Jan. 6, 1953 F. H. KEATON ET AL 2,624,779

RAIL FLAW DETECTING APPARATUS

Filed July 14, 1948

Fig-1

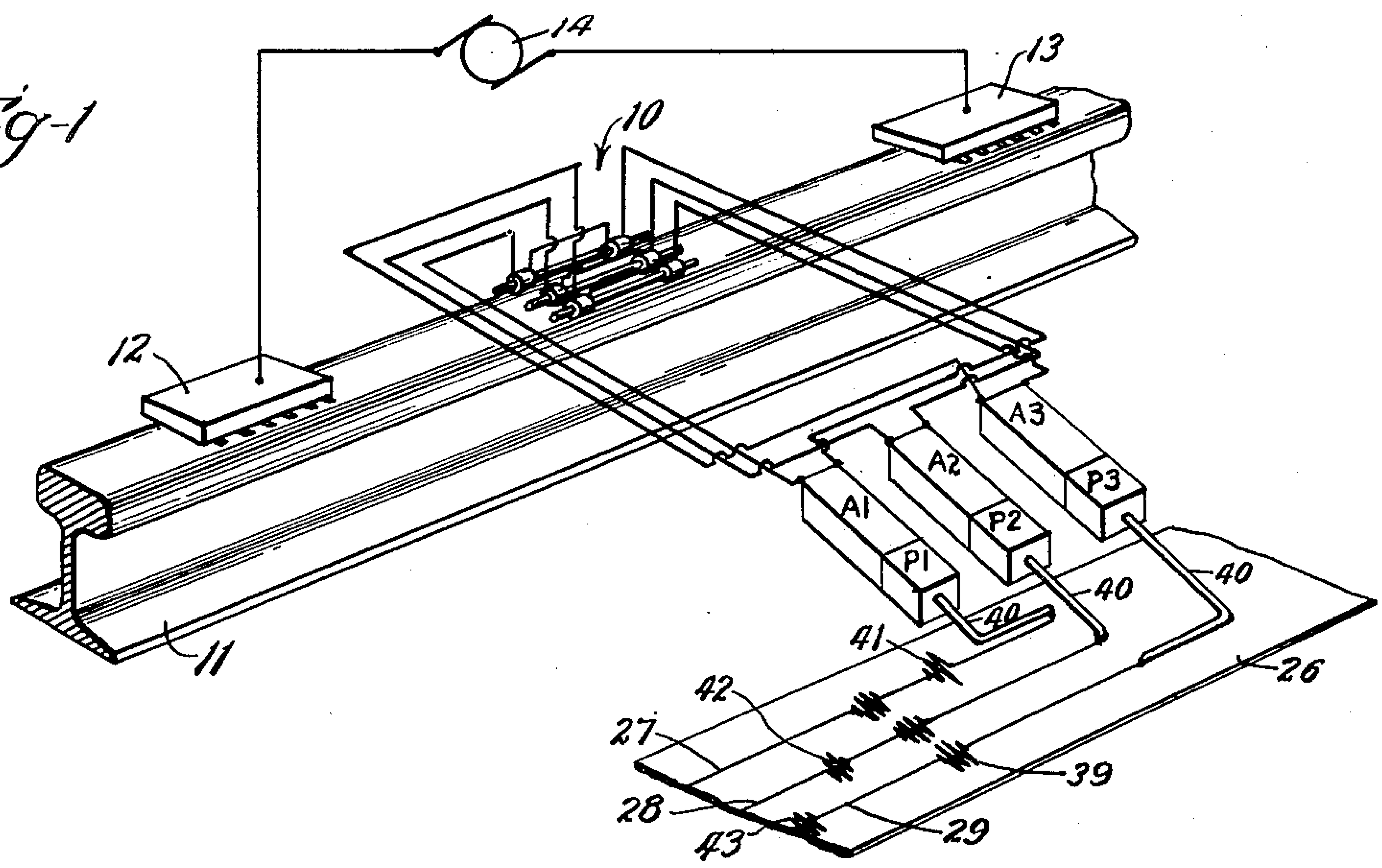


Fig-2

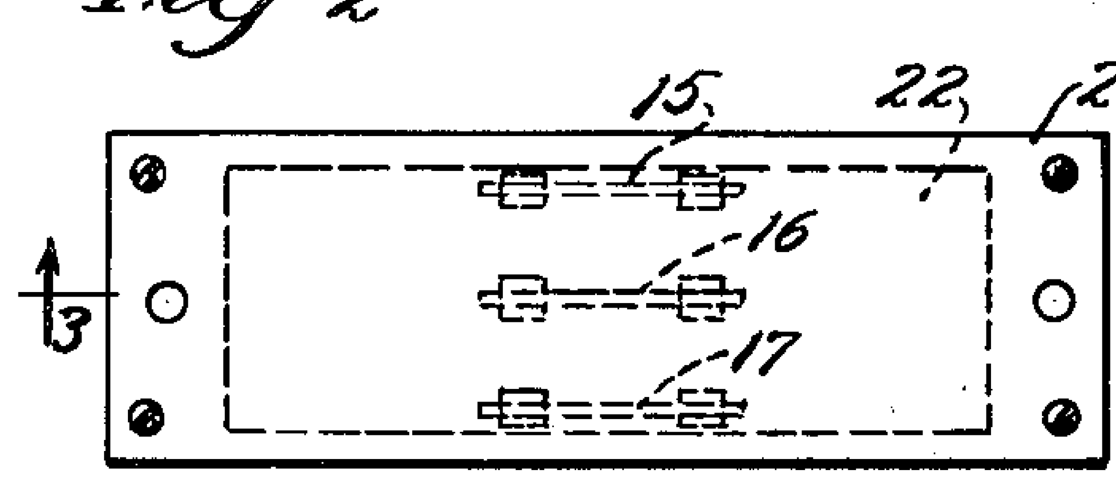


Fig-5

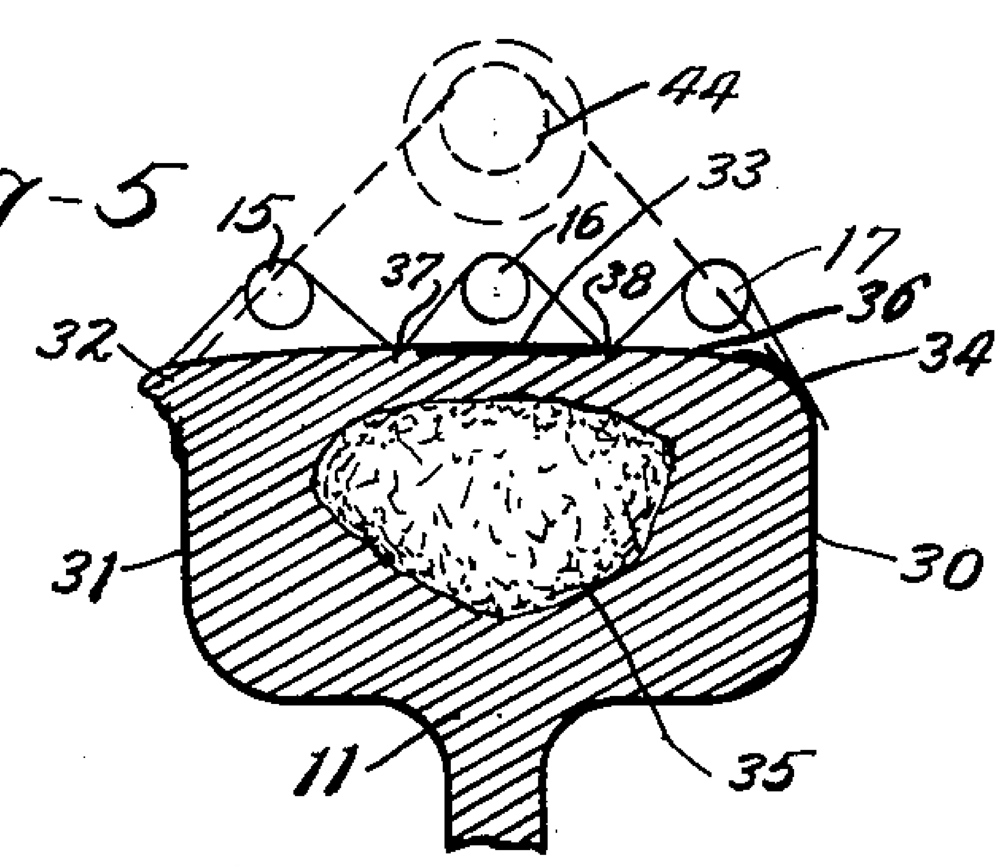


