

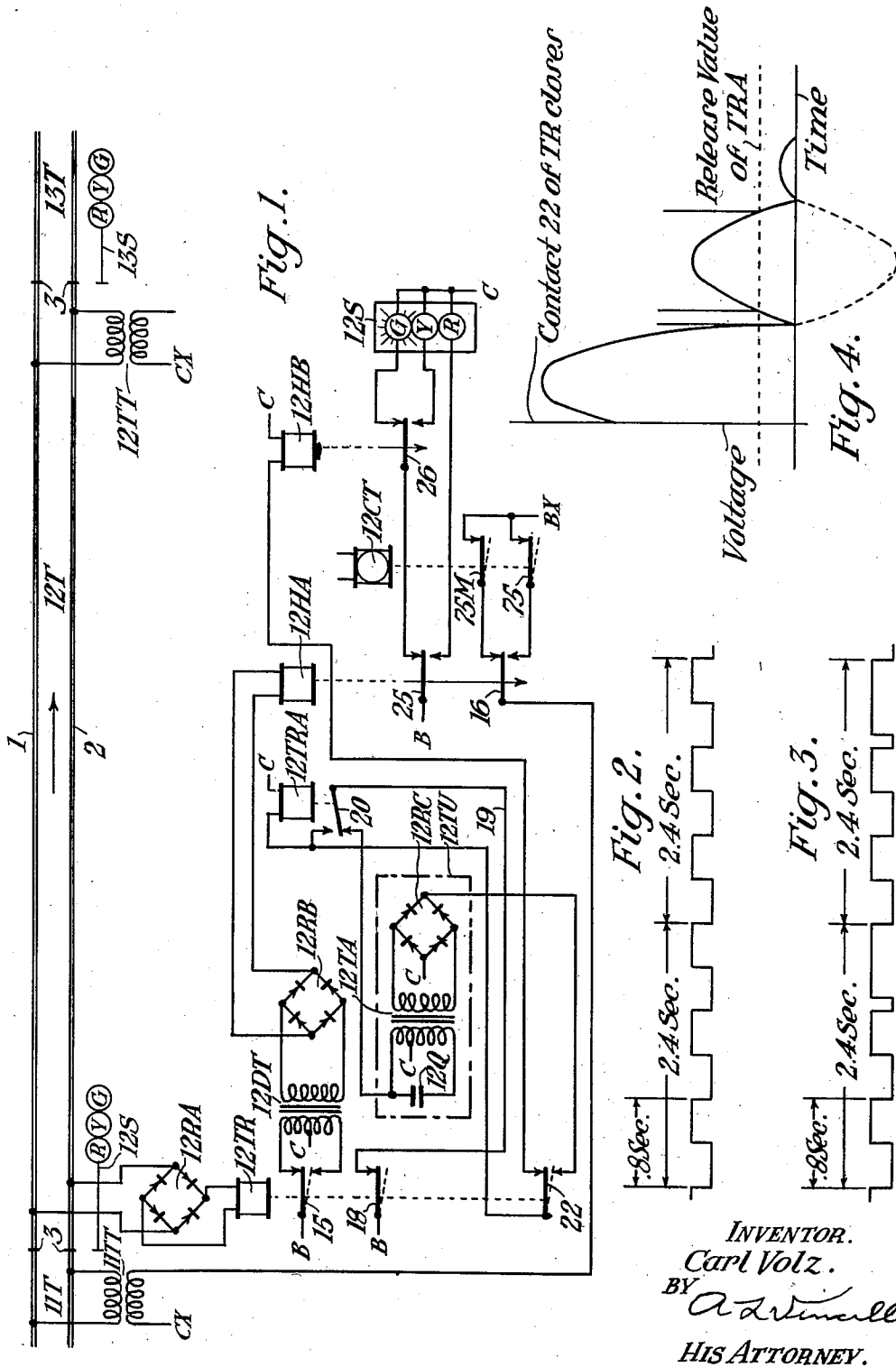
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C, VOLZ

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CODE DETECTING MEANS

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CODE DETECTING MEANS

Carl Volz, Pittsburgh, Pa., assignor to The Union
Switch & Signal Company, Swissvale, Pa., a
corporation of Pennsylvania

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1 Claim. (Cl. 177—353)

My invention relates to impulse timing means of a type adapted for use in railway signaling systems.

