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(54) **Device for the protection of track relays from electrical disturbances.**

(57) The object of the invention is a device for protecting track relays (9), controlled by two voltages V_I and V_L having a phase difference of 90°, utilized in so-called "single-track" track circuits.

According to the invention, the supply voltage V_c applied to the track circuit and the local voltage V_L applied to the track relay (9) are supplied through polarity change switches CC and CL.

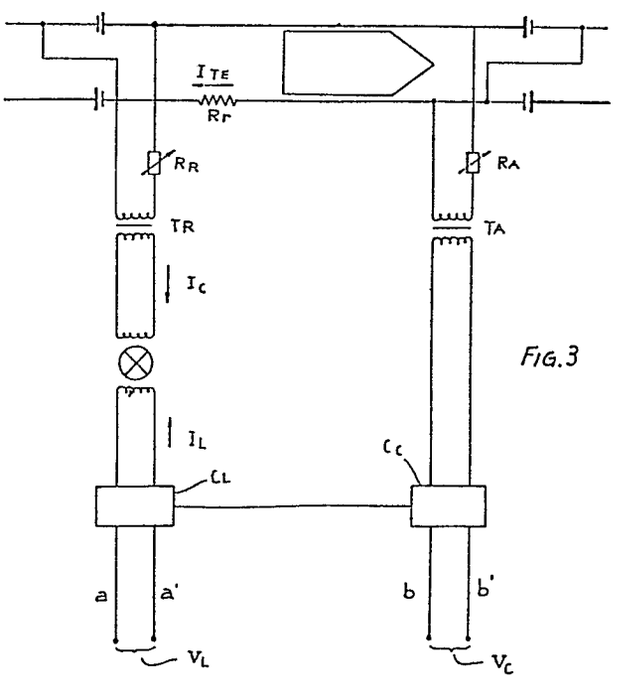

FIG. 3

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DEVICE FOR THE PROTECTION OF TRACK RELAYS FROM ELECTRICAL DISTURBANCES

The object of this invention consists of a device for protecting track relays from electrical disturbances.

The invention is applicable to electromagnetic and/or electronic track relays.

The disturbances which the claimed device is able to eliminate also include electrical vectors identical to those of the signal normally used to energize track relays.

In addition to the above, although in the description given herebelow reference is made to a track circuit of the so-called "single-track" type, the invention may equally be applied to other types of track circuits, whether on lines or in stations, with one or two tracks, and of any length.

It is well-known that for railway signalling, tracks are divided up into sections, each of which is inserted in a corresponding electrical circuit, known as a track circuit.

In general, these track circuits have a coded signal emitter, usually located at one end of each of the above railroad sections, and a receiver for said coded signal, usually located at the other end of the rail-

road section.

If no rolling stock is present on the railroad section in question, the receiver receives regularly the coded signal transmitted by the emitter and this reception is interpreted as confirmation that the line is clear.

If, on the other hand, there is rolling stock on the section, the axles of the locomotive or of the wagons pulled by it short-circuit the track circuit, and the receiver no longer receives the signal from the emitter, or receives a very different signal from the one received when the railroad section is clear.

This second situation is interpreted as a signal that the line is not clear.

This, in principle, is how track circuits operate.

It should however be noted that traction current also circulates in the tracks, and sometimes this current can provide harmonics which may have waveforms, frequencies and intensities similar to those of the current introduced into the track circuit by the emitter. It may happen, although this is not very likely, that the receiver interprets as a "line free" signal a disturbing current which is part of the traction current of the locomotive, a situation which is hardly compatible with the conditions of safety required of a railway signalling system.

The aim of the invention is that of overcoming this problem.

According to the invention, the hypothetical case of a disturbing signal of the track current having characteristics of stability within a suitably selected interval of time is exploited.

Having established this interval of time, arrangements are made to change periodically the polarity of the signal given off by the emitter with a frequency greater than the inverse of the abovementioned interval of time.

In this way it is possible, by making a relatively simple alteration in the track circuit, to recognize a disturbing current which has a frequency, form and base similar to the current generated by the emitter.

The characteristics of the invention are summarized and schematically described in the claims; its objects and advantages are also given in the following description, concerning an embodiment of the invention chosen by way of example only, with particular reference to the attached drawings, in which :

- figure 1 shows a single-track type circuit of the traditional type, that is to say not fitted with the claimed device;
- figure 2 refers to the same known type of circuit al-

ready illustrated in figure 1, and in which it is taken that there is a locomotive on the tracks of the track circuit;

- figure 3 shows a track circuit according to the invention, fitted with the claimed control device, and in the same situation illustrated in figure 2;
- figure 4 is a time diagram of the currents for a traditional type of track circuit;
- figure 5 is similar to figure 4, but refers to the currents which circulate in the track circuit according to the invention;
- figure 6 is similar to figure 5, but refers to the case of traction current containing a disturbing signal similar to the signal emitted by the abovementioned emitter;
- figure 7 is a basic schematic representation of the switches required to implement the device according to the invention.

