July 2, 1940. H. C. DRAKE 2,206,768

RAIL FLAW DETECTOR MECHANISM

Filed Aug. 12, 1937

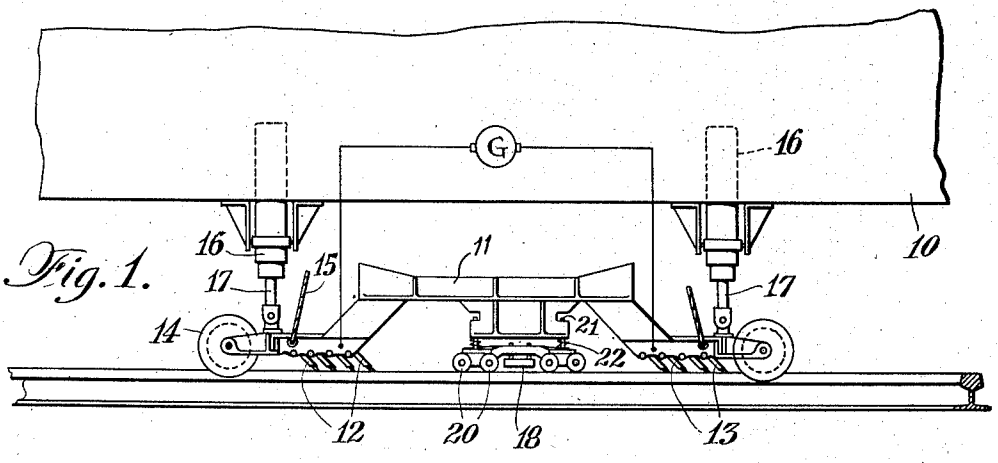


Fig. 1.

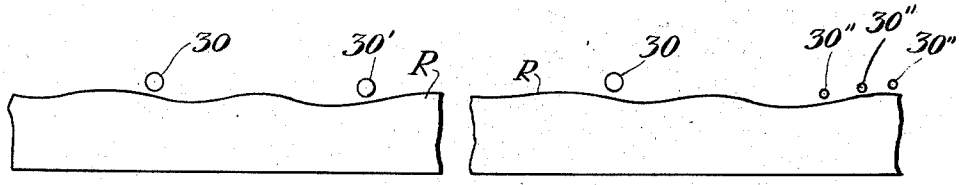


Fig. 2.

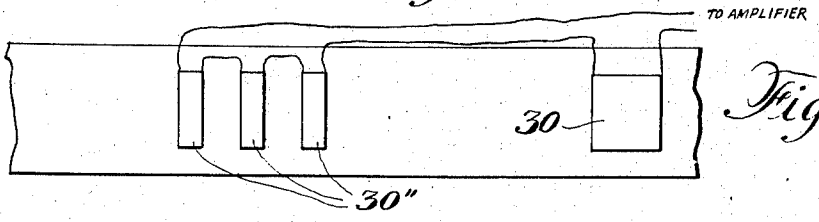


Fig. 3.

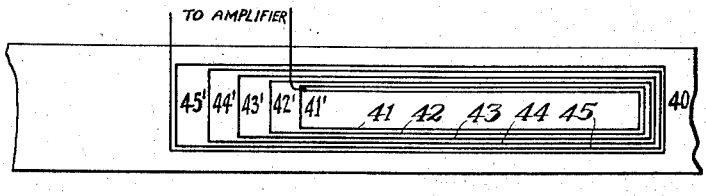


Fig. 4.

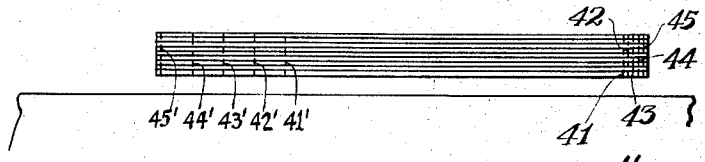


Fig. 5.

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RAIL FLAW DETECTOR MECHANISM

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14 Claims. (Cl. 175—183)

This invention relates to rail flaw detector mechanisms of the type employed in the Sperry rail flaw detector car. The principle of operation of the Sperry rail flaw detector cars consists in passing current through the rail between spaced points to establish an electromagnetic field surrounding the rail and then detecting irregularities in said field caused by the presence of internal defects within the rail. For this purpose a plurality of flux responsive devices, such as induction coils, are employed, said devices being connected in oposition so as not to be affected by variations in current supply or variations in gap between the inductive means and the rail surface. The inductive devices are arranged in tandem along the rail so that they will enter a region of flaw successively whereby first one inductive means and then the other will cut a different number of lines of force from that which it normally cuts, to generate a differential E. M. F. which, after being suitably amplified, may be caused to operate suitable indicators such as a recorder in the car and paint mechanism for marking the rail with paint at the point of defect.

