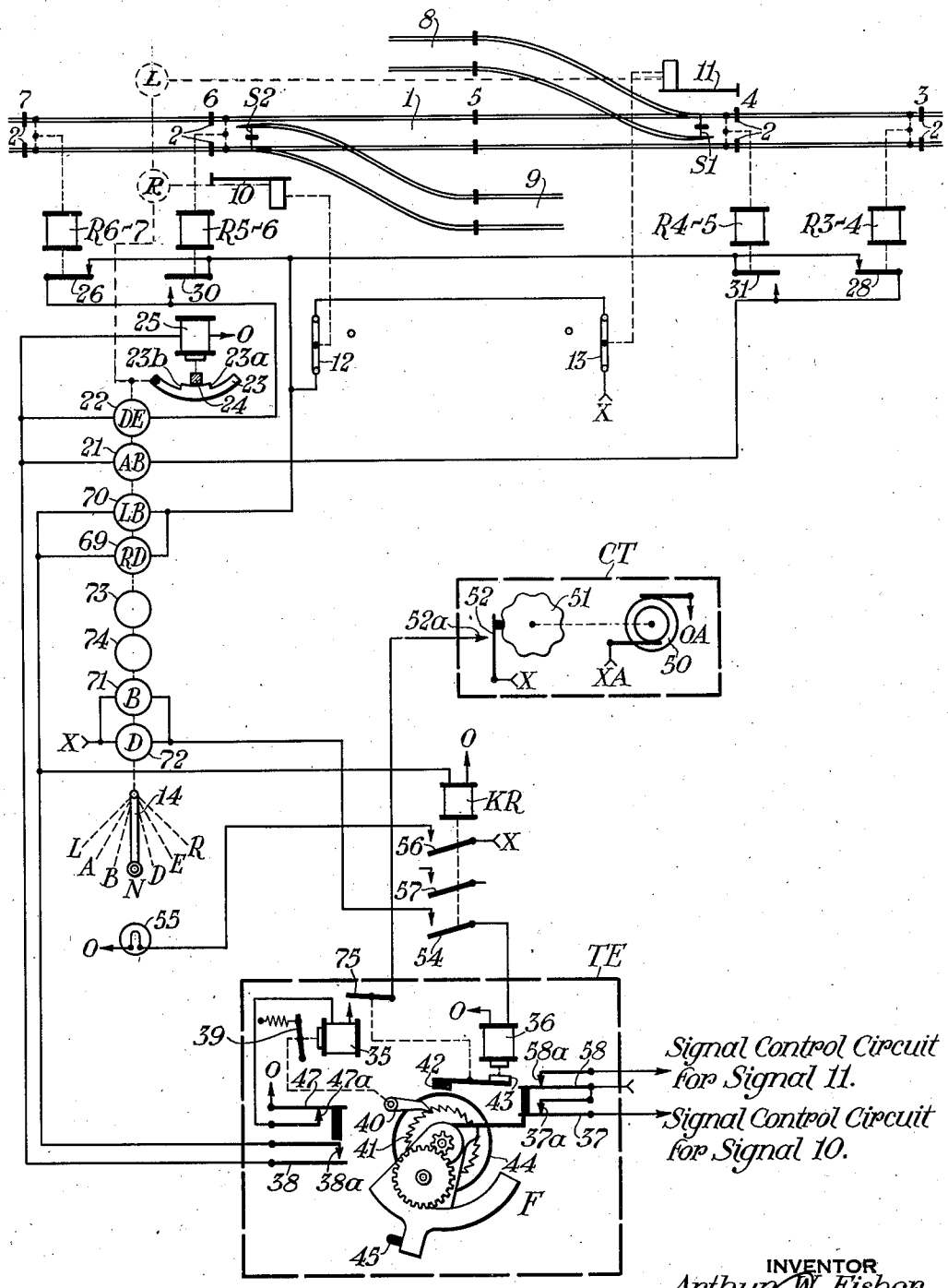


Fig. 3.

INVENTOR
Arthur W. Fisher.
BY
HIS ATTORNEY

Patented Apr. 7, 1942

2,279,117

UNITED STATES PATENT OFFICE

2,279,117

CONTROL APPARATUS

Arthur W. Fisher, Forest Hills, Pa., assignor to The Union Switch & Signal Company, Swissvale, Pa., a corporation of Pennsylvania

Application January 31, 1940, Serial No. 316,609

4 Claims. (Cl. 246—161)

My invention relates in general to control apparatus, and in particular to control apparatus utilizing manually operable levers. More particularly my present invention relates to time release mechanism for use in connection with the levers of interlocking machines employed in railway signaling systems.