In application Serial No. 452,894 of Frank H. Nicholson and Crawford E. Staples, filed July 30, 1942, now Patent No. 2,331,134, issued October 5, 1943, there is shown a coded signaling system in which one proceed indication is provided by a modified code employing at recurring intervals a code component which is much shorter than those employed in the standard code. In order to differentiate between the standard code and the modified code a relay is employed to detect the short component in the modified code.

It is an object of my invention to provide improved means for detecting a code component shorter than a predetermined length.

A further object of the invention is to provide impulse generating means which operates to supply to a relay impulses of energy which are effective to pick up the relay contacts and to cause them to remain picked up for a period slightly longer than the short code components, but not so long as the code components of normal length.

Another object of my invention is to provide improved impulse generating means arranged so that the impulses of energy supplied therefrom will not be effective to maintain the associated relay picked up for longer than a predetermined time regardless of variations in voltage of the source from which energy is supplied to this means, variations in temperature, effects of rectifier ripple, relay contact wear, or shorted turns in the winding of the equipment.

A further object of my invention is to provide impulse generating means controlled by a code following relay and arranged so that it will supply energy to the impulse detecting relay only on movement of the contacts of the code following relay from one position to the other.

Other objects of the invention and features of novelty will be apparent from the following description taken in connection with the accompanying drawing.

I shall describe one form of apparatus embodying my invention, and shall then point out the novel features thereof in a claim.

In practicing my invention I employ a code following relay to control the supply of energy from a source of unidirectional current to the primary winding of a transformer, and to control the supply of energy from the transformer secondary winding through a rectifier to a detector relay. A condenser is connected across the transformer primary winding and is proportioned so

that the condenser and the transformer primary winding together form a highly damped oscillating circuit. When the code following relay contact opens, oscillations in this circuit are initiated while the period during which the impulses of energy supplied from the transformer to the detector relay are of a value effective to keep the detector relay contacts picked up is determined by the frequency of oscillation in the transformer primary winding. In addition, when the short code component is encountered, a contact of the code following relay cooperates with a contact of the detector relay to establish a stick circuit for the detector relay and to also establish a circuit to supply energy to a slow release control relay.

In the drawing

Fig. 1 is a diagram of a railway signaling system incorporating my invention,

Figs. 2 and 3 are diagrams illustrating the types of coded energy employed in the system shown in Fig. 1, and

Fig. 4 is a diagram of the energy impulses supplied from the timing unit to the detector relay.

Referring to Fig. 1 of the drawing, there is shown therein a stretch of railroad track having track rails 1 and 2 over which traffic normally moves in the direction indicated by the arrow, that is from left to right. The rails of the track stretch are divided by insulated joints 3 into the customary successive track sections for signaling purposes.

In the diagram one complete section, which is identified as section 12T, and parts of the two adjoining sections, identified as sections 11T and 13T, are shown. Each of these sections has located at the entrance end thereof a signal S governing movement of trains in the track stretch. The signals illustrated are of the familiar color light type having a green or clear lamp G, a yellow or caution lamp Y, and a red or stop lamp R.

The rails of each track section form a part of a track circuit to which coded alternating current signal control energy is supplied at the exit or leaving end from the secondary of a track transformer TT. The energy supplied to the track circuits is derived from any suitable source and may be distributed throughout the track stretch by a transmission line, not shown. The terminals of this source are designated BX and CX, and it will be assumed that the energy supplied from the source is alternating current of a frequency of 100 cycles per second.

Each of the signal locations has associated

therewith a suitable source of direct current, such as a primary or a storage battery, not shown, the terminals of which are designated B and C.