Fig-3

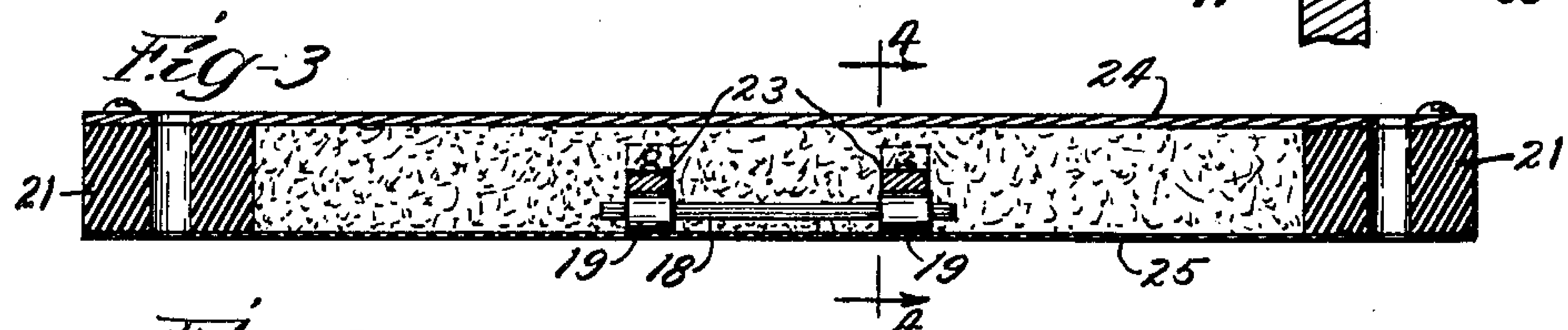
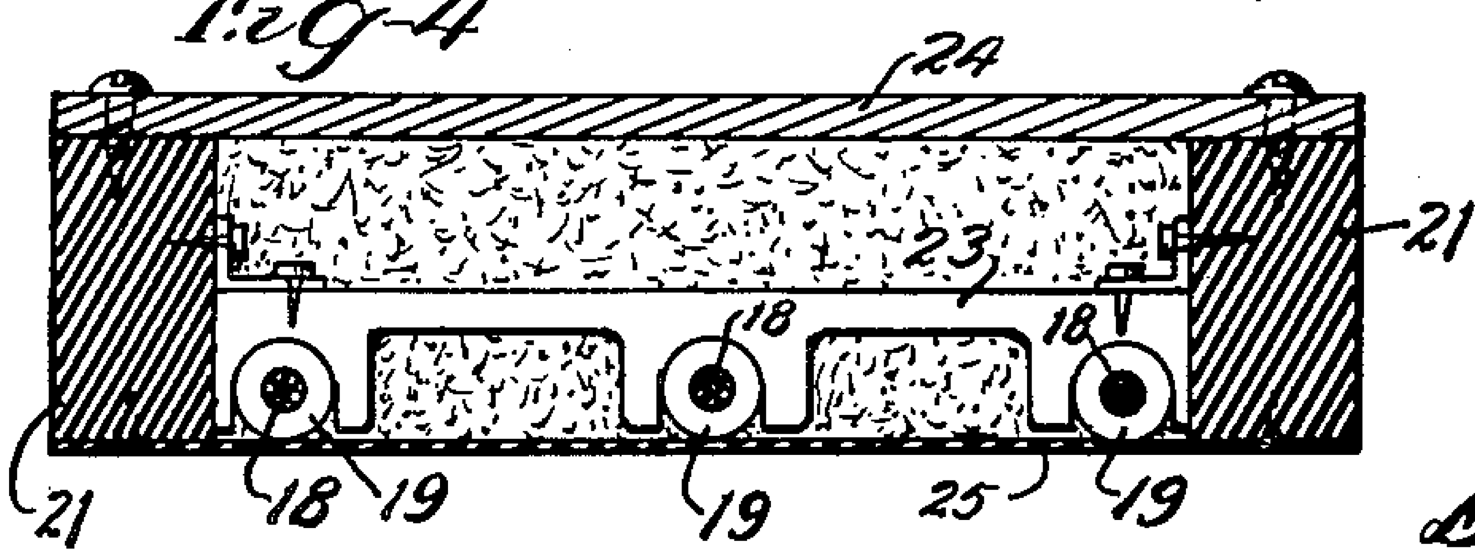