In interlocking machines of the type referred to, time release mechanism is employed to enforce a timed sequence of operation between the levers. For example, a time release mechanism may be employed in connection with a signal lever which controls the signals over conflicting routes, and which is mechanically interlocked with a switch lever for setting up the routes, to prevent an operator from changing a route after a train has started to approach unless there is adequate time as measured by the release mechanism to insure that the proposed change if effected will not result in a dangerous condition. When a release mechanism is thus used in connection with a signal lever, the operator having once set up a route for an approaching train and having operated the signal lever to clear the signal for the route, may return the signal lever to its normal indication position and put the signal to stop, but he is prevented from returning the signal lever to the position in which it releases the locking for the switch lever, until after the time release mechanism has operated to energize an electric lock which is provided on the signal lever. Heretofore, the release mechanism has usually been connected with the lever through cam means in such manner that after the release had been operated to unlock the lever, the next movement of the lever to either extreme position will act through the cam means to condition the release mechanism for a new timing period. This cam means in some instances imposes an undesirable load on the lever, and necessitates mounting the release mechanism in a position which in some cases is undesirable because of the limited space available.

One object of my present invention is to provide time release mechanism which will not require any mechanical connection with, or the addition of any mechanical device to, the lever.

In accordance with my present invention, I accomplish the above object by utilizing as a part of the time release mechanism a time measuring device which is electrically controlled to initiate the timing period by virtue of contacts provided on the lever, and which returns to its normal condition, following its timing operation, under the influence of gravity. This time measuring device in its preferred form includes a stepping magnet and a clutch magnet both of which must be energized to initiate the timing period. The stepping magnet is supplied with current impulses from a code transmitter which may be utilized to supply current impulses to a plurality of similar timing devices. The time contact of the timing device is operated by a planetary arm which is biased by gravity to a normal position, and which is moved away from this position toward the position in which it closes the time contact in response to energization of the stepping magnet when and only when the clutch magnet is simultaneously energized. This time measuring device has no mechanical connection of any kind with the lever, and may be located at any desired location remote from the lever.

Other objects and characteristic features of my invention will become apparent as the description proceeds.

My present invention is an improvement on the time release mechanism described and claimed in the copending application for Letters Patent of the United States, Serial No. 344,739, filed by William C. McWhirter on July 10, 1940, for Control apparatus.

I shall describe three forms of time release mechanism embodying my invention, and shall then point out the novel features thereof in claims.

In the accompanying drawings, Fig. 1 is a diagrammatic view showing time release mechanism embodying my invention applied to a signal lever. Figs. 2 and 3 are views similar to Fig. 1 showing modifications of the mechanism illustrated in Fig. 1, and also embodying my invention.

Similar reference characters refer to similar parts in each of the several views.

Referring first to Fig. 1, the reference character 1 designates a stretch of railway track over which traffic normally moves in both directions. The stretch 1 is divided by means of the usual insulated joints 2 into an approach section 3—4, a detector section 4—5, a detector section 5—6 and an approach section 6—7, and is connected by means of switches S1 and S2 located respectively in the detector sections 4—5 and 5—6, with branch tracks 8 and 9.

Associated with each track section is the usual track relay designated by the reference character R followed by distinguishing subscripts. In the interest of simplicity the control circuits for these track relays are not shown, but it will be

understood that these relays will be energized or deenergized according as the associated section is unoccupied or occupied.

Traffic entering the detector section 5—6 from left to right is controlled by a signal 10 illustrated conventionally in the drawing, while traffic entering the detector section 4—5 from right to left is governed by a similar signal 11. These signals may be of any suitable type, and the signal 10 has associated therewith a contact 12 which is closed only when the associated signal is at stop, while the signal 11 likewise has associated therewith a contact 13 which is closed only when this signal is at stop.

