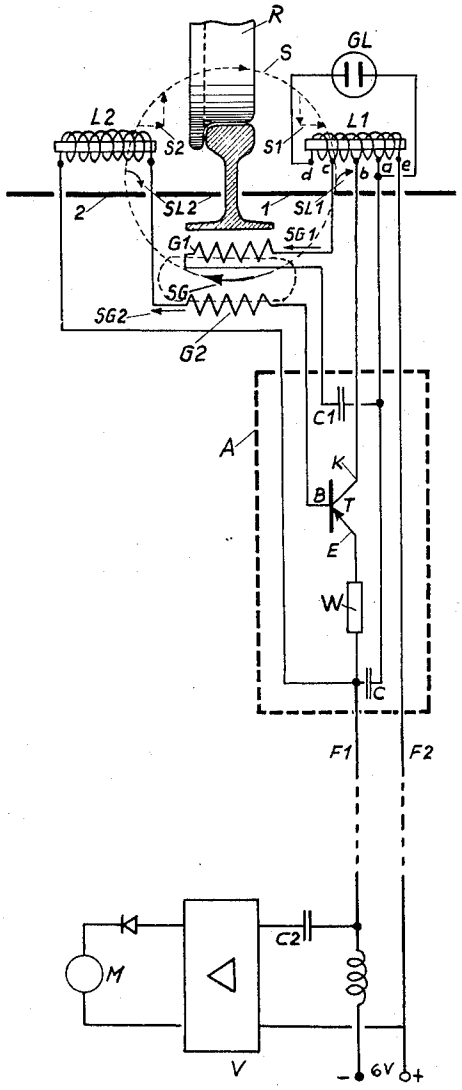
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RAILROAD SIGNALLING

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RAILROAD SIGNALLING

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This invention relates to railroad signalling and is particularly concerned with a device for signalling the presence of trains along a track.

The art of railroad signalling uses for the control, by trains, of stationary signal apparatus disposed along the track, mechanically actuated contact means, for example, contact means actuated responsive to the flexing of rails, and frequently also magnetically or inductively controlled devices. The latter may be used, for example, in installations for counting the axles of trains wherein the passing wheels affect the stationary apparatus. The advantage of the magnetically controlled devices is that they provide for reliable operation even with high train speeds. The mechanical contact devices must be disposed directly at the rails and are thus subjected to shocks and dangers of the traffic as well as to the elements. This disadvantage is avoided by inductively controlled devices because only those parts need be disposed at the rails which are directly inductively affected while the devices which are controlled by the inductively produced or altered current may be located, protected against shocks and the elements, in switch casings along the track or within signal towers.

Prior inductively controlled devices comprise, for example, a U-shaped iron element embracing a rail, carrying upon one leg a transmitter coil supplied for excitation by alternating current, and carrying upon the other leg an inductively coupled receiver coil, the coupling factor being amplified by train wheels passing along the space between the coils. Arrangements of this kind are unfavorable because the alteration of the signal voltage corresponds only to the slight alteration of the coupling factor.

The invention provides for a considerable improvement by disposing one coil in the oscillation circuit of a self-excited generator while disposing the other coil in the feedback circuit thereof; the feedback being so adjusted that the oscillations either cease or start when the coupling of the coils is affected by a passing train. Even if the least alteration of the coupling that may have to be considered amounts, for example, to 20%, the signal voltage, in such arrangement, will be altered by 100%. It is advisable to use a plural-stage generator which may be equipped with tubes as well as with transistors. The desired working point of the generator may be easily set by adjusting the feedback.

A still more favorable arrangement results from the provision of an adjustable capacitive or inductive opposed coupling that may be disposed either completely shielded against exterior affects within the generator casing or else disposed unshielded at a rail. In the latter case, coils used for the opposed coupling may be disposed, for example, alongside or underneath a rail in such a manner, that the opposed coupling is only slightly altered by the parts which affect the feedback, while interference fields that may be produced, for example, the field produced by currents flowing through the rails induce in each opposed coupling coil and the respectively

associated feedback or oscillation circuit coil opposed voltages, so that the interference effects are compensated when the respectively associated coils are connected, for example, in series. The series connection also gives greater security for the cessation of oscillations responsive to any kind of line disturbance.