As mentioned above, figure 1 illustrates a traditional track circuit : in this figure 1 stands for insulating joints which insulate electrically the various segments of rail of each single length. 2 indicates the so-called Z electrical connections which guarantee electrical continuity between the non-insulated parts of the various lengths of rail. In the figure the insu-

lated parts, 3, are shown with thick lines, while the non-insulated parts, 4, are shown with thin lines.

The insulation of the rail makes it possible to implement the track circuit; in effect by applying a voltage between the insulated rail 3 and the ground-rail 4, it is possible to keep a track relay 9 energized, as long as no axle of rolling stock physically enters the ambit of the track circuit; when this happens, the track relay is de-energized as the axle of the rolling stock short-circuits the supply voltage of the track relay 9; in this way the information that the track circuit is occupied by the axle of a rolling stock is obtained (track circuit not clear).

The ground-rails 4, together with the Z connections, 2, allow return of the traction current to the electrical substations.

Thus, in this type of circuit, the traction current runs alternatively along one or the other of the pair of rails.

R_R and R_A indicate the adjustment and setting resistances, which control respectively the power supply and receiving voltages of the track circuit, V_C and V_L.

T_R and T_A indicate respectively the receiving and power supply transformers; these provide galvanic insulation

of the track circuit from the cab electric circuits; the availability of control inlets makes it easy to adjust the supply and receiving voltages to the characteristics of the different track circuits.

The track relay is indicated by 9 and the information which can be obtained from this relay is the following:

- relay energized : the track relay is clear, that is to say no rolling stock is provided on the length of track in question;
- relay de-energized : rolling stock is present on the track relay.

It should be noted that the state of excitation of the track relay 9 is not linked only to the value of the voltages applied to the windings.

The torque (C) which acts on the moving element as it rotates (or the output power from the electronic device which performs the function equivalent to that of the relay) depends on the I_r and I_c (receiving and supply currents) as per the formula :

$$C = K.I_r.I_c.\sin \alpha$$

where α indicates the phase angle between the two currents and K indicates a constant which depends on the type of relay.

This torque is at its maximum, in the direction of excitation of the relay, when the current I_c leads the

current I_L by 90°.

These alternating voltages, are derived from the same source, as they must be absolutely synchronous. Suitable arrangements shall be made to obtain the necessary phase difference required for the track relay to operate correctly.

This may be achieved, for example, by deriving the two voltages from the voltages of a three-phase triad and/or by inserting a suitable capacitator.

Finally, R_r indicates the resistance of the ground-rail 4.

As mentioned above, when the track relay is not clear due to the presence of rolling stock, for example a locomotive, as shown in figure 2, the track relay 9 is de-energized, as the axles of the locomotive short-circuit the track circuit.

The de-energized state of the relay 9 is used as a signal that the length of rails forming the track circuit is occupied, and this signal is used to prevent further rolling stock from being sent towards the same circuit, thus avoiding collisions.

Figure 2 illustrates schematically a case for which, in spite of the presence of rolling stock on the track circuit, undesired energizing of the relay 9 is possible under certain conditions, with the consequence of

a potential danger arising.

Indeed, in spite of the presence of rolling stock on the track circuit, which, as shown in figure 2, short-circuits the V_c power supply current, the relay 9 may be in an energized state if the following circumstances come about :

- the resistance R_r of the ground-rail reaches a sufficient value
- the locomotive emits a disturbing current I_{TE} at a frequency of 50 Hz with a suitable phase difference as compared to the local voltage V_L.

In practice, it is seen that if a disturbing current I_{TE}, at 50 Hz, has the correct phase difference as compared to the voltage V_L, for the relay to be energized it is sufficient for this disturbing current to have a value of 3A (Amperes) and for the resistance R_r to have a value of 0.6 Ohms.

This disturbing current value is considered too low to guarantee safety.

The device covered by this invention makes it possible to raise the minimum disturbing current able to cause undue energizing of the track relay 9, and thus to increase the operating safety of the track circuit.

Figure 3 shows schematically, as indicated above, the solution put forward by this invention, and which con-

sists of the insertion of polarity changing devices between the track relay 9 and the receiving voltage V_L on the one hand, and between the supply voltage V_c and the receiving voltage V_L on the other.