The signals 10 and 11 are controlled by means of a signal lever 14 which is arranged to be moved between a plurality of positions L, A, B, N, D, E and R and which, for convenience, may be termed in the order named a left-hand control position, a left-hand intermediate position, a left-hand indication position, a mid or normal position, a right-hand indication position, a right-hand intermediate position and a right-hand control position. Associated with the lever are a plurality of contacts 15 to 22, inclusive, adjacent each of which are letters indicating the lever positions in which the associated contact is closed. For example, each contact adjacent which the letters DE are located is closed in the D position, the E position or any position intermediate these two positions, while each contact adjacent which the letters AB are located is closed in the A position, the B position or any position intermediate these two positions.

The lever 14 is also provided with two other contacts shown in dotted lines in the drawings, and closed in the R and L positions, respectively, of the lever, for controlling the signals 10 and 11. For purposes of the present specification, it is sufficient to point out that these contacts control the signals in such manner that signal 10 will be at stop at all times except when lever 14 is moved to its R position at which time this signal will be moved to its clear or proceed position to permit a train approaching section 5—6 from the left to enter this section, and that signal 11 will be at stop at all times except when lever 14 is moved to its L position, at which time this latter signal will be moved to its proceed position to permit a train approaching section 4—5 from the right to enter this section.

It will be understood that the lever 14 will be included in an interlocking machine, and will be mechanically interlocked with one or more levers for controlling the switches S1 and S2 in such manner that the switch lever or levers cannot be operated to reverse the switches S1 and S2 except when the signal lever 14 occupies its N or normal position in which the signals 10 and 11 both occupy their stop positions.

Also associated with the lever 14 is a lever lock comprising a locking segment 23 secured to the lever and cooperating with a locking dog 24 controlled by a lock magnet 25. The locking segment 23 is provided with two shoulders 23a and 23b, and the parts are so proportioned that when the lever 14 is moved to its L or R position the locking dog 24 will drop by gravity behind one or the other of the shoulders 23a and 23b, and will thus act to prevent the lever from being subsequently moved toward its normal position past the intermediate indication position B or D unless the magnet 25 is energized, in which event the locking dog 24 will be lifted clear of the shoulders. Electric locks of the type described are in widespread use, and their detail construction is too well known to require further discussion.

The magnet 25 of the lever lock is provided with a plurality of energizing circuits which are controlled in accordance with traffic conditions in the stretch 1. One of these circuits passes from terminal X through contact 13 of signal 11, contact 12 of signal 10, front contact 26 of track relay R6—7, contact 22 of lever 14, and the winding of magnet 25 to terminal 0. This circuit is closed when and only when section 6—7 is unoccupied by a train, both signals 10 and 11 are at stop and contact 22 of lever L is closed, and its function is to energize magnet 25 to permit the lever to be moved between its R and N positions without interference by the lever lock when section 6—7 is unoccupied.

The magnet 25 is also provided with a similar energizing circuit which passes from terminal X through contact 13 of signal 11, contact 12 of signal 10, wire 27, front contact 28 of track relay R3—4, wire 29, contact 21 of lever 14 and the winding of magnet 25 to terminal 0, and the function of which is to permit the lever 14 to be moved freely between its L and N positions whenever section 3—4 is unoccupied.

The magnet 25 is further provided with another energizing circuit which is similar to the circuit first traced with the exception that this circuit includes back contact 30 of track relay R5—6 instead of front contact 26 of relay R6—7. The function of this latter circuit is to automatically unlock lever 14 to permit free movement of the lever from its R to its N position as soon as a train approaching section 5—6 from the left has passed signal 10.

Magnet 25 is still further provided with another circuit which is similar to the second circuit traced above with the exception that this circuit includes back contact 31 of track relay R4—5 instead of front contact 28 of relay R3—4. The function of this circuit is to unlock lever 14 to permit free movement of the lever from its L to its N position as soon as a train moving from right to left over track 1 has passed signal 11.

The apparatus thus far described is all well known, and further detailed description of this portion of the apparatus is believed to be unnecessary.

In accordance with my present invention, electrically controlled time measuring means are provided for energizing the magnet 25 at the expiration of a predetermined time interval after the lever is moved away from either its L or its R position provided the movement of the lever away from its L position takes place while a train approaching switch S1 is in section 3—4, or the movement of the lever away from its R position takes place when a train approaching switch S2 is in section 6—7.

As here illustrated, these means comprise a time element device TE, a stick relay SR and a code transmitter CT.

