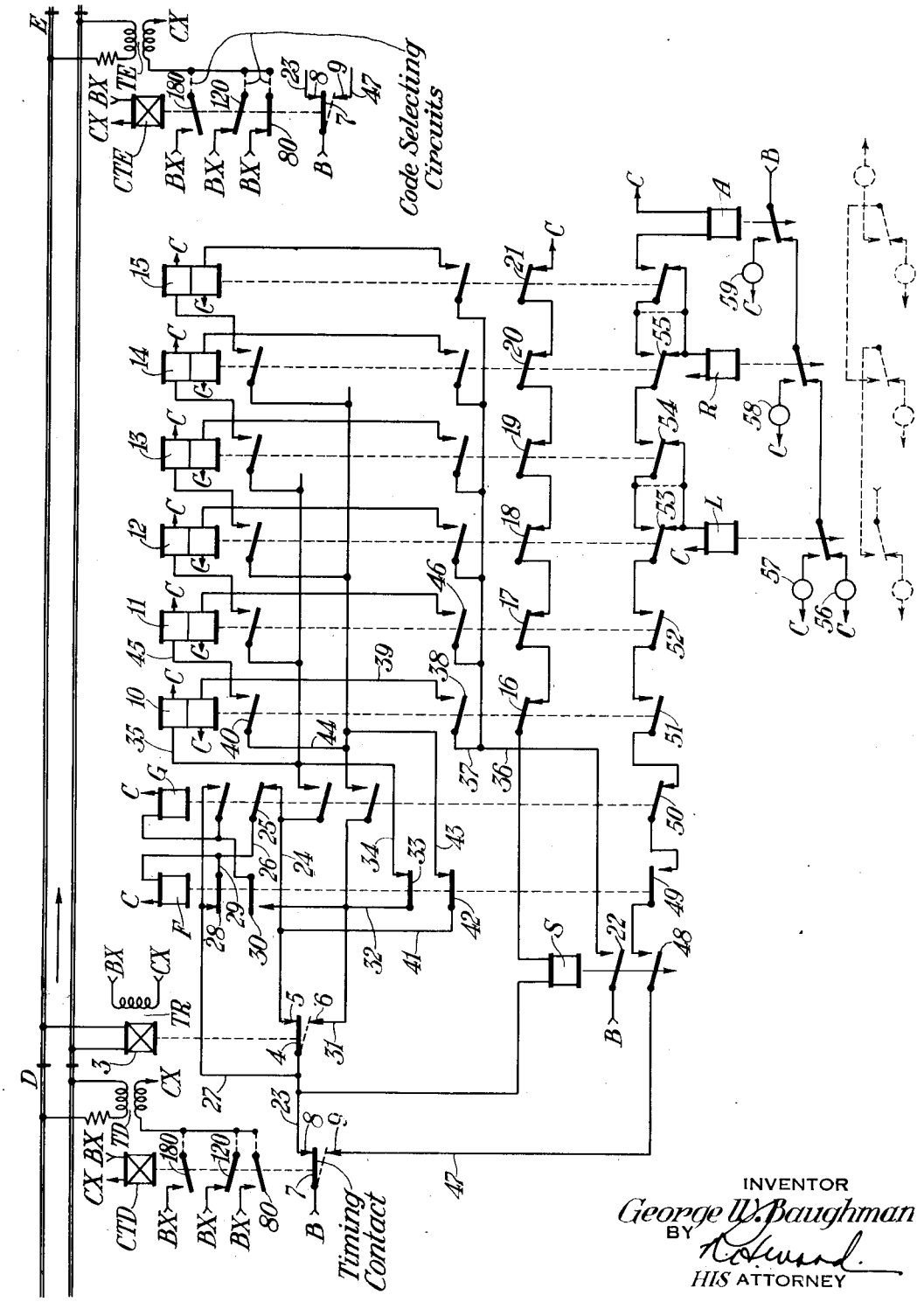
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DECODING APPARATUS AND METHOD