Interference fields may also be compensated in this manner by reversed arrangement of parts, namely, by disposing the feedback coils underneath the rails while disposing the opposed coupling coils within the control areas.

If the degree of coupling of the coils is improved by the passage of the train, the two arrangements will differ only insofar as working current operation will result responsive to effecting the feedback upon start of the oscillations of the generator, while resting operation would result upon effecting the opposite coupling responsive to cessation of the oscillations.

In order to stabilize the arrangement so far as temperature fluctuations are concerned, which may amount to 100° C. at the rails, the invention proposes to dispose the temperature-sensitive parts, for example, transistors, underground. In order to gain access to these parts in case of trouble, the invention provides near the corresponding control area a tube or pipe extending into the ground for a least 0.5 m. The parts in question are contained within another sealed tube which may be placed into the pipe. The corresponding arrangement is also to be recommended for other temperature-sensitive devices used in railroad signalling, for example, for relays cooperating with rectifiers or amplifiers disposed along the tracks.

This also applies to devices provided according to the invention for protection against overloads, caused, for example, by the effect of lightning upon open air lines. Such overloads are made harmless by connecting, parallel to the devices to be protected, a glow lamp over a transformer which increases the voltage.

The generator constitutes a frequency changer, and a plural utilization of the lines required between the affected area and the observation point is accordingly possible by using the same lines for the supply of the current for the self-excited generator and for the supervision of the current produced by the generator and corresponding to the signal. If there are several affected areas, for example, two independently affected generators for the counting of axles in accordance with directions of train travel, a single pair of lines will suffice for the current supply and for the supervision, provided that the generators are tuned to different frequencies.

The invention proposes to provide, particularly in connection with such self-excited generators and also in connection with known exteriorly excited transmitter coils, frequencies exceeding 500 cycles, preferably from 5 to 10 kc. At such frequencies, the shifting of the flux coupling the coils, by eddy currents which are induced in the affected parts, is greater than the possible increase of the magnetic conductivity between coupled coils that may be caused by the corresponding parts. When the coils are operatively affected, a weakening of the coupling will result instead of an increase as in the prior devices. The result is that effects sufficient for the signal transmission will be obtained not only by iron parts, for example, by train wheels, but also by other parts moving through the coupling flux, for example, by magnetic rail brakes, even if they do not move along the rails. The use of frequencies higher than until now customary results in the further advantage that the operative affect will extend over several cycles even with highest train speeds.

The coils affected by passing trains are advantageously provided with cores adapted to focus the coupling flux,

This may be achieved, for example, by cores having a length at least four times the core diameter. Known ferrites with as high a permeability as possible are especially suitable particularly with frequencies on the order of around 10 kc. If the exciting and the excited coils are fastened on a rail independently, for example, each with its own fastening device, there will be added security for reliable operation because, in case the fastening means should be destroyed, the coupling will not suffice for the transmission of the required signal voltage.

The foregoing and other objects and features of the invention will appear from the description of an embodiment which is rendered below with reference to the accompanying diagrammatic drawing.