The particular signaling system shown in Fig. 1 is of the three indication variety and makes use of coded track circuit energy of two different types which are diagrammatically illustrated in Figs. 2 and 3 of the drawing. This coded energy is provided by code transmitters CT which have contacts which interrupt the supply circuits for the associated track transformers a definite number of times per minute according to traffic or other conditions ahead. As shown, the code transmitters have two circuit making and breaking contacts 75 and 75M which are continuously actuated by a motor or other suitable mechanism. The contact 75 is operated so as to produce 75 energy impulses of uniform length per minute which are separated by periods of equal duration during which no energy is supplied.

The contact 75M is operated so as to produce two cycles of energy of 75 code frequency of normal pattern, each cycle consisting of an "off" period followed by an "on" period of equal length. Every third code cycle in the 75M code is modified so that the "off" period in this code cycle is much shorter than the "off" periods in the normal code cycles, while the duration of the "on" period in this code cycle is increased so that the length of the code cycle is the same as the code cycles of normal pattern.

The two types of coded energy are illustrated diagrammatically in Figs. 2 and 3 of the drawing. Fig. 2 is a diagram of the energy of 75 code frequency and as therein illustrated this energy consists of recurring code cycles each .8 second long, and each consisting of an "off" period of .4 second followed by an "on" period of .4 second.

Fig. 3 is a diagram of the 75M code and as therein illustrated this energy consists of two cycles of energy of 75 code frequency of normal pattern, while the "off" period in every third code cycle is reduced to approximately one-third its normal length, and the "on" period in this code cycle is increased in length so that the code cycle is of .8 second duration. Accordingly, in the 75M code a short "off" period occurs once every 2.4 seconds.

Each of the track sections includes a code following track relay TR located at the entrance end of the section. As shown the track relay 12TR is of the direct current type and is connected across the section rails through a suitable rectifier 12RA.

The track relay 12TR has associated therewith a decoding transformer 12DT, an auxiliary relay 12HA, a rectifier 12RB, a timing unit 12TU provided by this invention, a detector relay 12TRA, and a slow release control relay 12HB.

The timing unit 12TU includes a transformer 12TA, a condenser 12Q, and a rectifier 12RC. The condenser 12Q is connected across the end terminals of the primary winding of the transformer 12TA. A circuit controlled by contacts of the relays 12TRA and 12TR is provided for establishing connection from terminal B of the source of direct current to an end terminal of the primary winding of transformer 12TA, while the transformer primary winding has an intermediate tap which is connected to terminal C of the source.

The equipment is shown in the condition which it assumes when the track stretch is vacant. At this time energy of 75M code frequency is supplied to the rails of section 12T and this energy feeds to the track relay 12TR and produces code

following operation of its contacts. As a result of movement of contact 15 between its two positions, the two portions of the primary winding of transformer 12DT are alternately energized and energy is induced in the transformer secondary winding from which it is supplied through the rectifier 12RB to the relay 12HA so that the contacts of this relay are picked up. The relay 12HA is of a type the contacts of which are slow in releasing so that they remain picked up during the intervals between the impulses of energy supplied thereto.

Since relay 12HA is picked up, its contact 16 establishes the circuit of the contact 75M of code transmitter 12CT so that energy of 75M frequency is supplied to the track transformer 11TT.

On movement of track relay contact 18 to its picked-up position at a time when the contacts of relay 12TRA are released, energy is supplied to the primary winding of transformer 12TA over the circuit which is traced from terminal B through front contact 18 of track relay 12TR, wire 19, back contact 20 of relay 12TRA, and the upper portion of the primary winding of transformer 12TA to terminal C. At this time the condenser 12Q is charged by energy supplied over the circuit traced from terminal B through front contact 18 of relay 12TR, wire 19, and back contact 20 of relay 12TRA to one terminal of the condenser 12Q, while the other terminal of the condenser is connected through the lower portion of the transformer primary winding to terminal C of the source. The inductance of this portion of the transformer primary winding is such that flow of energy in the circuit of the condenser is delayed with the result that wear on the track relay contacts is minimized.