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INVENTOR
George W. Baughman
BY
HIS ATTORNEY

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DECODING APPARATUS AND METHOD

George W. Baughman, Pittsburgh, Pa., assignor to The Union Switch & Signal Company, Swissvale, Pa., a corporation of Pennsylvania

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My invention relates to decoding apparatus and more particularly to apparatus of this character which enables codes such as are used in coded wayside signaling and automatic train control to be decoded by a group of counting relays. My invention also relates to the method of decoding which involves setting up a definite reference time periodically and counting the number of impulses which occur during such reference time.

One object of my invention is to provide a simple and effective method for decoding a "frequency" code by means of impulse counting. Another object of my invention is to provide a relay counting chain comprising relays which may be of the non-safety type for decoding codes of the "rate" or "frequency" type which are distinguished from one another by the number of impulses occurring per unit of time. A further object of my invention is to provide certain safety features and so arrange the apparatus that it will operate with the safety and reliability which is essential in apparatus designed for railway signaling service.

I accomplish the foregoing objects by establishing a definite reference time interval which determines the number of impulses of a given code which can be effective during such time interval and which, in turn, determines the number of counting relays which can operate during the reference interval, thus providing selective operation in accordance with the code being received.

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

The accompanying drawing is a diagrammatic view showing decoding apparatus embodying my invention applied to a section of railway track adapted for coded wayside signaling employing a frequency code.

Referring to the drawing, the insulated section of railway track D—E is traversed by traffic normally passing from left to right, in the direction of the arrow, and receives coded current at its exit end from the track transformer TE, the primary winding of which is periodically energized with alternating current supplied from a source having the terminals BX—CX over one or another of the coding contacts **80**, **120**, or **180** of the code transmitter CTE. The code which is supplied to the track at any given time depends on the traffic conditions in advance of the section D—E. That is to say, if two or more blocks in advance of the section are unoccupied, then 180 code will be supplied; if only one block is unoccupied, the code will be 120; whereas if the block immediately in advance is occupied, the effective code will be 80. The specific code selecting circuits are not shown in the drawing since these are well known and are not essential for an understanding of the invention. It will be sufficient to say that each code transmitter CTE and CTD is so designed that it closes its contacts **180**, **120**, and **80** at the rate of 180, 120, and 80 times per minute, respectively, and that track circuit current coded at one or another of these rates is constantly supplied to the rails of section D—E.

Connected across the rails at the entering end of the section is a code following alternating current track relay TR having a constantly energized local element **2** and a track-connected element **3**. Relay TR will follow the individual impulses of the code supplied to the track and will operate its contacts **4—5** and **4—6** in step with the code. Each code transmitter is provided with a timing contact **7** which is closed for a predetermined time interval and open for another predetermined time interval during each cycle of operation of the code transmitter. If the code transmitter is of the motor driven type, a convenient way of obtaining these time intervals is to employ an additional cam which closes contact **7—8** for the desired portion of the cam revolution and opens it, closing contact **7—9** for the remainder.

For purposes of illustration, I shall assume that one complete timing cycle consumes 1.5 seconds and that of this period, 1.05 seconds represents the time during which front contact **7—8** is closed and 0.45 second represents the time during which this contact is open. The back contact **7—9** will be closed for a time interval slightly less than 0.45 second because of the two transit times of contact finger **7** involved in the movement between the fixed contacts **5** and **6**. These time intervals are chosen for purposes of illustration only and are not to be understood as limiting the scope of the invention in any way.

