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RAIL FLAW DETECTOR MECHANISM

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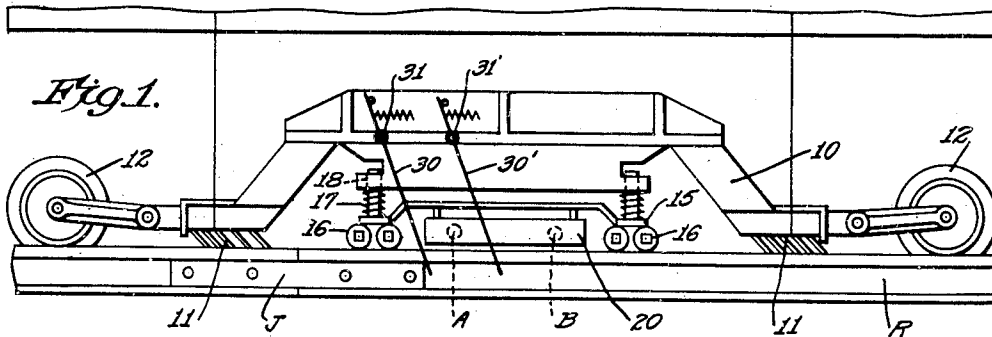


Fig. 2.

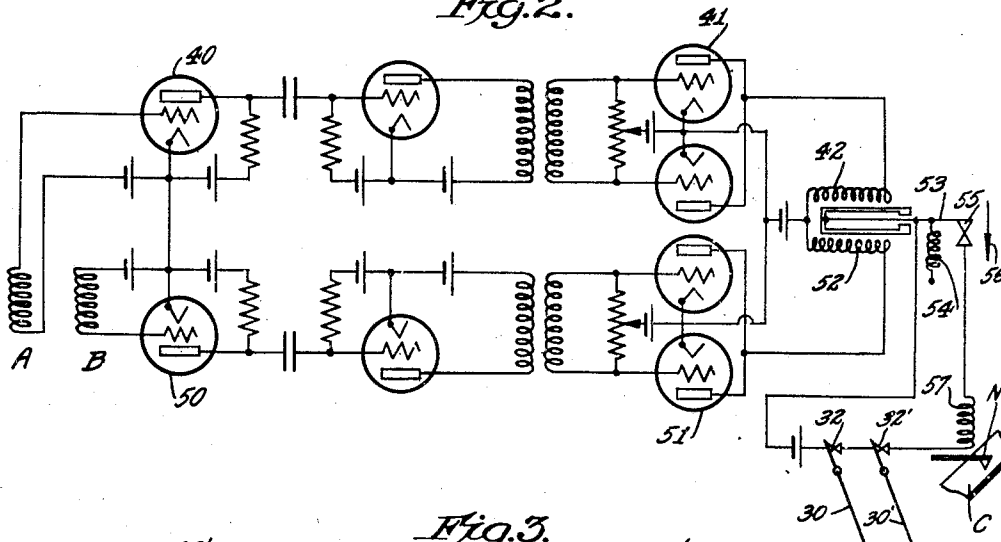
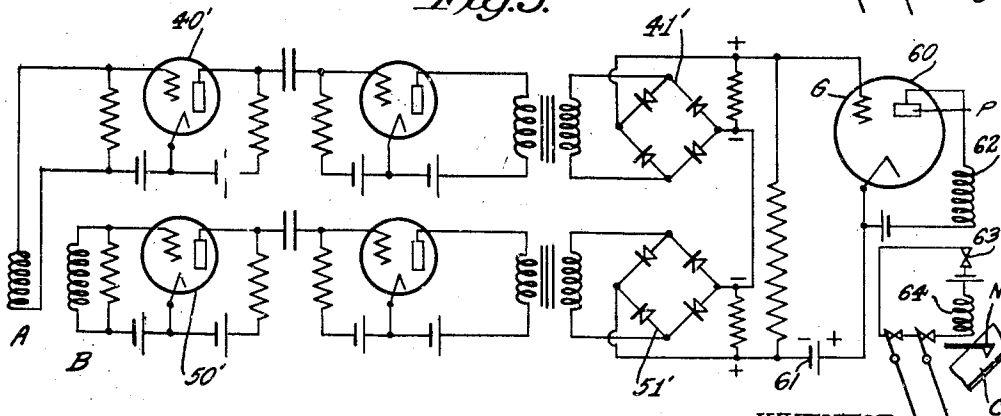


Fig. 3.