Fig-4



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RAIL FLAW DETECTING APPARATUS

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3 Claims. (Cl. 175—183)

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The problem of eliminating false indications in the detection of rail flaws is a continuous one and many solutions or partial solutions have been proposed. Although some of the proposed solutions tend to minimize the problem of false indications, none can be said to be a complete answer to the problem.

The present invention approaches the problem from a very practical point of view. It recognizes that false indications are probably inevitable, but proceeds to distinguish between true fissure indications and false indications by clearly indicating in which portion of the rail head the magnetic disturbance is found, thereby enabling the car operator to correlate this information with surface defects clearly visible, and more accurately judge which indications should be hand-checked for the possibility of an internal fissure.

More specifically, the invention contemplates dividing the top of the rail head into a plurality of longitudinal, substantially non-overlapping strips or areas, and associating with each strip or area a detecting coil which is so closely coupled magnetically with its own strip or area that it is substantially unresponsive to surface defects in any other strip or area, but is, nevertheless, responsive to most internal defects regardless of where they may be positioned within the rail. By channeling the responses from the several pickups through separate amplifiers and recording pens, with each coil responsive only to those surface defects which lie in whole or in part within the particular strip or area with which the coil is associated, it is possible for a car operator to ascertan quickly whether there is a surface defect located in the same longitudinal strip which produced the indication, and if not, there is evidence of an internal fissure.

These and other objects and advantages will be apparent as the disclosure proceeds and the description is read in conjunction with the accompanying drawings, in which

Fig. 1 is a diagrammatic perspective view showing a preferred embodiment of the invention;

Fig. 2 is a plan view of the pickup box with the position of the pickup coils indicated in dotted lines;

Fig. 3 is a vertical section view taken on the line 3—3 of Fig. 2;

Fig. 4 is a vertical section view taken on line 4—4 of Fig. 3; and

Fig. 5 is a schematic cross-sectional view through the rail which will be used in explaining the theory which is believed to underlie the present invention.

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It should be understood that the embodiment of the invention chosen for explaining the invention is merely illustrative of the various embodiments which are possible within the scope of the appended claims.

The invention is shown applied to the electroinductive system of testing, but the invention is not limited to this system. As applied to the electroinductive system, the detecting unit generally designated 10 is mounted for movement along a rail 11 in close proximity thereto and between front and rear current brushes 12 and 13 respectively, which pass a low voltage, high amperage current through the rail with power being derived from a generator 14. The ability of a longitudinally arranged detecting coil to locate internal defects is well known in the art, and in this case, the detecting unit comprises a plurality of detectors 15, 16, and 17, each of which comprises a core 18 which may comprise a plurality of soft iron wires, and series opposed induction coils 19. The coils are preferably not more than one-half inch in length and three-eighths inch in diameter with each coil comprising five hundred turns of No. 40 silk enamel copper wire. Since the coils are of such small size, each detector, in width, is less than one-fourth the width of the rail head.