The time element device TE is a modification of the time element relay described and claimed in Letters Patent of the United States No. 1,966,965, granted to Branko Lazich and Harry E. Ashworth, on July 17, 1934, for electrical relays, and comprises a stepping magnet 35 and a clutch magnet 36. The stepping magnet 35 is adapted to be supplied with timed current impulses from the code transmitter CT in a man-

ner which will be made clear presently, and controls an armature 39 in such manner that when the stepping magnet is energized, the armature will be oscillated in step with the current impulses supplied to the stepping magnet. The armature 39 actuates a pawl 40 which cooperates with a ratchet wheel 41, the parts being so arranged that oscillation of the armature 39 will cause a step-by-step rotation of the ratchet wheel in a clockwise direction. The ratchet wheel 41, in turn, is operatively connected with a planetary contact arm F in such manner that when a clutch wheel 44 which is also connected with the arm is engaged by a clutch 42, rotation of the ratchet wheel will cause corresponding rotation of the arm, but that, when the clutch 42 is out of engagement with the clutch wheel, the arm F will return due to the bias of gravity to the position shown. The arm F is identical with the arm F shown and described in the above-mentioned Lazich and Ashworth patent, and a detailed description of this arm is therefore deemed to be unnecessary.

The clutch 42 is arranged to be moved into engagement with the clutch wheel 44 in response to energization of the clutch magnet 36 by means of an armature 43 which is connected with the clutch. When the magnet 36 is deenergized, the clutch is moved out of engagement with the clutch wheel by gravity. It should be noted that when the clutch is engaging the clutch wheel, the arm F will be held in any position to which it is rotated by the stepping magnet.

The arm F as here shown operates three contacts 37—37*a*, 38—38*a* and 47—47*a*. The contact 37—37*a* is a checking contact for checking when the arm occupies its normal position, and is arranged to be closed by means of an insulating strip 46 secured to the arm when and only when the arm occupies its full normal position, and to open immediately as soon as the arm starts to move away from this position.

The contact 38—38*a* is a time contact, and is arranged to be closed at the expiration of the time interval for which the time element device is set, by engagement of an insulating piece 45 secured to the arm F.

The contact 47—47*a* is provided for the purpose of deenergizing the stepping magnet 35 following completion of the time interval, and is normally closed, but is arranged to become opened following the closing of the contact 38—38*a* in a manner which will be apparent from an inspection of the drawings.

The time required to close the contact 38—38*a* depends upon the arc through which the arm F has to be rotated before the insulating piece 45 moves into engagement with the contact finger 38, and the frequency of the current impulses which are supplied to the stepping magnet 35. The length of the arc through which the arm F has to be rotated to close the contact 38—38*a* can be adjusted in the manner described in the aforementioned Lazich and Ashworth patent, while the frequency of the current impulses supplied to the stepping magnet may be varied by proper design of the code transmitter CT. It follows, therefore, that the device TE can be made to close its time contact 38—38*a* at the expiration of any desired time interval after the two magnets 35 and 36 both become energized.

The code transmitter CT may be of any suitable type which when energized will supply current impulses at a predetermined frequency. As here shown, this transmitter comprises an alternating current motor 50 which is constantly supplied with current from the terminals XA and OA of a suitable source, and which drives a cam wheel 51. The cam wheel 51 actuates a contact finger 52 to alternately open and close a contact 52—52*a*.