Starting relays F and G control the operation of the relay counting chain comprising relays **10** to **15**, inclusive, and the energization of one or the other starting relay depends on whether front contact **4—5** or back contact **4—6** of relay TR is closed at the time contact **7—8** closes and the counting begins. If contacts **4—5** and **7—8** are closed, then a pick-up circuit for relay F is established, but if contact **4—6** is closed when contact **7—8** becomes closed, then relay G is picked up. When once picked up, relay F or relay G

remains in the picked up position by virtue of a stick circuit which remains closed until the opening of the timing contact 7—8. The pick-up of one or the other of these relays prepares a pick-up circuit for the first counting relay and for subsequent counting relays, as will appear hereinafter.

The relay S is a slow release relay having a release time slightly greater than 1.05 seconds or sufficient to bridge the closed time of contact 7—8, but less than 1.5 seconds, that is, less than the duration of one timing cycle. Relay S prepares the stick circuits for the counting relay chain. Each counting relay is provided with an upper winding, as viewed in the drawing, which is the pick-up winding, and with a lower or holding winding.

Depending on the number of counting relays picked up during the timing cycle, which depends in turn upon the code then effective in the track, one or another of the signal control relays L, R, A will be picked up, thereby causing the proper signal indication in accordance with traffic conditions in advance to be displayed for traffic entering the section.

By drawing a diagram of each of the three codes to scale, it can be shown that during the assumed time interval of 1.05 seconds, the code following track relay will change its position a maximum of 3 and a minimum of 2 times for 80 code; a maximum of 5 and a minimum of 4 times for 120 code; and a maximum of 7 and a minimum of 6 times for 180 code. That is to say, during the time that the timing contact 7—8 is closed, contact 4—5 or 4—6 of relay TR may close the above number of times, depending upon how far in-step or out-of-step the two code transmitters CTD and CTE may be at the particular time.

Having given the foregoing general explanation, I shall now describe more specifically the operation of the apparatus in decoding the track circuit code. I shall assume that track relay TR is responding to 80 code and that the timing contact 7—8 became closed simultaneously with the closing of front contact 4—5 of relay TR. The closing of contact 7—8 establishes an obvious energizing circuit for relay S which includes the terminals B—C of a source of current and the back contacts 16 to 21, inclusive, of the counting relays connected in series. Pick-up of relay S closes the front contact 22 which prepares stick circuits for the counting relay chain, as individual relays of the chain become picked up in sequence. As shown in the drawing, contact 7—8 has just closed and relay S is ready to pick up.

The simultaneous closing of contacts 7—8 and 4—5 causes energy to be supplied to the starting relay F over a pick-up circuit which can be traced from one terminal B, contact 7—8, wire 23, contact 4—5, wire 24, back contact 25 of relay G, wire 26, and winding of relay F, to the other terminal C of the source. Once relay F picks up, it establishes a stick circuit for itself which includes contact 7—8, wires 23 and 27, front contact 28 of relay F, and wire 29, to the relay winding. This stick circuit excludes contact 4—5 of relay TR, so that once relay F is picked up, it will remain in this condition until the expiration of the full time during which the timing contact 7—8 is closed, as previously pointed out. Pick-up of relay F opens the back contact 30 so that pick-up of relay G cannot occur until the start of a new counting cycle. It is to be noted that if the back contact 4—6 of relay TR had been closed at the time contact 7—8 became closed, then an obvious pick-up circuit would have been established for relay G over back contact 30 of relay F so that relay G rather than relay F would, under that condition, prepare the pick-up circuits for the counting relays.

The pick-up of relay F has no immediate effect upon the counting relays until relay TR releases in response to the first "off" period of the code. At that time, a pick-up circuit is closed for counting relay 10 as follows: from one terminal B, timing contact 7—8, back contact 4—6 of relay TR, wires 31 and 32, front contact 33 of relay F, and wires 34 and 35, to the upper or pick-up winding of relay 10 and the other terminal C of the source. Relay 10 closes a stick circuit for itself over front contact 22 of relay S, wires 36 and 37, front contact 38, and wire 39, to the lower or stick winding of relay 10. Relay 10 will subsequently remain picked up for the remainder of the cycle and will prepare a pick-up circuit for the counting relay 11 at its front contact 40.