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RAIL FLAW DETECTOR MECHANISM

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This invention relates to rail flaw detector mechanism of the type employed on the Sperry rail flaw detector cars. Such cars are provided with means for energizing the rail by passing electric current through the rail to establish an electromagnetic field surrounding the same, and exploring the field irregularities caused by the presence of internal defects within the rail. For such exploration purposes one or more pairs of induction coils are passed along the rail head at a constant distance therefrom, the coils of each of said pairs being arranged in tandem lengthwise of the rail and oppositely connected so that normally no differential E. M. F. is generated even when the current supply changes, or the distance of the coils above the rail head is varied, because both coils respond equally and oppositely. On entering a region of flaw, however, each coil in succession cuts a different number of lines of force from that cut by the other coil to generate a differential E. M. F. which, after being suitably amplified, is caused to operate indicators such as a pen on a moving chart within the car and a paint gun for squirting paint on the rail in the region of flaw.

From the above description of the operation of the Sperry rail flaw detector mechanism, it will readily be understood that at a rail joint which consists of angle bars, bolts, etc., in addition to the rail ends, the flux surrounding the joint is increased in density, and therefore the leading coil of a pair of detector coils, on approaching the rail joint, will encounter an electromagnetic field of increased flux density to cause the generation of a differential E. M. F. in the same manner as an internal defect. Similarly, on leaving the rail joint there would be generated a differential E. M. F. which is not due to an internal defect. Since this is undesirable, the Sperry rail flaw detector cars are provided with joint cutout fingers such as shown in my Patent No. 2,069,030, granted January 26, 1937, positioned in advance and to the rear of the detector unit so as to cut out the indicating mechanism when the leading coil of the detector mechanism reaches the increased flux density caused by the joint, and to maintain said indicating mechanism ineffective until the last detector coil has passed beyond said region of increased flux due to the rail joint.

Since the coils are arranged in tandem and the cutout mechanism begins to function when the leading coil approaches the region of increased flux caused by the rail joint and remains effective until the last coil has passed beyond the region of increased flux caused by the rail joint, there is

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necessarily a portion of rail adjacent each end of the angle bar which remains untested, and in these untested regions internal rail fissures sometimes occur. The length of these untested portions is equal to the distance between the rail joint end and the leading coil occupied by the region of increased flux due to the rail joint, plus the overall distance of the coils. It is the principal object of this invention therefore, to provide means which will enable a rail flaw detector mechanism such as that employed on the Sperry rail flaw detector cars to test closer to the rail joints than has heretofore been possible, that is to say, the indicating means is rendered ineffective for a shorter distance at each end of the angle bar than is at present possible.

Further objects and advantages of this invention will become apparent in the following detailed description thereof:

In the accompanying drawings,

Fig. 1 is a side elevation of a portion of a rail fissure detector car having my invention applied thereto.

Fig. 2 is a wiring diagram of one embodiment of my invention.

Fig. 3 is a wiring diagram of a modified form of my invention.

Referring first to Fig. 1, there is shown the main carriage 10 of a Sperry rail fissure detector car. The carriage is suspended from a car body not shown, within which there is a generator which supplies current to front and rear sets of current brushes 11. The carriage rides on the rail R on wheels 12. Suspended from the main current brush carriage 10 is a detector carriage 15 which rides on the rail by means such as wheels 16, said detector carriage being supported on the main carriage 10 by means such as bolts 17 extending loosely through openings 18 on the main carriage so as to provide a certain amount of universal movement to permit the detector carriage to align itself in accordance with the variations in the contour of the rail. The detector carriage 15 carries a housing 20 within which are mounted a plurality of induction coils such as A and B. By the arrangement just described, the coils A and B will maintain their parallelism with the rail surface and will normally cut a constant number of lines of force in the electromagnetic field set up around the rail R by the current passing between sets of brushes 11. On entering a region of flaw, first coil A and then coil B will cut a different number of lines of force, and this difference in the number of lines of force cut by the detector coils is utilized to operate a recorder in the form of a

pen N on a chart C within the car body, and also to energize a paint gun relay to spray paint on the rails in the region of the flaw.