According to the invention, the polarity of the receiving voltage V_L and supply voltage V_c is changed periodically by means of polarity switching devices C_c and C_L.

It therefore follows that when there is no rolling stock on the track circuit, in the case of a traditional track, currents I_L and I_c are represented by figure 4 : they are constantly out of phase by 90° and therefore the track relay 9 is energized : this energized state corresponds to the "line clear" condition of the track circuit.

According to the invention, the presence of the inverters C_L and C_c controlled synchronously gives rise to receiving and supply currents I_L and I_c respectively the polarities of which are changed over at each inversion interval (t_i), as shown in figure 5.

The operating principle of the invention is therefore extremely simple : it is possible that the disturbing current I_{TR} caused by a locomotive might give rise to a receiving current I_L able to simulate the intensity, frequency and phase of the receiving current cor-

responding to the "line clear" condition for a certain period of time (t_1), but it is extremely improbable that this current could change its polarity with the same frequency (1/ti) at which the polarity changing switches C_L and C_c operate.

The least favourable case, which with traditional systems would cause the track relay 9 to be energized, would, according to the invention, attempt to cause periodical energizing and de-energizing at intervals of (t_1) of the track relay; but if the interval (t_1) is suitably selected, that is to say if it is made to be less than the time required for the relay to pass from an energized to a de-energized state, in these conditions the relay 9 cannot be energized.

This is equivalent to supposing that the the disturbing signal may have any phase, intensity and frequency whatsoever, but that it is of a permanent type.

According to the invention, it is presumed that the probability of this disturbing signal being identical to the signal V_L switched at intervals of (t_1) is nil.

In this hypothetical case, should the hazardous case shown in figure 2 occur, in the worst case the waveforms are those shown in figure 6, where I_c represents the disturbing current which simulates the supply current, shunted by the rolling stock present on the

track circuit. It can be seen that during the period (t_1') the two currents are out of phase in such a way that a torque is determined in a direction opposite to that required to energize the relay 9.

During the second period (t_1''), the two currents are again out of phase so as to determine energizing of the relay 9; as mentioned above, however, the intrinsic energizing delay of the track relay 9 is such that it is sufficient to select an interval (t_1) lower than a pre-established value in order to arrange for the minimum receiving voltage able to energize the relays to be higher by a few factors than that required in normal conditions.

Figure 7 illustrates schematically the principle according to which the switches are inserted in the device according to the invention.

With particular reference to this figure, the supply voltage (V_c) and the receiving voltage (V_L) which feed the track relay have different power and amplitude levels; it is therefore necessary to use two reversing circuits (CL and CC) having the function of changing the voltage polarity.

By using two separate reversing circuits, the autodetection characteristic for revealing any faults which may occur in the circuits themselves is ac-

complished : the effect of any fault is that of causing phase differences between the supply (V_c) and receiving (V_L) voltages, and consequently de-energizing of the track relay, that is to say a condition of no danger in the railway signalling.

The change of polarity in each of the two reversing circuits is obtained by means of a bridge (indicated by A in circuits CL and CC of figure 7) consisting of four semiconductors (indicated by 1-1 and 1-2; 2-1 and 2-2 with reference to the two sides of the bridge which conduct alternatively).

The two sides of each bridge are driven by modulation and pilot circuits (B) and coupling transformers (T); the pilot signals consist of series of modulated pulses with certain carrier frequency and cycle characteristics. As the form of these signals is a decisive factor for the correct functioning of the track relays, a modulating signal control circuit (C) is used).

The carrier signal is provided by a high frequency generator (F).

The modulating signal is supplied by a coincidence gate (D) which takes its reference from a current circuit (El) and a current sensor (E) run through by the current which flows from the pole changing switch towards the track circuit : in this way the pilot signals are

synchronized with the time during which the current is nil, in order to control switching when the semiconductors are not conducting.

The separation of the reversing circuits makes is necessary to synchronize the polarity change control, so that the exact phase difference between the supply voltage and the receiving voltage is maintained; this is accomplished by a synchronization circuit (G) which provides the two coincidence and pilot circuits (D) with reference signals.

The synchronization circuit (G) also provides the possibility of piloting further reversing circuits present in lengths of track adjacent to the one where the device is installed, in order to synchronize the signals of the adjacent track circuits and achieve the characteristic of automatic detection of insulation loss existing between adjacent lengths of track (insulating joints).

Although for descriptive reasons this invention is based on the above specification, and is illustrated, by way of example only, with particular reference to the attached drawings, many modifications and variations may be made in the embodiment of the invention. Any such modifications and variations shall however be deemed as being based on the following claims.