Because of the characteristics of certain rail surfaces, as, for instance, corrugated rail surface, it sometimes happened that with the above arrangements defects were indicated where in fact none existed. This was due to the above described arrangement wherein a pair of similar inductive devices were arranged in tandem and oppositely connected. In such arrangement it sometimes happened that said inductive devices were both positioned with respect to the corrugations in the rail surface so that E. M. F.'s were generated in said coils in such direction as to be additive and thus generate an E. M. F. as in the case of an actual defect. It is the principal object of this invention, therefore, to provide a detector mechanism which will remedy the defect just described and which will permit the operation of such mechanism over corrugated and similar rail surfaces without producing false indications.

It is a further object of my invention to provide in connection with the device for remedying the above described effect, a detector mechanism which is capable of testing close to the bond wire and angle bars which connect the rails at a joint.

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

In the accompanying drawing,

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

Fig. 2 is a diagram illustrating the theory underlying my invention.

Fig. 3 is a plan view largely diagrammatic showing an arrangement of inductive devices constituting one form of my invention.

Fig. 4 is a view similar to Fig. 3 showing another arrangement of inductive means for accomplishing the object of this invention.

Fig. 5 is a side elevation of the wiring arrangement of Fig. 4.

Referring first to Fig. 1, there is shown a portion 10 of the car body of a Sperry rail flaw detector car adapted to ride along the rails, said car having a generator G therein for supplying current to front and rear sets of brushes 12 and 13 to pass current through a section of the rail progressively as the car moves along the rails. The said brushes may be mounted on a current brush carriage 11 adapted to ride on the rail by means such as flanged wheels 14, the said carriage being normally held in elevated position by means such as springs, not shown, and cables 15, but which may be lowered into engagement with the rail when testing is desired by sending fluid pressure such as compressed air into cylinder 16 to lower pistons and piston rods 17, the latter being pivotally connected to the carriage 11. As the car moves along the rails, an electromagnetic field is set up surrounding the same between sets of brushes 12 and 13 and said field will be uniform except in the region of a flaw where said field will be distorted. Such distortions may be detected by inductive means carried by housing 18 supported on a detector carriage 19 which is adapted to ride along the rail by means such as rollers 20 to maintain the inductive means normally at a fixed distance above the rail surface. Said detector carriage 20 may be mounted on the current brush carriage 11 by means such as loosely fitting bolts 21 and springs 22 to permit movement of the detector carriage independently of the current brush carriage, so that said detector carriage may at all times follow the contour of the rail surface and maintain an inductive means parallel to and at a constant distance above the rail surface. Normally, the inductive means cuts a constant number of lines of force, but on entering the region of flaw it will cut a different number of lines of force. Heretofore, the inductive means has consisted of two coils of equal inductance arranged in tandem and connected in opposition, so that, on entering a region of flaw, first one and then

the other of the coils would cut a different number of lines of force to generate a differential E. M. F. which after being suitably amplified would operate an indicator such as a recorder pen on a chart and a spraying device for spraying paint on the rail in the region of flaw. The connection of the coils in opposition was necessary in order to eliminate the effect of variations in the current supply to the rail, and also the effect of varying the gap between the inductive means and the rail surface. Also, the inductive means were positioned with respect to one another close enough so that the E. M. F. generated by the second coil would be added to the E. M. F. generated by the first coil to reinforce the same.

Referring to the left portion of the diagram of Fig. 2, there is illustrated a corrugated rail surface R and it will be seen that when one coil 30 of the pair of inductive coils is moving along a corrugation so as to come closer to the rail surface and cut a larger number of lines of force, the other coil 30' which is oppositely connected to coil 30 may be moving along a corrugation so as to increase the gap. The variation in flux through the coil 30 may yield a current in a given direction, and, while the opposite effect is taking place in coil 30', the fact that said coil is oppositely wound will yield a current in the same direction as coil 30, so that said currents are additive rather than in opposition; and since the coils are positioned close enough to each other so that the E. M. F.'s generated over-lap, an E. M. F. is generated which is amplified and caused to operate the indicators in the same manner as an internal defect. This results in a false indication with consequent inefficiency of testing

To obviate the condition which may thus be set up in the type of detector mechanism heretofore employed, I may utilize an arrangement such as shown in Fig. 3 wherein instead of having a balancing coil 30' of equal inductance to balancing coil 30, I employ as the balancing means a plurality of balancing coils 30'' whose total inductiveness equals the inductiveness of the main coil 30. The said balancing coils 30'' are spaced longitudinally along the rail.