As stated in the introduction hereto, it has heretofore been the practice to make coils A and B of equal inductance, and to connect them in series opposition so that variations in the current supply or variations of the height of the detector housing 20 relative to the rail surface which affected both coils, would affect them equally and oppositely, and thus no differential E. M. F. would be generated. However, on entering a region of flaw, first one and then the other coil would cut a number of lines of force different from the number cut by the other coil, and thus generate a differential E. M. F. One of the difficulties inherent in this system is that presented by rail joints. Referring to Fig. 1, it will be seen that a rail joint J joining the rail ends and comprising an angle bar and bolts sets up a variation in the electromagnetic field which begins to affect the approaching detector coil A several inches before the coil has reached the joint, and continues to affect the pickup coils until they pass a distance beyond the joints J to a point where the joint no longer sets up variations in electromagnetic field. Therefore, there were provided joint fingers which operated as described in my said Patent No. 2,069,030, to cut out the indications at a time beginning just before the coil A reached the field of distortion set up by the rail joint. Thus, a joint finger 30 sliding along the rail head engaged the projecting joint J and was pivoted around its pivot 31 to cause short-circuiting of the indicator mechanism, as for instance, by opening contacts 32. Since the finger 30 rode off the joint J in advance of coils A and B, and since it was necessary to keep the indicator cut out until coil B had passed a sufficient distance beyond joint J so as to be unaffected thereby, a second joint finger was employed to the rear of the coil B the same distance substantially as joint finger 30 was positioned in advance of coil A. Thus, referring to Fig. 1, it will be seen that the cutout began when the joint finger 30 engaged joint J, therefore a portion of rail extending from the joint to coil B remained untested. A similar portion at the leaving end remained untested.

By my present invention I cut down materially the portion of the rail at each end of the joint which remains untested. For this purpose, instead of having coils A and B connected in series opposition, I cause each coil to act independently, but nevertheless make provision for cancelling out any factors which simultaneously affect coils A and B equally. By such an arrangement it is not necessary to wait until coil B has left joint J and passed beyond its field of influence before rendering the indicator effective, but rather the indicator may be rendered effective as soon as coil A has passed beyond the field of influence of joint J. This means that the rear joint finger 30', instead of being positioned to the rear of coil B the same distance that joint finger 30 is positioned in front of coil A, I can position rear finger 30' to the rear of coil A the same distance that finger 30 is positioned in front of coil A. It will thus be apparent that a very substantial reduction in untested portion of rail is effected.

To carry out the above solution, I cause coils A and B to be electrically independent and to operate into independent channels 40 and 50 of an amplifier. Since each coil passing through a region of varying flux generates a positive pulse

and a negative pulse, I cause each channel to be provided with a full wave rectifier 41 and 51 so that each pulse will produce a similar output. The output from channel 40 is caused to energize a coil 42, while the output from channel 50 is caused to energize a coil 52. The coils 42 and 52 are part of a polarized relay whose armature 53 is normally biased by spring 54 in the direction indicated by the arrow 56 to keep a set of contacts 55 normally closed, and energize the pen relay 57.

The operation of the device shown in Fig. 2 is as follows:

If a pulse is received by coil B, coil 52 of the polarized relay is energized tending to draw the armature in the direction of arrow 56, but since this armature is already drawn in this direction to maintain contacts 55 closed, nothing additional happens. However, if coil A generates a pulse, and coil 42 of the polarized relay is energized, armature 53 is attracted to open contacts 55 and thus permit coil 57 to release its pen armature N which thus makes a mark on chart C. It can thus be seen that sudden current changes or sudden movement of the pickup containing the two coils will produce equal and opposite energization of the polarized relay, and therefore nothing of this nature can operate the armature 53. However, any output from channel 40 greater than that from channel 50 will actuate pen N. Thus, it will be seen that the actuation of pen N on chart C is a function only of the pulses generated by coil A, while those pulses generated by coil B have no effect on the armature 53, and hence on the pen N. This enables the rear joint cutout finger 30' to be so positioned that the indicator is rendered effective again as soon as coil A has passed beyond the region affected by the joint, even though coil B is still within that region, because even if coil B does generate pulses caused by the increased flux of the joint, such pulses coming through channel 50 and energizing coil 52 will have no effect upon the pen N. At the same time, it will be seen that those factors which affect coils A and B equally and oppositely, cancel out in the outputs of the two channels, and thus the same desirable effect is obtained as when coils A and B were series-connected while permitting testing with coil A alone, and hence permitting closer positioning of the joint fingers to coil A.