CLAIMS

1

Device for the protection of track relays, electrodynamic and/or electronic, driven by two voltages having a phase difference of 90°, utilized in track circuits of the so-called single-track type, with a high signal/disturbance ratio, characterized in that the supply voltage applied to the track circuit and the receiving voltage applied to the relay are supplied through polarity changing switches.

2

Device for the protection of track relays, according to the preceding claim, characterized by the fact that said polarity changing switches are fitted with means for reversing the two voltages of the track circuit in accordance with a pre-established interval and in a synchronized manner.

3

Device for the protection of track relays, according to the preceding claims, characterized in that this inversion period is lower than the time required for the track relays to operate.

4

Device for the protection of track relays, according to

the preceding claims, characterized in that the signal/disturbance ratio in the track circuit is raised to considerable levels using the polarity change switches.

5

Device for the protection of track relays, according to the preceding claims, substantially implemented and installed as described and illustrated by way of example only, with particular reference to the attached drawings.

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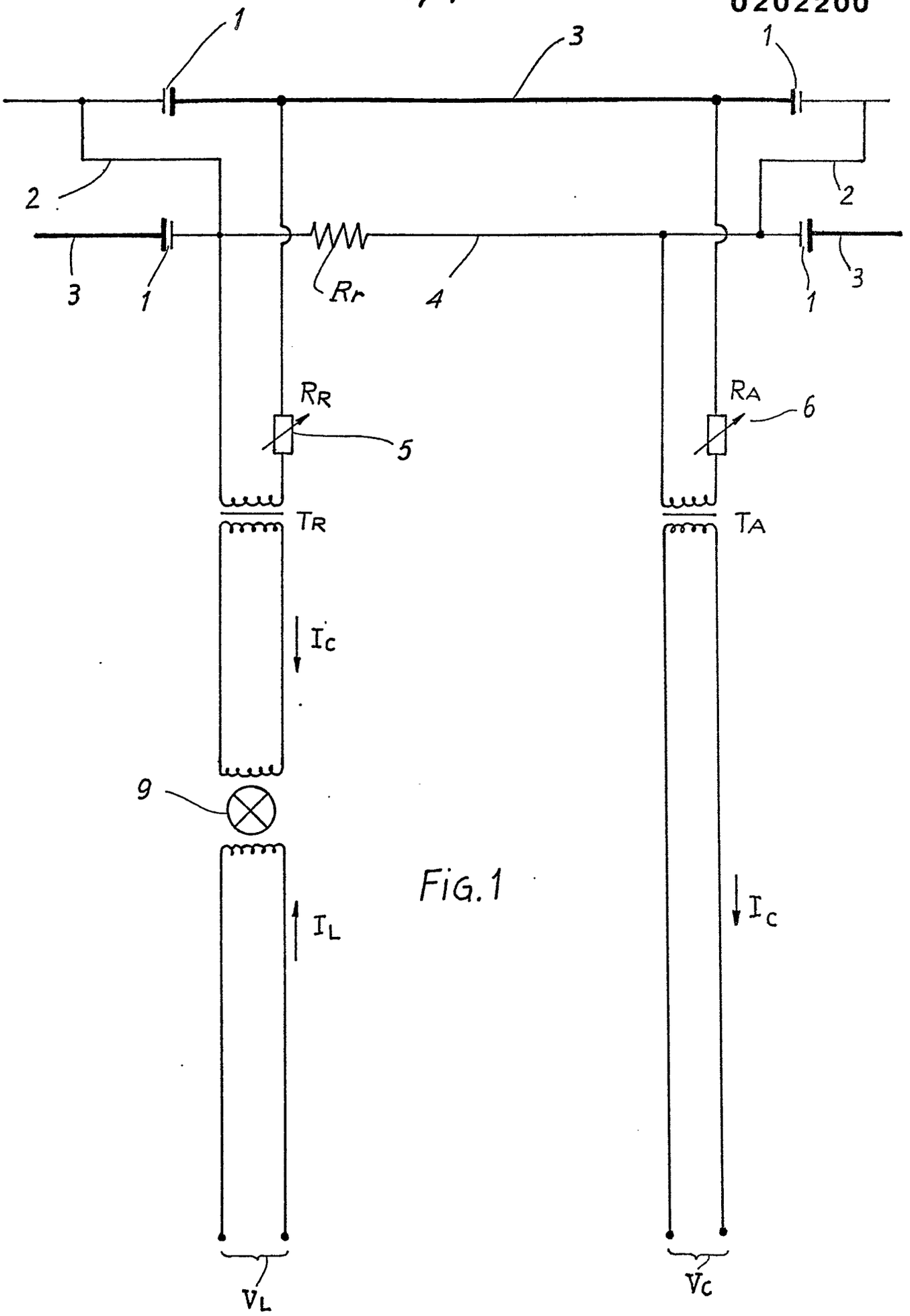


