

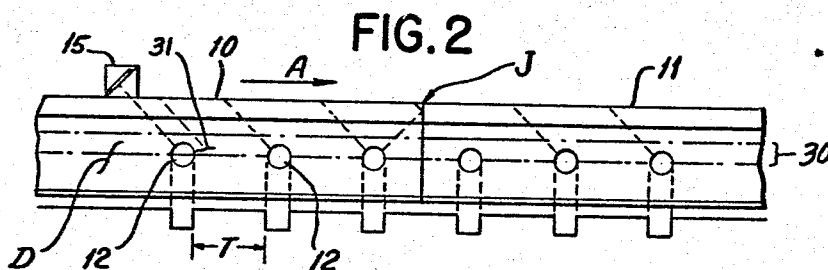
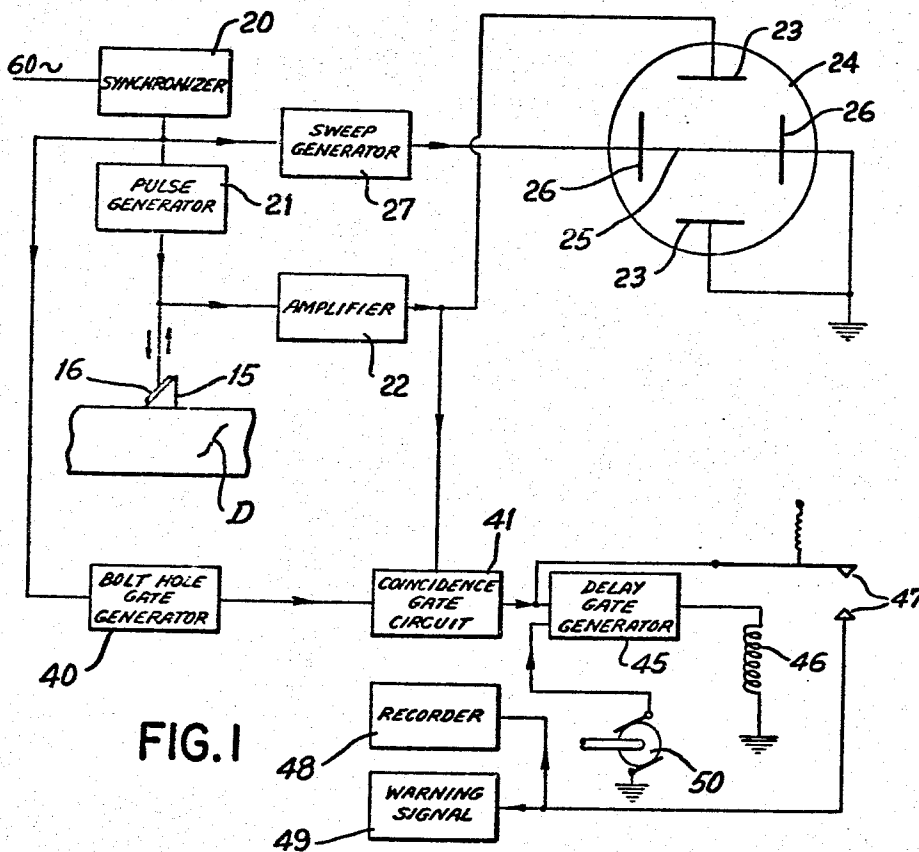
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ULTRASONIC INSPECTION OF RAIL JOINTS

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ULTRASONIC INSPECTION OF RAIL JOINTS

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This invention relates to the ultrasonic inspection of rail joints. In such inspection, ultrasonic beams are periodically transmitted in to the rail through the head thereof, and if there are internal defects, the beams are reflected by the reflecting surfaces of such defect back to the transmitting point where they are caused to operate suitable indicating means. A problem in connection with such testing arises by reason of the fact that the rail joints are held together by mechanisms which comprise angle bars which are bolted to the rail by bolts passing through the angle bars and through bolt holes in the rail ends. Obviously the bolt holes constitute reflecting surfaces in a manner similar to a defect, and in order that such bolt hole indications shall not be received and therefore shall not complicate the indicated defects, it has been the practice heretofore to provide gating means which gated out from the indicating means the passage of the ultrasonic beams through a longitudinal strip of rail joint in which the bolt holes are located. Thus while the bolt holes were not indicated, it was also the case that bolt hole cracks radiating from the bolt holes to a length of as much as one-half inch were also gated out, and therefore remained undetected. Since bolt hole cracks are defects which it is desirable to detect, it is the principal object of this invention to provide a means whereby such bolt hole cracks may be detected while at the same time gating out the indications which would otherwise be caused by the bolt holes themselves.