In explaining the operation of the time release mechanism, I shall assume that the operator having cleared signal 10 to permit the train to proceed past switch S2 by moving the lever 14 to its R position, decides after the train has entered the approach section 6—7 to change the route and cause the train to enter the branch track 9. To effect this change the operator will first move the lever to its D position in which position its movement will be arrested by engagement of the locking dog 24 with the shoulder 23*b* of the locking segment 23. As soon as the lever has been moved to its E position, the circuit over which signal 10 was previously energized will become interrupted, and this signal will therefore immediately move to its stop position and will close its contact 12. The movement of lever 14 to its D position will also close contact 17, and as soon as this contact and contact 12 are both closed, a circuit will become completed for relay SR passing from terminal X through contact 13 of signal 11, contact 12 of signal 10, contact 17 of lever 14, checking contact 37—37*a* of time element device TE and the winding of relay SR to terminal 9. Relay SR will therefore become energized, and will close its front contacts 53 and 54. The closing of front contact 53 of relay SR will complete a stick circuit for this relay which is identical with the circuit just traced with the exception that this latter circuit includes front contact 53 of relay SR in place of checking contact 37—37*a* of time element device TE. The closing of front contact 54 of relay SR will complete a pick-up circuit for the clutch magnet 36, which circuit is obvious from an inspection of the drawing, and the clutch 42 will therefore move into engagement with the clutch wheel 44. The movement of lever 14 to its D position further closes contact 15, and as a result current impulses are then supplied to the stepping magnet 35 over a circuit which passes from terminal X through contact 52—52*a* of code transmitter CT, contact 15 of lever 14, contact 47—47*a* of timing device TE and the winding of stepping magnet 35 to terminal 0. The current impulses supplied to the stepping magnet will cause the armature 39 to oscillate in the manner previously described, and since the clutch 42 is then in engagement with the clutch wheel 44, the arm F will start to rotate in a clockwise direction. As soon as the arm moves away from its normal initial position, contact 37—37*a* will open and will interrupt the pick-up circuit for the relay SR, but this relay will now remain energized by virtue of its stick circuit. The magnet 35 will continue to step the arm F until the time interval required to close contact 38—38*a* and open contact 47—47*a* has expired. When this happens, the resultant opening of contact 47—47*a* will interrupt the circuit for magnet 35 to stop operation of the stepping magnet, while the closing of contact 38—38*a* will complete a circuit for the lock magnet 25 of the lever lock passing from terminal X through contact 13 of signal 11, contact 12 of signal 10, contact 19 of lever 14, contact 38—38*a* of time element device TE, and the winding of magnet 25 to terminal 0. Magnet 25 will therefore be-

come energized and will unlock the lever 14 so that the lever will then be free to move to its N position, and the operator will therefore move the lever to this position. This latter movement of the lever will interrupt the stick circuit for relay SR, whereupon this relay will become deenergized and will deenergize the clutch magnet 36. The deenergization of the clutch magnet 36, in turn, will permit the contact arm F to return to its normal position in which it is shown in the drawing. This latter movement will, of course, cause contact 38—38*a* to open, and will also cause contacts 47—47*a* and 37—37*a* to become closed, thereby restoring all parts of the time element device to their normal positions. As soon as lever 14 has been returned to its normal position, the lever which controls the switch S2 will become unlocked, and the operator may then reverse the switch provided the train has not proceeded into the detector section 5—6 in which event the detector locking will prevent reversal of the switch. The time required to close the time contact 38—38*a* after the operation of the timing device is initiated will be so chosen that when the time contact becomes closed and energizes the lock magnet 25 to unlock the lever, the train will have either proceeded past the signal 10, or will have had a sufficient opportunity to permit it to stop by the time it reaches the signal.

The operation of the time release mechanism when the operator attempts to change the route after signal 11 has been cleared by moving lever 14 to its L position, and a train has entered the approach section 3—4, is similar to that just described, and will be apparent from the foregoing description and from an inspection of the drawings without further detailed description.

In connection with the signal levers of interlocking machines, it is customary to provide an indication relay for controlling a lever light to indicate to the lever operator when the signals controlled by the lever have responded to the lever movements, and in the modified form of the invention shown in Fig. 2 I have illustrated a circuit arrangement in which this relay is utilized to control the time element device TE in place of the relay SR shown in Fig. 1, thereby making possible the necessary control of the time element device without the use of any extra relays.

Referring to Fig. 2, the indication relay as here shown is designated by the reference character KR, and is provided with the usual control circuit which may be traced from terminal X through contact 13 of signal 11, contact 12 of signal 10, contact 69 or 70 of lever 14, and the winding of relay KR to terminal 0. It will be seen, therefore, that when lever 14 is moved from its N position to either its L or R position to clear signal 11 or signal 10, this relay will become energized until the signal has cleared, at which time the relay will immediately become deenergized. It will also be seen that after the signal 11 or the signal 10 has been cleared and the lever 14 is subsequently moved to its indication position B or D to restore the cleared signal to its stop position, as soon as the signal has returned to its stop position, the relay KR will become energized, and will subsequently remain energized until the lever is moved to its N or normal position.

Associated with the relay KR is the usual indication light 55 which is arranged to be energized over a circuit which includes a front contact 56 of relay KR and which is obvious from an inspection of the drawings. It follows that this light 55 will become lighted whenever relay KR is energized.