The upper portion of the transformer primary winding is preferably formed from a relatively few turns of heavy wire so that on establishment of the circuit of this winding current of relatively high value quickly builds up in the winding and insures that the transformer core is saturated with flux. The lower portion of the transformer primary winding is preferably formed of a relatively large number of turns of fine wire so that it requires little space on the transformer core yet has high enough inductance to function properly with a condenser of small capacity.

On the supply of energy to the primary winding of transformer 12TA an impulse of energy is induced in the transformer secondary, but energy is not supplied therefrom to relay 12TRA as contact 22 of the track relay 12TR is picked up.

On release of the track relay its contact 18 interrupts the circuits traced above for supplying energy to the upper portion of the primary winding of transformer 12TA and to condenser 12Q, while its contact 22 establishes the circuit to supply energy from the secondary winding of transformer 12TA to relay 12TRA.

On release of track relay contact 18 and interruption of the supply of energy to the transformer primary winding and to the condenser 12Q, the flux in the transformer core tends to collapse, while the energy stored in the condenser 12Q discharges through the transformer primary winding. The collapse of the flux in the transformer core and the flow of energy from the condenser through the transformer primary winding cause oscillations to be set up in the primary circuit which in turn cause energy to be induced in the transformer secondary winding.

The terminals of the transformer secondary winding are connected to the input terminals of

the rectifier 12RC, while one output terminal of this rectifier is connected to terminal C and thus to one terminal of the winding of relay 12TRA. The other output terminal of the rectifier is connected through back contact 22 of relay 12TR to the other terminal of the relay 12TRA. Accordingly, on release of the track relay 12TR energy is supplied from the secondary winding of transformer 12TA through the rectifier 12RC to the relay 12TRA and its contacts pick up.

The condenser 12Q, and the primary winding and the core of transformer 12TA are selected and proportioned so that on opening of track relay contact 18 the condenser and the transformer primary winding form a highly damped oscillating circuit, and the energy flowing in this circuit causes energy to be induced in the transformer secondary winding from which it is supplied through the rectifier 12RC to the relay 12TRA and maintains the contacts of this relay picked up. However, because of the highly damped characteristic of the oscillating circuit, the impulses of energy induced in the transformer secondary winding rapidly decrease in value and very soon are reduced to such an extent that the energy supplied to the relay 12TRA is ineffective to maintain the relay contacts picked up.

The various parts of the timing unit TU and of the relay TRA are selected and proportioned so that the energy supplied from the timing unit to the relay is effective to keep the relay contacts picked up for a period longer than the short "off" period in the 75M code, but will not keep them picked up for a period as long as the "off" periods in the 75 code, or the "off" periods of normal length in the 75M code.

Accordingly, when the track relay releases, energy is supplied from the timing unit 12TU to the relay 12TRA and the contacts of the relay 12TRA pick up and its contact 20 interrupts the circuit for supplying energy to the timing unit 12TU and establishes a circuit over which energy may be supplied to the relay 12TRA and also to the relay 12HB.

If the "off" period in the code which causes the release of the track relay is the short "off" period in the 75M code, the contacts of the track relay 12TR will pick up before the contacts of the relay 12TRA release. Under these conditions contact 18 of track relay 12TR does not establish the circuit for supplying energy to the timing unit 12TU since contact 20 of relay 12TRA is picked up, but does establish circuits to supply energy to relays 12TRA and 12HB. The circuit for supplying energy to relay 12TRA is traced from terminal B through front contact 18 of relay 12TR, wire 19, front contact 20 of relay 12TRA, and winding of relay 12TRA to terminal C. The circuit for supplying energy to relay 12HB is the same as that for relay 12TRA up to the front contact 20 of relay 12TRA, and is traced therefrom through front contact 22 of relay TR, and thence through winding of relay 12HB to terminal C.

The energy supplied to the relay 12TRA keeps the contact of this relay picked up so that it maintains the circuit for supplying energy to relay 12HB throughout the long "on" period following the short "off" period in the 75M code. The energy supplied to relay 12HB during this long "on" period picks up the relay contacts, if they are not already picked up, while it energizes the relay sufficiently that its contacts will remain picked up throughout the intervals between the long "on" periods in the 75M code.