It will now be seen that the condition which arose when the single balancing coil 30' is used cannot arise in the present case because the portions 30'' are in various positions with respect to every corrugation (see right portion of diagram of Fig. 2) so that the general effect would be to average out the E. M. F.'s which might otherwise be induced in a single coil and therefore to generate little or no E. M. F. Also, by the longitudinal spacing of portions 30'' it is impossible for these portions to add their E. M. F.'s to that of coil 30. Thus, by the spaced arrangement of the balancing coil portions 30'' it cannot occur when passing over corrugations that a sufficient E. M. F. is generated to operate the indicators. The E. M. F. generated by coil 30 alone when passing over corrugations is, because of the setting of the output relays 25 and 26, insufficient to operate said relays. An internal defect, however, generates an E. M. F. which is sufficiently larger than that generated in coil 30 when passing over corrugations, to operate the output relays.

In another form of the invention, instead of having separate coils positioned as shown in Fig. 3, I may wind a coil as shown in Fig. 4 in the form of a nest of rectangles in close proximity to one another at the leading or testing end 40 but spaced longitudinally along the rail progressively in a direction away from end 40 to form a plurality of vertical banks of coils 41—45 inclusive. The coil portions 41'—45' perform the same function as the sets of coil portions 30'' in that they average out the effect of a corrugation, that is, the positive and negative impulses tend to wipe each other out; furthermore, the spaced positioning of coil portions 41'—45' is such that they do not add their E. M. F.'s at any time to the impulse generated by the testing end 40. The E. M. F. generated by the testing end 40 when passing over a flaw is equal to the total of the E. M. F.'s generated by the portions 41'—45' and therefore end 40 will, when passing over an internal defect, generate an E. M. F. sufficient to operate the output relays, whereas the coil portions 41'—45' passing successively over the defect will each generate a fraction of the total impulse generated by end 40, said fraction being insufficient to operate the output relays.

Another advantage of this invention lies in the fact that I utilize only a single coil or a single end of a coil for detection purposes instead of a pair of coils, and this enables me to test closer to bond wires and angle bars than was heretofore possible. This is apparent from the fact that heretofore the additive effect of both coils 30 and 30' was necessary since the sensitivity of the output relays was set such that it required the combined reinforced outputs of coils 30 and 30' to operate them. Therefore, it was not possible to test close to a bond wire or angle bar since by the time the second coil 30' would reach the portion of rail immediately preceding the bond wire a leading coil would have reached the bond wire or angle bar and consequently the electromagnetic distortion caused by said bond wire and angle bar would nullify the testing. Therefore, the portion of the rail for a considerable distance in advance of the bond wire or angle bar, equal to at least the distance between the coils 30 and 30', had to remain untested. With the present invention, in both forms thereof, it is possible to test close to the bond wire by coil 30 or the leading edge 40 of the Fig. 4 form, since the E. M. F.'s generated by the balancing coil portions 30'' or by the balancing portions 41—45 inclusive are not relied upon to add their effect to the E. M. F.'s generated by coil 30 and leading edge 40. The output relays are set so as to be actuated by the amplified E. M. F.'s from coil 30 and leading edge 40 alone when passing over the smallest defect which it is desired to detect.

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 having means for establishing a magnetic field surrounding the rail, a detector for detecting variations in flux in said field caused by the presence of defects in the rail, said detector being adapted to generate impulses in response to said defects,

said detector comprising inductive means and a second inductive means oppositely connected to said first inductive means, said first inductive means having an inductance such that it generates an impulse in excess of a predetermined magnitude in response to internal rail defects in excess of a given minimum size and an impulse less than said predetermined magnitude in response to rail surface defects less than a given maximum size, said second inductive means comprising a plurality of spaced inductive members, the inductance of each of said members being such that the impulse generated in response to any rail defect in excess of said minimum size is less than said predetermined magnitude.