The time element device TE as shown in Fig. 2 is provided with an additional checking contact 58—58*a* which is closed when and only when the contact arm F occupies its normal position. The checking contacts 37—37*a* and 58—58*a* with the form of the apparatus shown in Fig. 2 are adapted to be included in the control circuits for the signals 10 and 11, respectively, in such manner that these signals cannot be cleared unless these contacts are closed. The remainder of the apparatus shown in Fig. 2 is similar to that shown in Fig. 1.

In explaining the operation of the timing mechanism when arranged as shown in Fig. 2, I shall assume that the operator having cleared signal 11 to permit a train to proceed from right to left past switch S1 decides after the train has entered the approach section 3—4 to change the route and cause the train to enter the branch track 8. To effect this change, the operator will move lever 14 to its B position where its movement will be arrested by the locking dog 24 engaging shoulder 23*a*. As soon as the lever is moved away from its L position, the circuit for signal 11 will be interrupted, and this signal will therefore move to its stop position. When this happens, contact 13 will become closed and will complete the circuit for relay KR including contact 70 of lever 14, and relay KR will therefore become energized and will complete the circuit for signal light 55 to indicate to the lever operator that signal 11 has moved to its stop position. The picking up of relay KR will also complete a circuit for the stepping magnet 35 and a circuit for the clutch magnet 36. The circuit for the stepping magnet 35 may be traced from terminal X through contact 52—52*a* of code transmitter CT, front contact 57 of relay KR, contact 73 of lever 14, the winding of magnet 35, and contact 47—47*a* of time element device TE to terminal 0, while the circuit for the clutch magnet 36 may be traced from terminal X through contact 71 of lever 14, front contact 54 of relay KR and the winding of magnet 36 to terminal 0. Time element device TE will therefore start to operate, and after the proper time interval has expired will close its contact 38—38*a* and open its contact 47—47*a*. The opening of contact 47—47*a* will interrupt the circuit which was previously closed for the stepping magnet 35, but the contact arm F will be held in the position in which the contact 38—38*a* is closed and the contact 47—47*a* is open by the clutch 42. The closing of contact 38—38*a* completes a circuit for the magnet 25 of the lever lock which is identical with the circuit previously described in Fig. 1 except for the fact that this circuit includes the LB and RB contacts 69 and 70 in place of the NB and ND contacts 19 and 20, whereupon magnet 25 will pick up and will unlock lever 14. When this happens, the lever will be free to move to its N position and the lever operator will therefore move it to this position. This movement of the lever will interrupt the circuit for relay KR, and this relay will then become deenergized and will extenguish the lever light 55. The movement of the lever 14 to its N position will also interrupt the circuit for the clutch magnet 36 at contact 71 of the lever, so that the magnet will become deenergized and will permit the arm F to return ot its normal position. With the lever 14 in its normal position, the switch lever for con-

trolling switch S1 will become unlocked, and the switch S1 can then be reversed in the usual manner following which the lever 14 can be restored to its L position to clear signal 11.

The operation when it is desired to change a route after lever 14 has been moved to its R position to clear signal 10 and a train is approaching the signal within section 6—7 is similar to that just described, and will be apparent from the foregoing description without further detailed description.

It should be particularly pointed out that while in the foregoing description I have shown the timing mechanism for only one signal lever controlled by the code transmitter CT, in actual practice, the same code transmitter may be used to control all of the timing mechanisms for all of the signals in an interlocking plant.

In the form of the invention shown in Fig. 3, the clutch magnet 36 is provided with a contact 75 which becomes closed whenever magnet 36 becomes energized, and this contact is included in the energizing circuit for the stepping magnet 35 in place of the contact 57 of relay KR and the contacts 73 and 74 of lever 14 in Fig. 2, thereby eliminating the necessity for the contact 57 on relay KR and the necessity for the lever contacts 73 and 74, and hence simplifying the apparatus. The remainder of the apparatus shown in Fig. 3 is similar to that shown in Fig. 2.

With the apparatus constructed as shown in Fig. 3, when the relay KR picks up in response to movement of the lever 14 to its B or D position to initiate a route change, the resulting energization of magnet 36 will cause contact 75 to become closed and complete the circuit for the stepping magnet 35, thereby initiating the operation of the timing device TE. From this point on, the operation of the timing mechanism is similar to that previously described in connection with Fig. 2, and it is believed to be unnecessary therefore to repeat this operation.