FIG. 1

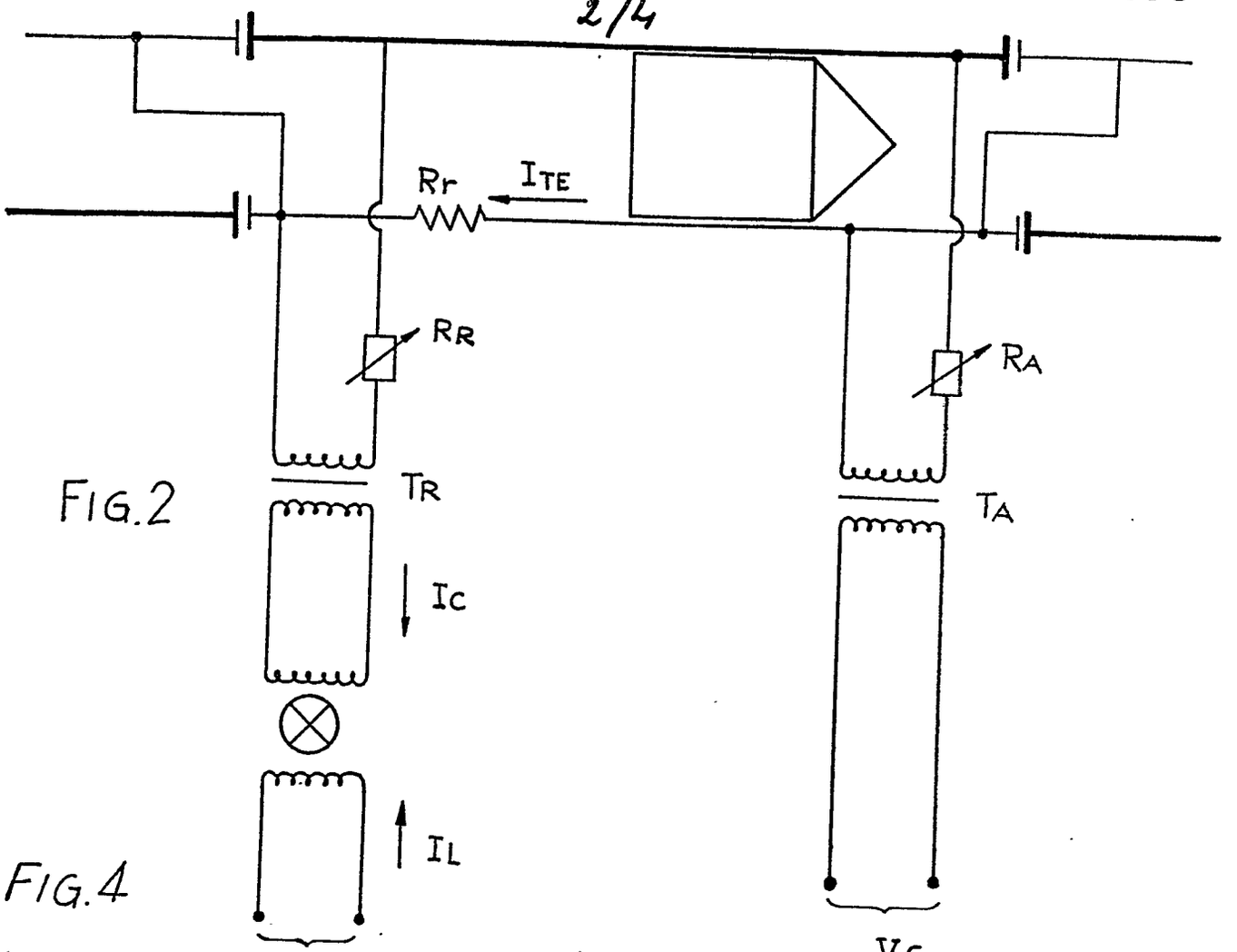
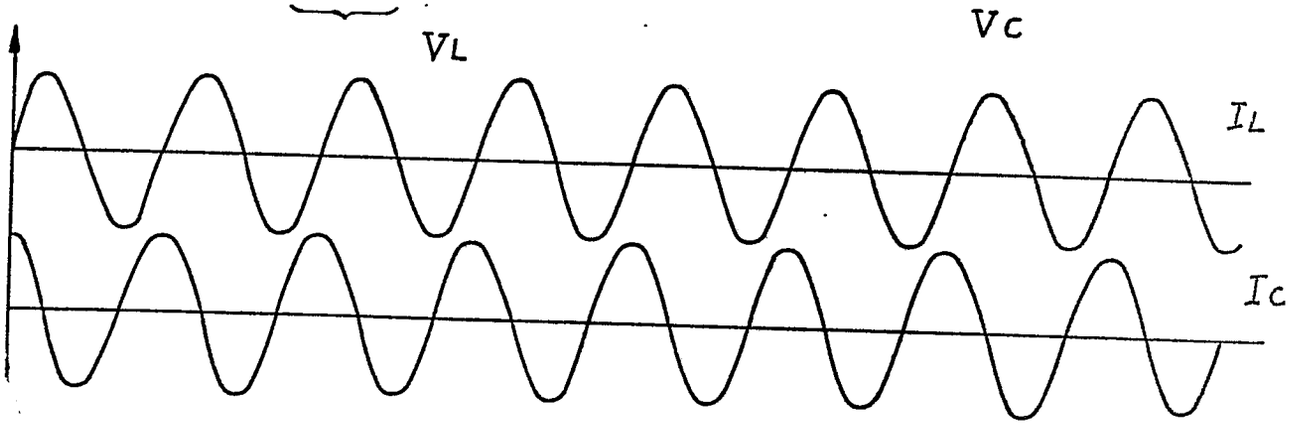