2. In a rail flaw detector mechanism having means for establishing a magnetic field surrounding the rail, a detector for detecting variations in flux in said field caused by the presence of defects in the rail, said detector being adapted to generate impulses in response to said defects, said detector comprising inductive means and a second inductive means oppositely connected to said first inductive means, said first inductive means having an inductance such that it generates an impulse in excess of a predetermined magnitude in response to internal rail defects in excess of a given minimum size and an impulse less than said predetermined magnitude in response to rail surface defects less than a given maximum size, said second inductive means comprising a plurality of spaced inductive members whose total inductiveness equals the inductiveness of said first inductive means, the inductance of each of said inductive members being such that the impulse generated in response to any rail defect in excess of said minimum size is less than said predetermined magnitude.

3. In a rail flaw detector mechanism having means for establishing a magnetic field surrounding the rail, a detector for detecting variations in flux in said field caused by the presence of defects in the rail, said detector being adapted to generate impulses in response to said defects, said detector comprising inductive means and a second inductive means oppositely connected to said first inductive means, said first inductive means having an inductance such that it generates an impulse in excess of a predetermined magnitude in response to internal rail defects in excess of a given minimum size and an impulse less than said predetermined magnitude in response to rail surface defects less than a given maximum size, said second inductive means comprising a plurality of inductive members spaced longitudinally of the rail.

4. In a rail flaw detector mechanism having means for establishing a magnetic field surrounding the rail, a detector for detecting variations in flux in said field caused by the presence of defects in the rail, said detector being adapted to generate impulses in response to said defects, said detector comprising inductive means and a second inductive means oppositely connected to said first inductive means, said first inductive means having an inductance such that it generates an impulse in excess of a predetermined magnitude in response to internal rail defects in excess of a given minimum size and an impulse less than said predetermined magnitude in response to rail surface defects less than a given maximum size, said second inductive means comprising a plurality of inductive members spaced longitudinally of the rail and whose total inductiveness equals the inductiveness of said first inductive means, the inductance of each of said inductive members being such that the impulse generated in response to any rail defect in excess of said minimum size is less than said predetermined magnitude.

5. In a rail flaw detector mechanism having means for establishing a magnetic field surrounding the rail, a detector for detecting variations in flux in said field caused by the presence of defects in the rail, said detector being adapted to generate impulses in response to said defects, said detector comprising inductive means and a second inductive means oppositely connected to said first inductive means, said first inductive means having an inductance such that it generates an impulse in excess of a predetermined magnitude in response to internal rail defects in excess of a given minimum size and an impulse less than said predetermined magnitude in response to rail surface defects less than a given maximum size, said second inductive means comprising a plurality of spaced inductive members arranged in tandem longitudinally of the rail with respect to said first inductive means and each other, the inductance of each of said inductive members being such that the impulse generated in response to any rail defect in excess of said minimum size is less than said predetermined magnitude.

6. In a rail flaw detector mechanism having means for establishing a magnetic field surrounding the rail, a detector for detecting variations in flux in said field caused by the presence of defects in the rail, said detector being adapted to generate impulses in response to said defects, said detector comprising inductive means and a second inductive means oppositely connected to said first inductive means, said first inductive means having an inductance such that it generates an impulse in excess of a predetermined magnitude in response to internal rail defects in excess of a given minimum size and an impulse less than said predetermined magnitude in response to rail surface defects less than a given maximum size, said second inductive means comprising a plurality of spaced inductive members arranged in tandem longitudinally of the rail with respect to said first inductive means and each other and whose total inductiveness equals the inductiveness of said first inductive means, the inductance of each of said inductive members being such that the impulse generated in response to any rail defect in excess of said minimum size is less than said predetermined magnitude.

7. In a rail flaw detector mechanism having means for establishing a magnetic field surrounding the rail, a detector for detecting variations in flux in said field caused by the presence of defects in the rail, said detector being adapted to general impulses in response to said defects, said detector comprising an induction coil and inductive means oppositely connected to said coil, said induction coil having an inductance such that it generates an impulse in excess of a predetermined magnitude in response to internal rail defects in excess of a given minimum size and an impulse less than said predetermined magnitude in response to rail surface defects less than a given maximim size, said inductive means comprising a plurality of spaced induction coils, the inductance of each of said plurality of induction coils being such that the impulse generated in response to any rail defect in excess of said minimum size is less than said predetermined magnitude.