Relay 11 will pick up as soon as relay TR again closes its front contact 4—5 in response to the "on" period of the code which marks the second change in position of relay TR. The pick-up circuit includes the timing contact 7—8, front contact 4—5 of relay TR, wire 41, front contact 42 of relay F, wires 43 and 44, front contact 40 of relay 10, and wire 45, to the pick-up winding of relay 11. Once picked up, relay 11 closes a holding circuit for itself over the front contact 22 of relay S and its own front contact 46. Since 80 code has been assumed and since for this code there will usually be two changes of position of relay TR, with a maximum of three changes, during the time that the timing contact 7—8 remains closed, this contact will now open during the "on" code period just referred to and the back contact 7—9 will close. As a result, relay F will release and in so doing will close an energizing circuit for the signal control relay L which may be traced as follows: from terminal B, back contact 7—9 of the code transmitter, wire 47, front contact 48 of relay S, back contacts 49 and 50 of relays F and G, respectively, front contacts 51 and 52 of relays 10 and 11, respectively, and back contact 53 of relay 12, to the winding of relay L and terminal C. If there had been three changes of position of relay TR, the energizing circuit for relay L would have included the front point of contact 53 of relay 12 and the back contact 54 of relay 13. Relay L is of the slow release type and will remain picked up during the counting operation provided that it receives an energizing impulse during an appreciable portion of the time that contact 7—9 remains closed.

Following the opening of the timing contact 7—8, relay S will release at the end of its slow release period and will thereby open the stick circuits for relays 10 and 11 (and any additional counting relays) at its contact 22 so that these relays will release, in preparation for the start of a new counting cycle. When the timing contact 7—8 again closes, the foregoing operations involving the pick-up of relays 10 and 11 will be repeated and relay L will receive the required impulse of energy for maintaining this relay picked up. It should be noted that all of the counting relays must first be released before the pick-up circuit for relay S can become closed. This introduces a checking feature into the apparatus which makes it possible to use counting relays of the non-safety type, thus appreciably decreasing the cost of the apparatus. Starting relays F and G are similarly checked against a

failure in their energized position since the circuits for the signal control relays are carried over back contacts of the starting relays. The track relay TR and the signal control relays L, R, A, should, of course, be of the safety type.

If the traffic conditions are such that 120 code is effective in the section, then under this condition there will be a minimum of 4 and a maximum of 5 changes in position of the track relay TR during the time that contact 7—8 is closed. Accordingly, in addition to the pick-up of counting relays 10 and 11, relays 12 and 13 (and sometimes relay 14) will also be picked up, in sequence, so that a short while after contact 7—9 closes, an energizing impulse will be delivered to the signal control relay R, over the same circuit as previously traced for relay L except that the front point of contact finger 53 of relay 12 will now be closed and the energizing circuit will include the front point of contact 54 of relay 13 and the back contact 55 of relay 14. When 180 code is effective in the section, the additional counting relays 14 and 15 will be picked up so that relay A will receive energy and will remain picked up as long as this code is effective.

By a slight change in the connections as shown dotted in the drawing, all of the relays A, R, and L can be maintained picked up on 180 code, and relays R and L can both be picked up on 120 code, rather than having but one relay picked up on its respective code.

Should a defect develop in the code transmitter CTD so that its operation would slow down, resulting in a substantial increase in time during which contact 7—8 remained closed, a point would soon be reached where relay S would release before contact 7—9 became closed, thus making it impossible for any of the counting relays except the first to pick up. Under this condition, not any of the signal control relays would receive energy so that the fault would be indicated by the display of a "danger" indication at lamp 56 notwithstanding permissive traffic conditions. Lamps 57, 58, and 59 indicate the presence of 80, 120, and 180 code, respectively, in the section D—E and the energization of these lamps will be obvious from the drawing. If the relays L and R are connected as shown by the dotted lines, then the lamps may be connected in the manner shown by the corresponding dotted diagram. The particular devices controlled by relays L, R and A are well-known and form no part of my invention so that detailed description of this portion of the apparatus is unnecessary.