The drawing shows in its upper portion a single stage self-excited generator including a transistor T connected in emitter circuit. Between the collector K and emitter E is connected only a part of the coil L1 extending from the points *a* and *b*, the circuit including a resistor W and a capacitor C. The coil L1 forms with an opposing coupling coil G1 the oscillation circuit extending from the terminal points *a* and *c* and including a capacitor C1. The coil L1 is disposed at one side of a rail shown within the dotted circle S and a coil L2 is disposed at the other side thereof, the latter coil (L2) being in series circuit with an opposed coupling coil G2. The feedback and the opposed coupling are so arranged that the generator oscillates normally with a frequency of 5 kc. The coils L1 and L2, due to their arrangement relative to the rail, have a coupling factor K1. The coupling factor KG of the coils G1, G2 is adjusted so that the transmitted opposing voltage is normally lower than the feedback voltage corresponding to the coupling factor K1, thus causing the generator to oscillate. Appearance of a wheel R affects the arrangement so as to increase the value of the opposing voltage above the value of the voltage corresponding to the coupling factor K2 of the coils L1 and L2, at least to a point at which the resulting voltage for the auto-excitation is insufficient. The result is that the oscillations cease with certainty responsive to the passage of a wheel R. When the wheen R leaves the affected area, the voltage resulting from the opposed coupling and the feedback coupling will again be sufficient to start oscillation of the generator. Cessation of the oscillations interrupts transmission of the signal voltage from the terminal points *a* and *e* of the coil L1 to the feed lines F1 and F2, causing deenergization of a relay M which is connected to the line F1 and F2 by way of a capacitor C2 and an amplifier V. Deenergization effects in suitable and desired manner (not illustrated) corresponding signalling.

The illustrated arrangement operates in accordance with the resting current principle, the current produced by the generator and supervised by the relay M being interrupted responsive to passage of a wheel R. If operation in accordance with the working current principle is desired, assuming the same frequency used, the coils G1, L1 and L2, G2, respectively, may be interchanged. The opposing coupling and the feedback coupling may in such case be adjusted so that the voltage resulting normally from the coupling factors K1 and KG does not suffice for maintaining oscillation of the generator. However, appearance of a wheel R will reduce the coupling factor KG causing the generator to oscillate until the wheel has passed.

The resting current circuit shown in the drawing may also be converted to operate as a working current circuit, and the explained working current circuit may be converted to operate as a resting current circuit, respectively, by employing generator frequencies lower than 500 cycles in which case the iron mass of a wheel will increase the coupling factor of the coils L1 and L2.

As shown in the drawing, the opposing coupling coils are arranged at the rail. Interference voltages induced in the coils L1 and L2 are compensated by the field of driving currents. For this purpose, the coils G1 and G2 are, for example, arranged underneath the rail in such a manner that the components SG of an interferring field S indicated as a circle will induce interference voltages SG1 and SG2 as indicated by arrows. These interference voltages operate opposite to the interference voltages SL1, SL2 induced by the components S1 and S2 in the coils L1 and L2. It is possible, with proper dimensioning of the coil windings and arrangement of the opposing coupling coils to effect cancellation of the interference voltages. The arrangement of the coils G1 and G2 underneath the rail avoids or at least reduces disturbance of the coupling thereof by passing wheels, to a negligible point.

Character A indicates a shielding pipe or tube containing parts of the generator circuit including the transistor T, resistor W and capacitors C1 and C. This pipe which is disposed at least 0.5 m. underground, protects the corresponding parts against temperature fluctuations. The pipe may also accommodate devices for the opposing coupling, for example, if coils L1 and L2 are used with their axes extending in parallel to the rail. In such case, the field resulting from rail currents will not induce interference voltages in the corresponding coils. Disposal of such devices within the protecting pipe is also recommended in the case of installations in connection with non-electric railroad operation, using coils extending perpendicular to the rail, in which case the fields produced by track supervising currents or the like cannot induce any noticeable interference voltages.

The arrangement according to the invention also provides shielding sheets 1, 2 disposed underneath the coils L1, L2. These sheets are made of electrically conducting material and provide a downward limit for the space within which the field produced by the coils can propagate. The inductivity of the coils is thereby made lower and their coupling factor higher, because the opposing inductivity of the coils which largely depends from the coupling flux above the rail, is not reduced to the same extent. It follows, therefore, that a passing wheel produces a greater relative alteration of the coupling factor than in the absence of a shielding sheet.

If a greater alteration of the coupling for the alteration of the oscillation condition of the generator is not required, the coils may be disposed relative to the rail lower than was heretofore customary. As shown in the drawing, they may be disposed at the level of the rail crown or even lower, at levels where they are better protected against mechanical damage than coils which project above the level of the rail crown. It is for the same reason suitable to arrange the coils, with or without shielding sheets, so that their axes form an angle to the horizontal, that is, so that the parts facing away from the rail are disposed at the lower level.