On release of the track relay following the long

"on" period in the 75M code, contact 18 interrupts the supply of energy to relays 12TRA and 12HB, while contact 22 additionally interrupts the circuit of relay 12HB. At this time the contact of relay 12TRA releases, but because of the slow release characteristic of relay 12HB its contact remains picked up.

On release of the track relay its contact 22 establishes connection from the rectifier 12RC to the relay 12TRA, but as energy was not supplied to the timing unit 12TU during the preceding picked-up period of the track relay contacts no energy is stored in the timing unit, and energy is not supplied to the relay 12TRA at this time and its contacts remain released.

On picking up of the track relay contacts in response to the first "on" period in the code following the long "on" period, contact 18 establishes the circuit including back contact 20 of the relay 12TRA for supplying energy to the timing unit 12TU so that on the subsequent "off" period in the code, energy is supplied from the timing unit to the relay 12TRA over the circuit including back contact 22 of the track relay. Accordingly, the contact of relay 12TRA picks up, but it releases before the end of this "off" period in the code so that during the next picked-up period of the track relay contacts energy is again supplied to the timing unit 12TU.

The next "off" period in the code is the short "off" period, and on release of the track relay contacts energy is again supplied from the timing unit 12TU to the relay 12TRA and the contact of relay 12TRA picks up, while the track relay contacts pick up before the contact of relay 12TRA releases. Accordingly, energy is supplied to relay 12TRA over its stick circuit, while energy is also supplied to relay 12HB so that this relay is energized to maintain its contact picked up until the next long "on" period in the 75M code.

From the foregoing it will be seen that the timing unit 12TU and the relay 12TRA together provide means for detecting the short "off" periods in the 75M code. The timing unit 12TU supplies energy of substantially fixed value to the relay 12TRA, and this energy is of such value and duration as to maintain the contacts of the relay 12TRA picked up throughout a short "off" period, but not throughout an "off" period of normal length. Accordingly, when the track relay contacts pick up following a short "off" period in the code, the contacts of relay 12TRA are still picked up and energy is supplied to relay 12TRA over its stick circuit and is also supplied to relay 12HB. When the track relay contacts pick up following an "off" period of normal length, the contacts of relay 12TRA are released and hence energy is not supplied over the stick circuit for the relay, nor to relay 12HB, but is supplied to the timing unit so that it is prepared to supply energy to relay 12TRA on release of the track relay contacts. The relay 12HB, therefore, is energized during each long "on" period in the 75M code, and remains picked up in the intervals between these periods.

Since the contacts of relays 12HA and 12HB are picked up, energy is supplied to the green lamp G of signal 12S over the circuit which is traced from terminal B through front contact 25 of relay 12HA, front contact 26 of relay 12HB, and lamp G to terminal C. Accordingly, the green lamp of signal 12S is lighted so this signal displays its clear indication.

When a train moving in the normal direction of traffic enters section 12T, the track relay 12TR

is shunted and energy is no longer supplied through the transformer 12DT to relay 12HA, while energy is no longer supplied to the timing unit 12TU so energy is not supplied from this unit to relay 12TRA and its contact remains released and does not establish the circuit of relay 12HB. Accordingly, the contact of relay 12HB releases.

On release of relay 12HA its contact 25 interrupts the circuit of the green lamp G of signal 12S and establishes the circuit of the red lamp R of this signal, while its contact 16 interrupts the circuit of the contact 15M and establishes the circuit of the contact 15 of code transmitter 12CT so that energy of 75 code frequency is supplied to section 12T.

When the train advances into section 13T, the equipment for that section operates to cause signal 13S to display its red or stop indication and to cause energy of 75 code frequency to be supplied to section 12T.

When the train vacates section 12T, this energy feeds to track relay 12TR and its contacts follow code so that energy is again supplied through the decoding transformer 12DT to relay 12HA and its contacts pick up.