FIG.2

FIG.4



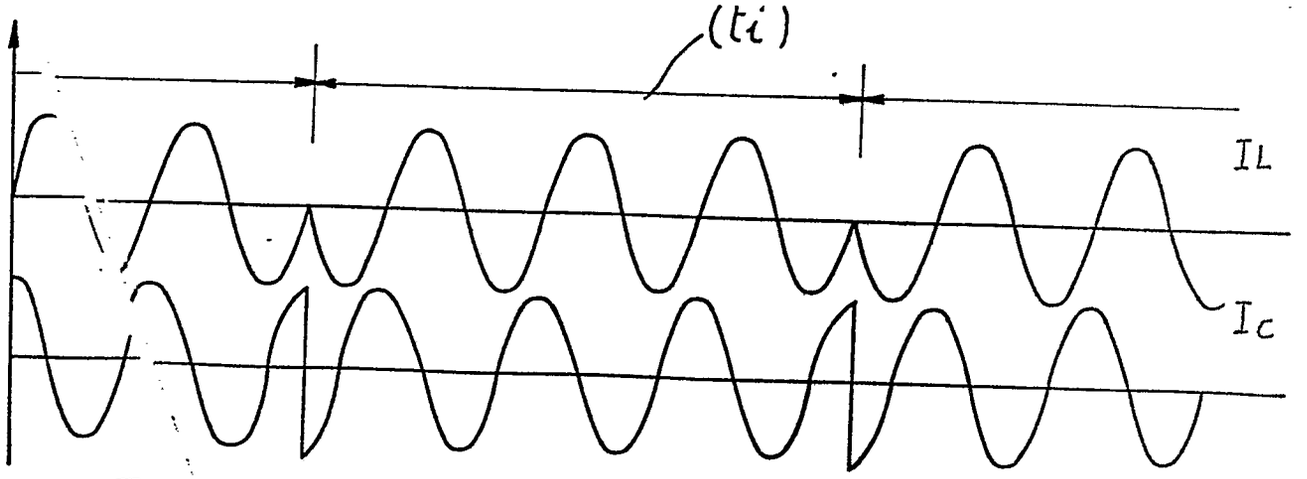


FIG.5

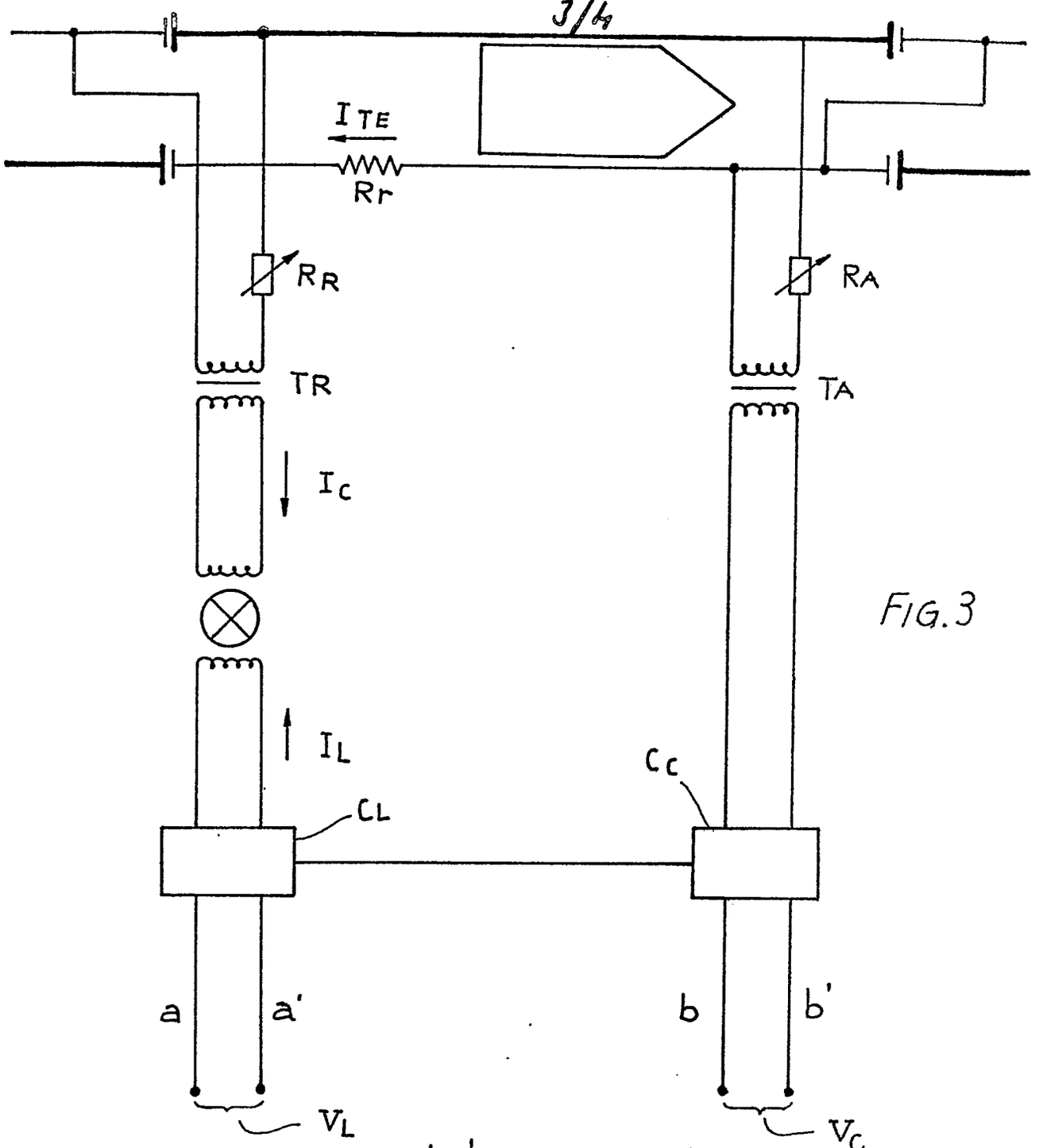