The detectors are mounted in the pickup box 21 in substantial lateral alignment, and when three such detectors are used, the cores are spaced apart preferably on the order of one inch.

The pickup box 21 is preferably made of Bakelite or other suitable insulating material and has a central cavity 22 in which the detectors are mounted. A mounting plate 23 of moulded plastic material may be employed, if desired, to facilitate the mounting of the detectors within the pickup box, and the pickup is closed at the top by a cover 24 and at the bottom by a brass plate 25. Preferably beeswax is used to fill the cavity 22 after the detector coils are in place and before both covers are applied in order to keep moisture from reaching the detector coils.

It will be understood that the pickup box 21 is mounted in a suitable manner from the detector car so that it will move along the rail head in close proximity thereto but slightly out of contact therewith.

Each of the detectors 15, 16, and 17 feed their output through a separae amplifier and recording pen, and for convenience, the amplifiers will be designated A_1, A_2, A_3, and the associating pen units P_1, P_2, and P_3, detector 15 feeding amplifier A_1 and pen unit P_1, detector 16 feeding amplifier A_2 and pen unit P_2, and detector 17 feeding amplifier A_3 and pen unit P_3. Hence, on the moving chart 26, the pen line indication 27 represents detector 15, pen line indication 28 represents detector 16, and the pen line indication 29 represents detector 17.

The particular construction of the amplifiers and pen units is unimportant here, and it need only be mentioned that a voltage impulse set up by one of the detectors in traversing a non-uniform magnetic condition will be suitably amplified and recorded on the tape 26 by a corresponding jog in the pen line represented by that detector.

Referring now to Fig. 5, let it be assumed that the side 30 of the rail 11 is the gauge side of the rail with side 31 representing the field side, and let it further be supposed that the rail is flowed on the field side as indicated at 32, that it has a centrally located burn as indicated at 33, that on the gauge edge of the rail there are some shelly spots as indicated at 34, and that the rail has an internal transverse fissure as indicated at 35. The detectors 15, 16, and 17 are indicated diagrammatically in close proximity to the top surface 36 of the rail head, and the magnetic coupling of each detector with the top surface of the rail head is such that the detector 15 has a range of response to surface defects limited to that longitudinal strip or area of rail head lying between the field edge of the rail 31 and the point 37; the detector 16 is similarly magnetically coupled to the rail head so that its range of response to surface defects is between the laterally spaced points 37 and 38 on the rail head; and the detector 17 has a range of responsiveness to surface defects which extends between points 38 and the gauge side 30 of the rail head. It will be noticed that the range of response of each detector establishes a longitudinal strip or area of which no two are overlapping or substantially overlapping, and it is this coupling of the detectors with the rail head which makes possible the advantages inherent in the present invention.

An internal fissure, such as fissure 35 will produce a characteristic magnetic condition in the rail such that it will normally cause all three detectors to respond, thus producing the type of indication on the tape 26 shown at 39 (it being understood that the pens 40 of the several pen units are in lateral alignment). If however, the detecting unit 10 traverses a section of rail in which there is considerable flowed rail, the detector 15 will indicate such flowed rail and produce such indications as 41 on the line 27. If the detecting unit traverses a centrally located burn such as the burn 30, the detector 16 will cause an indication such as 42 to appear on the chart line 28; and likewise if the rail is shelly, the detector 17 will produce an indication such as 43 on the chart line 29.

The practical result of all this is that a detector car operator, by watching the rail in conjunction with the moving tape can see whether the detector which responded to a changed magnetic field in the rail is correlated to some obvious surface defect in the longitudinal strip or area in which that detector operates, and if not, there is the strong suspicion of an internal defect. The close coupling of the detectors to the rail head makes it virtually certain that all three will respond to an internal defect, but if an operator ever sees an indication on any one pen that does not correspond to a surface defect in the channel searched by the corresponding detector, there is reason to suppose that a fissure may exist.