During the picked-up periods of the track relay its contact 18 establishes the circuit to supply energy to the timing unit 12TU, while contact 22 of the track relay, when released, establishes the circuit for supplying energy from the timing unit to the relay 12TRA. As the energy supplied to the track relay is of the 75 code frequency, all of the "off" periods therein are of normal length and the contacts of relay 12TRA release before the track relay contacts pick up. Accordingly, energy is not supplied to the relay 12HB and its contacts remain released, and energy is supplied to the yellow lamp Y of signal 12S over the circuit which is traced from terminal B through front contact 25 of relay 12HA, back contact 25 of relay 12HB, and yellow lamp Y of signal 12S to terminal C.

When the train advances far enough to vacate section 13T, the equipment for that section operates to cause signal 13S to display its yellow indication and to cause energy of 75M code frequency to be supplied to section 12T. When this energy is supplied to track relay 12TR, energy continues to be supplied through the transformer 12DT to the relay 12HA so that the contacts of this relay remain picked up. In addition, when the track relay 12TR responds to energy of 75M code frequency, energy is supplied to the relay 12HB during the long "on" periods in this code, as explained above, and the contacts of this relay are maintained picked up so the signal 12S displays its green or clear indication.

The timing means provided by this invention is arranged so that it will accurately detect the short "off" period in the 75M code and so that the detector relay 12TRA will not falsely respond to intermittent movement of the track relay contacts.

The track relay contact 18, when picked up, establishes the circuit to supply energy to the timing unit, while the track relay contact 22, when released, establishes the circuit to supply energy from the timing unit to the detector relay. Accordingly, if when the track relay contacts are picked up the supply of energy to the track relay is momentarily reduced or interrupted so that the track relay contacts vibrate without moving all of the way to their released

positions, energy will not be supplied from the timing unit to relay 12TRA as contact 22 of the track relay does not establish the circuit of the relay 12TRA. The contacts of relay 12TRA, therefore, will remain released and will not establish the circuit of relay 12HB.

The timing unit TU is arranged so that it supplies energy of uniform value under varying operating conditions. The transformer 12TA is designed so that its core is quickly saturated when the voltage of the energy supplied thereto is at the lowest value at which the equipment is required to operate. Accordingly, the energy stored in the transformer is substantially constant regardless of voltage variations. Some energy is also stored in the condenser 12Q, and while the amount of this energy is affected by variations in the voltage of the source of energy, the amount of energy stored in the condenser is relatively small compared to that stored in the transformer so that variations in the energy stored in the condenser have substantially no effect on the operation of the unit.

On release of contact 18 and interruption of the supply of energy to the unit TU, the condenser Q and the primary winding of transformer TA form a highly damped oscillating circuit. On each oscillation of the current in the transformer primary winding an impulse of energy is induced in the transformer secondary winding and may be supplied therefrom to the relay 12TRA. Because of the highly damped nature of the circuit of the condenser and the transformer primary winding, the amplitude of the oscillations rapidly decreases and the value of the energy impulses induced in the transformer secondary winding correspondingly decreases and quickly becomes ineffective to keep the contacts of relay TRA picked up.

Fig. 4 is a diagram illustrating the impulses of energy supplied from the timing unit TU to the relay TRA. There is a short time interval between the instant contact 18 of track relay TR opens to interrupt the supply of energy to the timing unit, and the instant at which contact 22 closes to establish the circuit to supply energy from the timing unit to relay TRA. In this time interval the first oscillation in the circuit of the timing unit is started and the voltage of the energy supplied to the circuit of the relay TRA is built up to a high value at the instant that contact 22 closes to complete the circuit of the relay TRA. The first impulse of energy supplied to the relay TRA greatly exceeds the value necessary to pick up the relay TRA. The first impulse of energy supplied to relay TRA soon terminates and a second impulse of energy is supplied thereto. The second impulse of energy does not reach as high a value as the first, but it considerably exceeds the release value of relay TRA so the contact of this relay remains picked up.