FIG.3

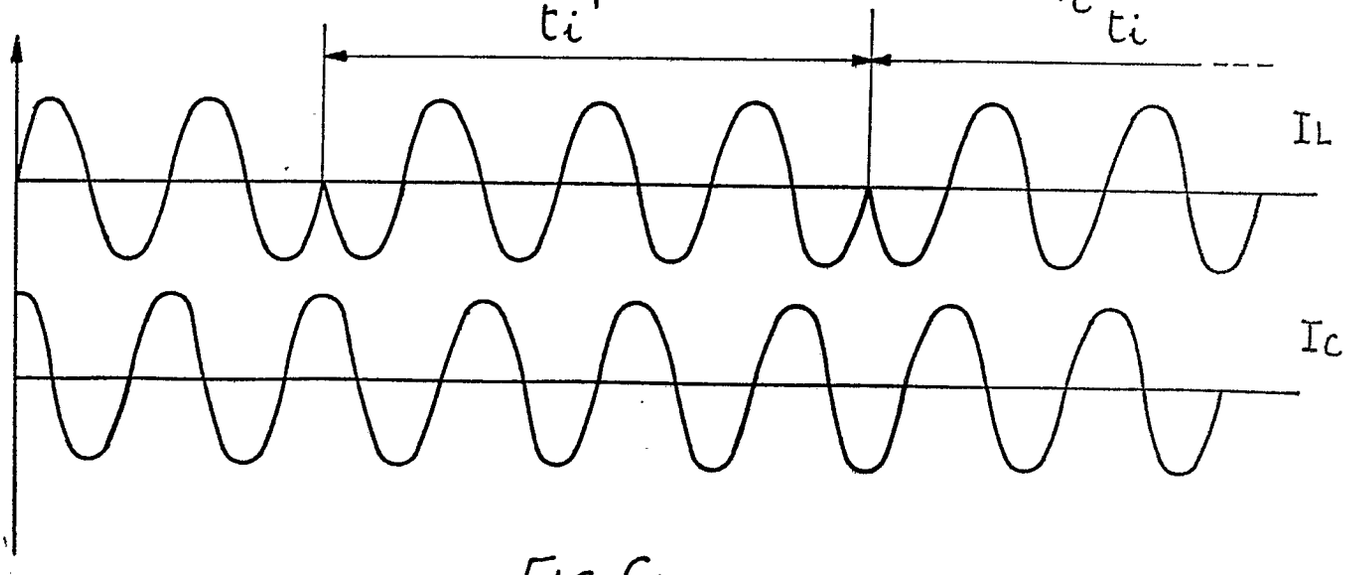


FIG.6