8. In a rail flaw detector mechanism having means for establishing a magnetic field surrounding the rail, a detector for detecting variations in flux in said field caused by the presence of defects in the rail, said detector being adapted to generate impulses in response to said defects, said detector comprising an induction coil and inductive means oppositely connected to said coil, said induction coil having an inductance such that it generates an impulse in excess of a predetermined magnitude in response to internal rail defects in excess of a given minimum size and an impulse less than said predetermined magnitude in response to rail surface defects less than a given maximum size, said inductive means comprising a plurality of spaced induction coils whose total inductiveness equals the inductiveness of said first coil, the inductance of each of said plurality of induction coils being such that the impulse generated in response to any rail defect in excess of said minimum size is less than said predetermined magnitude.

9. In a rail flaw detector mechanism having means for establishing a magnetic field surrounding the rail, a detector for detecting variations in flux in said field caused by the presence of defects in the rail, said detector being adapted to generate impulses in response to said defects, said detector comprising an induction coil and inductive means oppositely connected to said coil, said induction coil having an inductance such that it generates an impulse in excess of a predetermined magnitude in response to internal rail defects in excess of a given minimum size and an impulse less than said predetermined magnitude in response to rail surface defects less than a given maximum size, said inductive means comprising a plurality of induction coils spaced longitudinally of the rail, the inductance of each of said plurality of induction coils being such that the impulse generated in response to any rail defect in excess of said minimum size is less than said predetermined magnitude.

10. In a rail flaw detector mechanism having means for establishing a magnetic field surroundrounding the rail, a detector for detecting variations in flux in said field caused by the presence of defects in the rail, said detector being adapted to generate impulses in response to said defects, said detector comprising an induction coil and inductive means oppositely connected to said coil, said induction coil having an inductance such that it generates an impulse in excess of a predetermined magnitude in response to internal rail defects in excess of a given minimum size and an impulse less than said predetermined magnitude in response to rail surface defects less than a given maximum size, said inductive means comprising a plurality of induction coils spaced longitudinally of the rail and whose total inductiveness equals the inductiveness of said first coil, the inductance of each of said plurality of induction coils being such that the impulse generated in response to any rail defect in excess of said minimum size is less than said predetermined magnitude.

11. In a rail flaw detector mechanism having means for establishing a magnetic field surrounding the rail, a detector for detecting variations in flux in said field caused by the presence of defects in the rail, said detector being adapted to generate impulses in response to said defects, said detector comprising an induction coil and inductive means oppositely connected to said coil, said induction coil having an inductance such that it generates an impulse in excess of a predetermined magnitude in response to internal rail defects in excess of a given minimum size and an impulse less than said predetermined magnitude in response to rail surface defects less than a given maximum size, said inductive means comprising a plurality of spaced induction coils arranged in tandem longitudinally of the rail with respect to said first coil and each other, the inductance of each of said plurality of induction coils being such that the impulse generated in response to any rail defect in excess of said minimum size is less than said predetermined magnitude.

12. In a rail flaw detector mechanism having means for establishing a magnetic field surrounding the rail, a detector for detecting variations in flux in said field caused by the presence of defects in the rail, said detector being adapted to generate impulses in response to said defects, said detector comprising an induction coil and inductive means oppositely connected to said coil, said induction coil having an inductance such that it generates an impulse in excess of a predetermined magnitude in response to internal rail defects in excess of a given minimum size and an impulse less than said predetermined magnitude in response to rail surface defects less than a given maximum size, said inductive means comprising a plurality of spaced induction coils arranged in tandem longitudinally of the rail with respect to said first coil and each other, and whose total inductiveness equals the inductiveness of said first coil, the inductance of each of said plurality of induction coils being such that the impulse generated in response to any rail defect in excess of said minimum size is less than said predetermined magnitude.

13. In a rail flaw detector mechanism having means for establishing a magnetic field surrounding the rail, a detector for detecting variations in flux in said field caused by the presence of defects in the rail, said detector comprising inductive means including a plurality of angular windings having elements positioned longitudinally and crosswise of the rail, one set of crosswise elements at one end of said inductive means being positioned closely adjacent each other, the other set of crosswise elements at the other end of said inductive means being spaced from each other distances greater than the distance between the elements of said first set.

14. In a rail flaw detector mechanism having means for establishing a magnetic field surrounding the rail, a detector for detecting variations in flux in said field caused by the presence of defects in the rail, said detector comprising inductive means including a plurality of rectangular windings having elements positioned longitudinally and crosswise of the rail, one set of crosswise elements at one end of said inductive means being positioned closely adjacent each other, the other set of crosswise elements at the other end of said inductive means being spaced from each other distances greater than the distances between the elements of said first set, the inductiveness of the second set being equal to the inductiveness of the first set.

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