From the foregoing it will be apparent that I have provided means for decoding a frequency or rate type of code by means of a relay counting chain comprising relays which may be of non-safety type and have provided a safe, simple, and reliable arrangement of apparatus for accomplishing this result. Although I have used certain specific codes for illustrative purposes and have described a system employing but three codes, it will be obvious that the apparatus and method embodying my invention may be used for decoding any suitable code of the rate type and that by suitably increasing the number of counting relays, the number of codes which the apparatus is capable of decoding can likewise be increased.

Although I have herein shown and described only one form of decoding apparatus 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. Apparatus for decoding a frequency code comprising in combination, a code following relay responsive to the code being decoded, a timing contact which is closed periodically for a predetermined time interval, a pair of starting relays one or the other of which is picked up when said timing contact becomes closed depending upon whether said code following relay is in its picked up or released position respectively, the respective starting relay remaining picked up thereafter until said timing contact becomes opened, a chain of counting relays, and means including said timing contact, a contact of said code following relay, and a contact of said respective starting relay for causing sequential operation of said counting relays in step with changes in position of said code following relay, the code being determined in accordance with the number of said counting relays operated during said predetermined time interval.

2. Apparatus for decoding a frequency code comprising in combination, a code following relay responsive to the code being decoded, a timing contact which is closed periodically for a predetermined time interval, a pair of starting relays one or the other of which is picked up when said timing contact becomes closed depending upon whether said code following relay is in its picked up or released position respectively, the respective starting relay remaining picked up thereafter until said timing contact becomes opened, a slow release checking relay energized over said timing contact in its closed position and having a release time longer than said predetermined time interval, a chain of counting relays, a pick-up circuit for each relay of said counting chain including said timing contact, a contact of said code following relay and a front contact of said respective starting relay, and a stick circuit for each counting relay including a front contact of said checking relay and a front contact of the respective counting relay, said counting relays operating sequentially one at a time in step with changes in position of said code following relay, each counting relay when picked up closing its own stick circuit and preparing the pick-up circuit for the next counting relay of the chain.

3. Apparatus for decoding a frequency code comprising in combination, a code following relay responsive to the code being decoded, a timing contact which is closed periodically for a predetermined time interval, a pair of starting relays one or the other of which is picked up when said timing contact becomes closed depending upon whether said code following relay is in its picked up or released position respectively, the respective starting relay remaining picked up thereafter until said timing contact becomes opened, a chain of counting relays, means including said timing contact, a contact of said code following relay and a front contact of said respective starting relay for causing sequential operation of said counting relays in step with changes in position of said code following relay, said counting relays remaining operated until the expiration of said time interval, and an indicator effective when said timing contact is open and receiving energy over a circuit which includes a back contact of each starting relay and front contacts of those counting relays which have become operated during said time interval.

4. Apparatus for decoding a frequency code comprising in combination, a code following relay responsive to the code being decoded, a timing contact which is closed periodically for a predetermined time interval, a pair of starting relays one or the other of which is picked up when said timing contact becomes closed depending upon whether said code following relay is in its picked up or released position respectively, the respective starting relay remaining picked up thereafter until said timing contact becomes opened, a slow release checking relay energized over said timing contact in its closed position and having a release time longer than said predetermined time interval, a chain of counting relays, means including said timing contact, a contact of said code following relay and a front contact of said respective starting relay for causing sequential operation of said counting relays in step with changes in position of said code following relay, said counting relays remaining operated until the expiration of said time interval, and an indicator effective when said timing contact is open and receiving energy over a circuit which includes a back contact of each starting relay, a front contact of said checking relay, and front contacts of those counting relays which have become operated during said time interval.

GEORGE W. BAUGHMAN.