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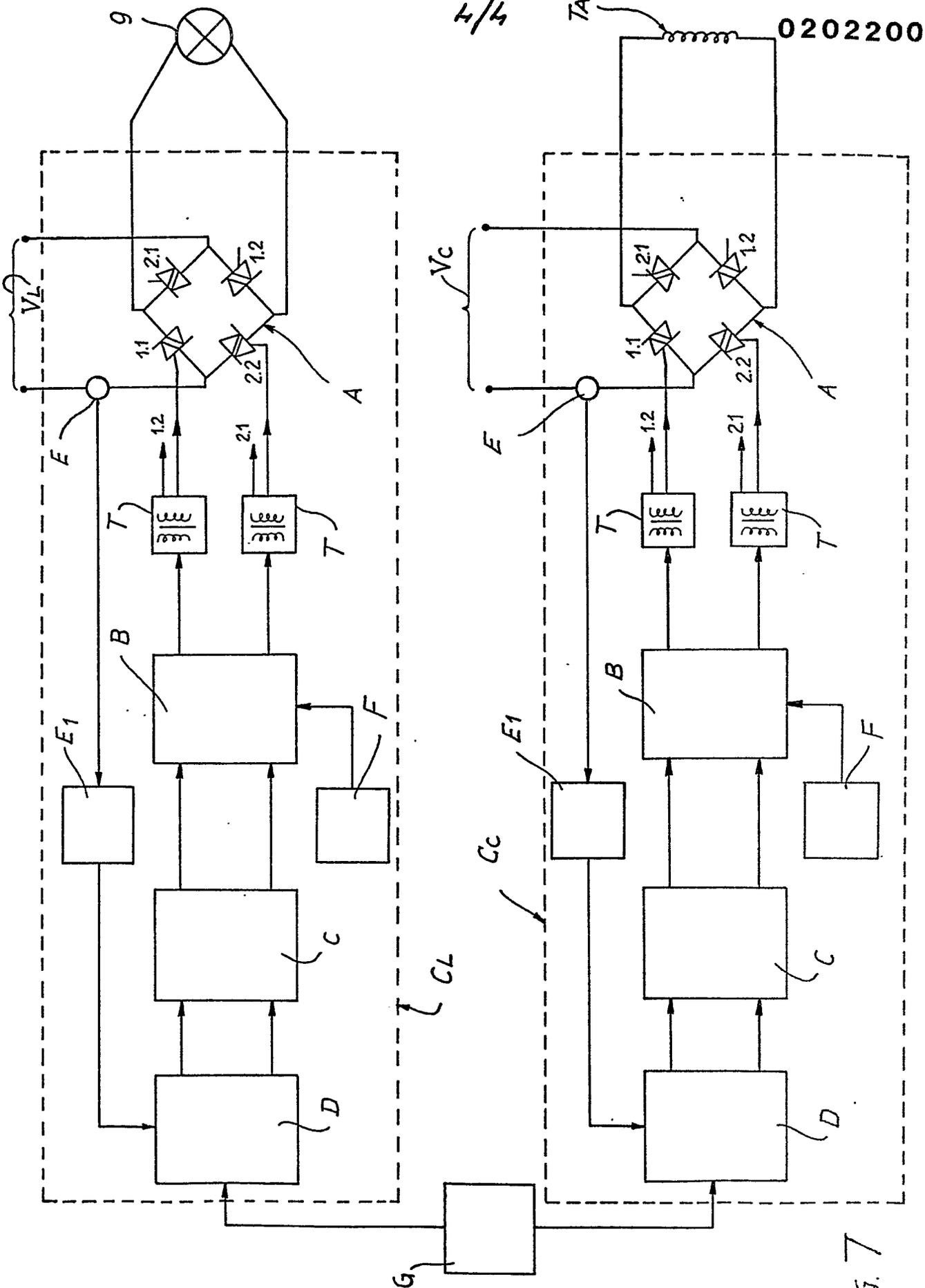

FIG. 7