Even when a surface defect may lie in two adjacent longitudinal strips or zones, a concurrent indication by the three detectors would suggest that there is a fissure beneath the burn and should be investigated.

Hence the detecting apparatus of this invention makes it possible by the correlation of the individual responses to particular longitudinal areas of the rail to locate more fully internal defects, and to disregard indications that are caused merely by surface or inconsequential defects in the rail.

It should be noted that the detectors 15, 16, and 17 are located in the bottom of the pickup box 28 so that there is the greatest possible magnetic coupling with the top of the rail head, and normally the pickup box is set to ride on the order of one-eighth of an inch from the rail head so that extremely close coupling is achieved.

If a single detector were used, such as indicated in dotted lines at 44, and either by using a core with wide pole pieces or by spacing the detector a sufficient distance above the rail head as to have the entire rail head within its range of responsiveness, it would then be impossible to make the discrimination between true and false indications. In such a case, a fissure located in lateral alignment with any surface defect would go by unnoticed because the car operator would assume that the visible defect was responsible for the indication produced on the chart. This merely illustrates the manner in which the plurality of laterally spaced detectors coupled as they are to separate amplifiers and recorders makes possible the detection of fissures that would otherwise be missed.

It should be understood that each of the amplifiers A_1, A_2, and A_3, are intended to operate a paint gun (not shown) in conventional manner to apply a paint spot to the rail at the point producing the indication. This assists in enabling the car operator to correlate the pen indications with rail surface conditions.

It should also be understood that the lateral alignment of the detectors across the rail head is not essential, although obviously desirable.

We claim:

1. In rail flaw detecting apparatus, the combination of means for progressively energizing a rail to establish characteristic magnetic conditions in the vicinity of flaws, and other characteristic magnetic conditions in the vicinity of surface defects, a detector unit comprising at least three detectors for inductively locating said conditions, a plurality of amplifiers, one associated with each detector and recording means including a moving tape and a plurality of recording pens, one associated with each amplifier and detector, for making parallel line records on the tape in response to the detector unit, said detectors being spaced apart in lateral alignment and each comprising a longitudinally arranged coil and a magnetic core in close magnetic coupling with a specified longitudinal portion of the top of the rail head, and of such size and inductive strength, and so arranged that there is substantially no overlapping between adjacent longitudinal portions of the top of the rail head magnetically searched by said laterally spaced coils, the width of each detector being less than one-fourth of the width of the rail head.

2. In rail flaw detecting apparatus, the combination of means for progressively energizing a rail to establish characteristic magnetic conditions in the vicinity of flaws, and other char-

acteristic magnetic conditions in the vicinity of surface defects, a detector unit for inductively locating said conditions, and recording means including a moving tape and a plurality of recording pens for making parallel line records on the tape in response to the detector, said detector unit comprising at least three detecting coils, laterally spaced and each having a longitudinally arranged magnetic core in close magnetic coupling with a specified longitudinal portion of the top of the rail head, and of such size and inductive strength, and so arranged that the characteristic magnetic conditions in the vicinity of internal flaws will actuate two or more of the recording pens and the other characteristic magnetic conditions in the vicinity of the surface defects will actuate only that pen or those pens responsive to the particular portion of the rail head in which said surface defect is found, the width of each detector being less than one-fourth of the width of the rail head, and each detector having associated with it a separate amplifier adapted to actuate one of the pens.

3. A detecting unit for use in rail flaw detecting apparatus, comprising a pickup box adapted to be moved along a rail in close proximity to the top surface thereto, and a plurality of longitudi-

nally arranged detectors mounted in the box closely adjacent to the bottom thereof, each of said detectors comprising an iron core and oppositely connected detector coils mounted thereon, and the detectors being laterally spaced from each other a sufficient distance to cooperate with specified substantially non-overlapping longitudinal portions or strips of the rail, the width of each detector being less than one-fourth of the width of the rail head.

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