In Fig. 2 the full wave rectifiers are shown as a pair of biased tubes in push-pull relationship, and also a polarized relay is employed. In Fig. 3 I have shown a different form of full wave rectifier, and also a different form of relay, namely, an electronic type, takes the place of the polarized relay. The electronic device may take the form of a tube 60 having a normal negative bias on its grid, supplied from means such as a battery 61. In this form, copper oxide rectifiers 41' and 51' may be employed in the channels 40' and 50'. The outputs from said rectifiers 41' and 51' are arranged in opposition so that when a signal comes out of rectifier 41', it will be of such sign as to render the grid G of tube 60 more positive, while if a pulse comes out of rectifier 51', it will render the grid G more negative. Thus, it will be seen that a pulse generated by coil A will render grid G more positive, and permit current to flow to the plate P to energize a coil 62 which will close a set of contacts 63 to energize pen coil 64 to operate pen N on the chart C. However, a pulse generated by coil B and coming through channel 50' will cause the rectifier 51' to generate

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a pulse which is in a direction to render the grid G more negative, and hence no current will flow through the pen circuit. Therefore, it will be seen that only the pulses out of A will cause operation of the pen circuit, while at the same time anything which affects A and B equally and simultaneously will cause outputs from the full wave rectifiers 41' and 51' which are equal and opposite, and will thus have no effect upon the degree of bias of grid G. Here, too, therefore there are obtained the beneficial results equivalent to that of series-connected coils, while at the same time permitting detection with one coil only, and hence closer positioning of the joint cutout fingers to said coil.

While the system has been described above in connection with passing electric current through the rail to establish an electromagnetic field surrounding the same, the system will be found applicable in any case in which variations in flux are measured in order to detect flaws. Thus, for instance, if the rail is included in a magnetic circuit in which the magnetic lines of flux extend longitudinally through the rail, it will be found that rail joints also distort these lines of flux. Therefore, coils such as A and B may be employed as above, except that in the case of magnetic energization the coils will be positioned with their axes longitudinal of the rail instead of transverse.

In accordance with the provisions of the patent statutes, I have herein described the principle and operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof, but I desire to have it understood that the apparatus shown is only illustrative and that the invention can be carried out by other equivalent means. Also, while it is designed to use the various features and elements in the combination and relations described, some of these may be altered and others omitted without interfering with the more general results outlined, and the invention extends to such use.

Having described my invention, what I claim and desire to secure by Letters Patent is:

1. In a rail flaw detector mechanism in which the rail is energized with flux, and having a pair of electrically independent flux responsive means spaced along the rail for detecting variations in flux caused by defects, said flux-responsive means having equal inductive outputs and being mounted for mechanical movement as a unit, and means for indicating said variation, operating means for said indicating means, means for maintaining said operating means normally ineffective to operate said indicating means, means actuated by responses from one of said flux responsive means to tend to actuate said operating means to render it effective, and means actuated by responses from the other of said flux responsive means to tend to maintain said operating means ineffective.

2. In a rail flaw detector mechanism in which the rail is energized with flux, and having a pair of electrically independent flux responsive means spaced along the rail for detecting variations in flux caused by defects, said flux-responsive means having equal inductive outputs and being mounted for mechanical movement as a unit, and means for indicating said variations, operating means for said indicating means, means for normally biasing said operating means in a direction to render it ineffective to operate said indicating means, means actuated by responses from one of said flux responsive means to tend to actu-

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ate said operating means in a direction opposite to said biased direction to render said operating means effective, and means actuated by responses from the other flux responsive means to tend to actuate said operating means in the biased direction.