There is a short period at the end of the first impulse and the start of the second impulse during which the energy supplied to relay TRA is below its release value, but the rectifier 12RC has a snubbing effect on the relay which maintains its contacts picked up during this interval. In addition, the rectifier controls the polarity of the energy supplied to the relay TRA.

After the second impulse of energy supplied to relay TRA terminates another impulse of energy is supplied thereto, but the oscillation in the timing unit is so reduced in magnitude by this time that the third impulse of energy supplied to the relay TRA is below the value neces-

sary to maintain the relay contacts picked up. Accordingly, the contacts of relay TRA release shortly after the second impulse of energy decreases below the release value of relay TRA.

The effect of the damping on the oscillations in the timing unit is so great that while the second impulse of energy supplied to relay TRA is well above the release value of relay TRA, the third impulse of energy is well below the release value of relay TRA. Furthermore, the wave shapes of the first and second impulses of energy supplied to relay TRA are such that these impulses exceed the release value of relay TRA most of the time. Accordingly, changes in the amplitude of the oscillations in the timing unit have little effect on the time during which the energy supplied to the relay TRA exceeds the value necessary to keep the relay contacts picked up. Instead the time during which the energy supplied to relay TRA exceeds the release value of the relay is determined principally by the frequency of the oscillations in the timing unit. The frequency of these oscillations is determined by the values of the condenser Q and the inductance of the transformer primary winding, and is substantially unaffected by variations in operating conditions.

On movement of the track relay contacts toward their released position contact 18 interrupts the supply of energy to the timing unit and the oscillations in the circuit of this unit start. A short time afterwards contact 22 closes and establishes the circuit to supply energy from the timing unit to the relay TRA. The length of the time from the instant front contact 18 opens and the instant back contact 22 closes is determined by the distance the relay armature must move, and this is affected by adjustment of the relay contacts and by wear on them. However, during this time interval there is no load on the timing unit, and accordingly there is little damping effect on the oscillations in the timing unit, while there is little loss within the unit self. Accordingly, wear on the track relay contacts, and consequent increase in the time between opening of contact 18 and closing of contact 22, has little effect on the energy supplied from the timing unit to relay TRA.

The timing unit also operates so that short circuiting of some of the turns of the transformer primary winding will not objectionably increase the picked-up periods of the relay TRA. If some of the turns of the transformer primary winding are short circuited, the rate of the oscillations in the circuit of the transformer primary winding

will be decreased, and the length of each oscillation will be correspondingly increased. However, the short circuited turns impose a load on the transformer and reduce the energy supplied to the relay TRA. It has been found that if enough turns of the transformer primary winding are short circuited to materially decrease the rate of oscillations in the circuit of the transformer, the value of the impulses of energy supplied to the relay TRA will be reduced so much that the second impulse of energy supplied to relay TRA is ineffective to maintain the relay contacts picked up.

Although I have herein shown and described only one form of apparatus embodying my invention, it is understood that various changes and modifications may be made therein within the scope of the appended claim without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

In combination, a code following relay having contacts movable between a first and a second position, means for supplying to said relay coded energy in which the code components are at times of one length and at other times are of a shorter length, a device including a winding mounted on a magnetic core and a condenser and arranged to form a highly damped oscillating circuit, a source of unidirectional energy, means including a contact of said code following relay closed when the relay contacts are in their first position to supply energy from said source to said device to store up energy therein and on movement of the relay contacts to their second position to disconnect said source from said device to cause current to oscillate in said device, a detector relay having contacts which occupy a picked-up position only when energy in excess of a predetermined value is supplied to the relay, and means including a contact of said code following relay closed when the relay contacts are in their second position and responsive to oscillations in said device for supplying to said detector relay energy the value of which varies in accordance with the magnitude of the oscillations in said device, said device and said detector relay being selected and proportioned so that the energy supplied to said relay as a result of oscillations in said device exceeds said predetermined value for a period longer than a code component of said shorter length but not for a period as long as a code component of said one length.

CARL VOLZ.