One advantage of timing mechanism embodying my invention is that it eliminates necessity for any mechanical connection between the timing mechanism and the lever, and does not therefore impose any load on the lever.

Although I have herein shown and described only three forms of timing mechanism embodying my invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. In control apparatus, the combination with a manually operable lever and an electric lock effective when deenergized for restraining movement of said lever; of a time element device including a stepping magnet, a clutch magnet, a first contact which becomes closed only when both said magnets are deenergized, a second contact which becomes closed only after both said magnets have been energized for a predetermined length of time, and a third contact which becomes opened when said second contact becomes closed; means controlled in part by said lever and in part by said first contact for energizing said clutch magnet, means controlled in part by said lever and in part by said third contact for successively energizing said stepping magnet, means controlled by said second contact for energizing said lock to remove the restraint from said lever, and means effective when said clutch magnet becomes energized for maintaining said clutch magnet energized until said lever is subsequently moved away from the position in which said clutch magnet initially became energized.

2. In control apparatus the combination with a railway signal, a manually operable lever for controlling said signal movable from a normal position to a control position past an indication position, and an electric lock effective when deenergized for preventing movement of said lever from its control position toward its normal position past its indication position, of a time element device including a stepping magnet adapted to be supplied with current impulses and a clutch magnet and also including a contact arm biased by gravity to a normal position and movable from said normal position toward an operated position at a predetermined rate when said two magnets are both energized, a checking contact controlled by said arm and closed only when said arm occupies its normal position, a normally open contact arranged to be closed by said arm when said arm is moved to its operated position, a normally closed contact arranged to be opened by said arm when said arm is moved to its operated position, a stick relay, a pick-up circuit for said stick relay including said checking contact and a contact of said lever closed in the indication position of the lever, a stick circuit for said stick relay including a front contact of said relay and a contact of said lever closed in the indication position of the lever, a source of current impulses; a circuit for said stepping magnet including said source of current impulses, a contact of said lever closed in the indication position of the lever and said normally closed contact; a circuit for said clutch magnet controlled by a front contact of said stick relay, and an energizing circuit for said lock controlled by said normally open contact.

3. In control apparatus, the combination with a railway signal, a manually operable lever for controlling said signal movable from a normal position to a control position past an indication position, and an electric lock effective when deenergized for preventing movement of said lever from its control position toward its normal position past its indication position, of a time element device including a stepping magnet adapted to be supplied with current impulses and a clutch magnet and also including a contact arm biased by gravity to a normal position and movable from said normal position toward an operated position at a predetermined rate when said two magnets are both energized, a stick relay; means for energizing said stick relay when said signal occupies its stop position, said lever is in its indication position, and said contact arm occupies its normal position; means for subsequently maintaining said stick relay energized until said lever is moved away from its indication position, means controlled by said stick relay for energizing said clutch magnet when said stick relay is energized, means for energizing said stepping magnet when said lever is in its indication position until said arm reaches its operated position, and means controlled by said time element device for energizing said electric lock when said arm reaches its operated position.

4. In control apparatus, the combination with a lever movable from a normal position to a control position past an indication position and an electric lock effective when deenergized for preventing movement of said lever from its control

position past its indication position, of a time element device including a stepping magnet adapted to be supplied with current impulses and a clutch magnet and also including a contact arm biased by gravity to a normal position and movable from said normal position toward an operated position at a predetermined rate when said two magnets are both energized, a checking contact controlled by said arm and closed only when said arm occupies its normal position, a normally open contact arranged to be closed by said arm when said arm is moved to its operated position, a normally closed contact arranged to be opened by said arm when said arm is moved to its operated position, a stick relay, a pick-up circuit for said stick relay including said checking contact and a contact of said lever closed in the indication position of the lever, a stick circuit for said stick relay including a front contact of said relay and a contact of said lever closed in the indication position of the lever, a source of current impulses; a circuit for said stepping magnet including said source of current impulses, a contact of said lever closed in the indication position of the lever and said normally closed contact; a circuit for said clutch magnet controlled by a front contact of said stick relay, and an energizing circuit for said lock controlled by said normally open contact.

ARTHUR W. FISHER.