3. In a rail flaw detector mechanism in which the rail is energized with flux, and having a pair of electrically independent flux responsive means spaced along the rail for detecting variations in flux caused by defects, said flux-responsive means having equal inductive outputs and being mounted for mechanical movement as a unit, and means for indicating said variations, operating means for said indicating means, separate amplifying means for amplifying the outputs of each of said flux responsive means, the outputs of said plurality of amplifying means being connected in opposition, means for maintaining said operating means normally ineffective to operate said indicating means, means actuated by the output from said opposed amplifying means in one direction to tend to maintain said operating means ineffective, and means actuated by the output from said opposed amplifying means in the other direction to tend to render said operating means effective.

4. In a rail flaw detector mechanism in which the rail is energized with flux, and having a pair of electrically independent flux responsive members spaced along the rail for detecting variations in flux caused by defects, said flux-responsive means having equal inductive outputs and being mounted for mechanical movement as a unit, and means for indicating said variations, operating means for said indicating means, separate amplifying means for amplifying the outputs from each of said members, the outputs of said plurality of amplifying means being connected in opposition, means for normally biasing said operating means in a direction to render it ineffective to operate said indicating means, means actuated by the output from said opposed amplifying means in one direction to tend to actuate said operating means in said biased direction, and means actuated by the output from said amplifying means in the other direction to tend to actuate said operating means in a direction opposite to the biased direction.

5. In a rail flaw detector mechanism in which the rail is energized with flux, and having a pair of electrically independent flux responsive means spaced along the rail for detecting variations in flux caused by defects, said flux-responsive means having equal inductive outputs and being mounted for mechanical movement as a unit, and means for indicating said variations, said last-named means comprising a polarized relay including an armature and a pair of oppositely acting coils, means for normally biasing said armature for movement in one direction, means rendered effective by responses from one of said flux responsive means to energize one of said coils to tend to move said armature in the biased direction, and means rendered effective by responses from the other of said flux responsive means to energize the other of said coils to tend to move said armature in the other direction.

6. In a rail flaw detector mechanism in which the rail is energized with flux, and having a pair of electrically independent flux responsive means spaced along the rail for detecting variations in flux caused by defects, said flux-responsive means having equal inductive outputs and being mounted for mechanical movement as a unit,

and means for indicating said variations, said last-named means comprising an electronic device having a filament, grid and plate, means for normally placing a negative bias on the grid, means rendered effective by responses from one of said flux responsive means for increasing the negative bias on said grid, and means rendered effective by responses from the other of said flux responsive means for decreasing the negative bias on said grid.

7. In a rail flaw detector mechanism in which the rail is energized with flux, and having a pair of electrically independent flux responsive means spaced along the rail for detecting variations in flux caused by defects, said flux-responsive means having equal inductive outputs and being mounted for mechanical movement as a unit, rail joints also causing variations in flux, and means for indicating variations in flux, operating means for said indicating means, means for maintaining said operating means normally ineffective to operate said indicating means, means actuated by responses from one of said flux responsive means to tend to actuate said operating means to render it effective, means actuated by responses from the other of said flux responsive means to tend to maintain said operating means ineffective, a joint responsive means actuable on encountering a joint, means actuated by said joint responsive means for rendering said first responsive means ineffective to operate said operating means, said first responsive means being so positioned relative to the joint responsive means as to be rendered ineffective in the region of flux affected by the rail joint.

8. In a rail flaw detector mechanism in which the rail is energized with flux and having a pair of electrically independent flux responsive means spaced along the rail for detecting variations in flux caused by defects, said flux-responsive means having equal inductive outputs and being mounted for mechanical movement as a unit, rail joints

also causing variations in flux, and means for indicating variations in flux, operating means for said indicating means, means for normally biasing said operating means in a direction to render said operating means ineffective to operate said indicating means, means actuated by responses from one of said flux responsive means to tend to actuate said operating means in a direction opposite to said biased direction, to render said operating means effective to operate said indicating means, means actuated by responses from the other flux responsive means to tend to actuate said operating means in the biased direction, a joint responsive means actuable on encountering a joint, means actuated by said joint responsive means for rendering said first responsive means ineffective to operate said operating means, said first responsive means being so positioned relative to the joint responsive means as to be rendered ineffective in the region of flux effected by the rail joint.

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