Reference GL indicates a glow lamp serving to protect the transistor T against overloads that might occur, for example, during atmospheric storms upon open air lines F1 and F2. The direct current input for the transistor could, of course, be protected by a filter chain comprising suitable capacitors; however, this expedient cannot be applied so far as the output side of the transistor is concerned because such side is used for the transmission of the signal voltage to the line. The transformer-like coupling indicated in the drawing also transmits frequencies such as occur frequently during lightning. The customary overload devices operate at voltages exceeding about 350 v., at which the usual transistors for peak voltages up to about 30 v. would be destroyed. Fuses are likewise unsuitable for the protection of transistors because they require a relatively high trigger current and also because they respond too slow due to inertia. The firing potential of glow lamps or gas discharge lamps suitable for overload protection, amounting to 130–150 v., indeed also exceeds the permissible peak volt-

age of transistors. However, the use of such glow lamps is in accordance with the invention possible, by placing the transistor between the taps *a* and *b* of the oscillation circuit coil, while connecting the glow lamp GL to the taps *d* and *a*. The glow lamp is accordingly on a considerably higher potential. The glow lamp, connected as indicated, cannot ignite in normal operation, that is, with 6 v. at the transistor and a voltage, for example, of 100 v. at the oscillator circuit. However, in case a voltage of 12 v. should appear at the transistor due to atmospheric causes, its peak voltage will not yet have been reached but at the oscillation circuit there will be a voltage of 200 v. which will ignite the glow lamp and thus prevent a further increase of the potential.

So far as protection of the transistor is concerned, it would suffice to connect the glow lamp in parallel to the oscillation circuit. The circuit as shown provides for additional potential increase between the oscillation circuit and the glow lamp and thereby also serves to protect the capaictor C1 against overload.

Changes may be made within the scope and spirit of the appended claims.

I claim:

1. In the art of railroad signalling, a device for producing signalling impulses responsive to the passage of wheels of a train along a rail of desired track section, said device comprising an oscillator means having an inductive feedback coupling circuit including a first pair of coils and an opposing coupling circuit including a second pair of coils for generating a varying current, said first pair of coils disposed above ground approximately at the level of the crown of said rail and relatively closely adjacent thereto, the oscillation of the oscillator means being inductively affected by the passage of said wheels, a souce of current, circuit means for connecting in an electrical circuit said source of current to one coil of said first pair, a signalling relay connected in an electrical circuit to said last named circuit means, said inductive feedback circuit comprising means for connecting predetermined turns of the winding of said one coil in said first pair in series with the winding of one coil of said second pair and further comprising feedback circuit means for connecting the winding of the second coil of said first pair in series with the winding of the other coil of said second pair of said oscillator means, whereby wheels of sad train passing over said rail effect by induction predominantly the coupling of the coils of the first of said pairs to alter the total coupling factor resulting from said feedback coupling circuit and said opposing coupling circuit and effect operation of said signalling relay for the purpose of signalling the passage of said wheel of the train relative to said device.

2. The device and cooperation of parts according to claim 1, wherein the coils of said first pair extend with their axes perpendicularly to the longitudinal direction of the rail, and wherein the coils of said second pair extend with their axes likewise perpendicularly to the longitudinal direction of the rail.

3. The device and cooperation of parts according to claim 2, wherein the coils of said second pair are spaced from the rail by an amount which exceeds the spacing of the coils of said first pair from the rail.

4. The device and cooperation of parts according to claim 2, wherein the coils of said first pair are disposed one on each side of the rail, and wherein the coils of said second pair are disposed below the rail, and means for shielding said second pair of coils against the inductive effect caused by the passage of wheels of the train.

5. The device and cooperation of parts according to claim 2, wherein said oscillator is a self-excited normally oscillating oscillator which maintains said signallng relay normally energized, the alteration of the total coupling factor effected by the passage of wheels of the train causing interruption of said oscillations and consequent deenergization of said relay to signal the passage of said wheels.

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