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

In the accompanying drawings,

Fig. 1 is an assembly including a block wiring diagram, showing one form of this invention.

Fig. 2 is a side elevation, largely diagrammatic, of a portion of a rail joint and a graph in relation thereto.

Referring to Fig. 1 of the drawings, the invention is shown as applied to the detection of defects in a rail joint indicated generally at J and comprising the rail ends 10 and 11 which are adapted to be joined by joint bars, not shown, and fixed to the rail ends by bolts, not shown, extending through bolt holes 12 in the rail ends. For the ultrasonic testing of such rail joints there may be provided an electro-acoustic transducer 15 which may take the form of a piezo-electric element such as a quartz crystal 16, preferably mounted so as to transmit vibrations into the rail ends at an angle. The electro-acoustic transducer 15 is adapted to be periodically energized by means of a synchronizer 20 which is energized periodically from a suitable source of energy such as 60-cycle A. C., and said synchronizer periodically trips a pulse generator 21 to generate wave trains of relatively high frequency which are applied to the transducer 15 which transforms the electric vibrations into mechanical vibrations and transmits such wave trains of ultrasonic vibrations into the rail through the rail head. The wave trains travel through the rail from top to bottom, and if

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a reflecting surface such as an internal defect D is encountered, the wave train will be reflected back to the transducer which will convert such reflected ultrasonic wave train into an electric voltage which after being suitably amplified by an amplifier 22 may be applied to the vertical plates 23 of an oscilloscope 24 to deflect the sweep 25 which is generated between horizontal plates 26 by a sweep generator 27 which is energized by the synchronizer 20 in synchronism with the generated wave trains.

Referring to Fig. 2, it will be seen that when the transmitted beam strikes a bolt hole 12 such bolt hole will reflect the transmitted beam back to the transducer 15 in the same manner as the defect D, and this will occur at every bolt hole throughout the rail joint region which is being tested. It is obvious therefore that the sweep 25 on the oscilloscope will show a large number of indications, similar to the indication of a defect, where in fact no defect exists. Therefore as stated in the introduction hereto, it has been customary to gate out all indications which would be caused by reflections of the wave train in the region between the dot and dash lines 30. While this resulted in eliminating the indications of the bolt holes on the indicator, it also resulted in bolt hole cracks, such as indicated at 31 and which lie within said gated-out area 30, escaping detection. It is desirable to detect such bolt hole cracks since they constitute true defects in the rail joint area.

In order that bolt hole cracks of the type described above may be detected, there is provided the following arrangement whereby instead of gating out an entire longitudinal section 30 of the rail, there is gated-out only the bolt holes themselves while the portion of the section 30 lying between bolt holes is rendered sensitive to detection.

For this purpose there is provided the additional circuitry disclosed in Fig. 1, which comprises a bolt hole gate generator 40 adapted to be periodically energized from synchronizer 20 in synchronism with the pulse generator and sweep generator to cause said bolt hole gate generator to apply a pulse to a coincidence gate circuit 41. Since only the region 30 is to be rendered sensitive to detection, the bolt hole gate generator does not start to generate a signal gate voltage until the transmitted pulse has traveled down to the region 30. By this time the voltage generated by the transmitted pulse, which is of relatively short duration, has terminated. In order to render coincidence gate circuit 41 effective it is essential that an additional pulse be received from the output of amplifier 22. Such a condition exists when the transmitted pulse first strikes a bolt hole 12. At this point the coincidence gate circuit 41 is rendered conductive so that further pulses from the output of amplifier 22 can pass through the coincidence gate circuit and operate a suitable indicator. However, it is not desired that any output from amplifier 22 shall pass through gate circuit 41 until the transducer 15, moving in the direction of the arrow A, causes the transmitted pulses to pass the bolt hole 12. Therefore the output of gate circuit 41 is fed into a delay gate generator 45 whose delay may be adjusted to correspond to the time that it takes the transducer 15 to move along the rail head a distance corresponding to the diameter of the bolt hole. As soon as this distance has been traversed the delay gate generator 45 enables any signals from amplifier 22 passing through coincidence gate circuit 41 to energize suitable indicating means. Therefore at the end of the delay the signals passing through coincidence gate circuit 41 from the amplifier 22 will energize a relay 46 to close contacts 47 which closes the circuit to an indicating device which may be a recorder 48 or a warning device 49, or both as shown. The delay gate generator 45 is timed so that

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once it energizes relay 46 it will maintain the relay energized for the time interval T (see graph in Fig. 2) which begins just after the transmitted beam has passed a bolt hole and ends just before the transmitted beam is about to strike the succeeding bolt hole. Therefore if a bolt hole crack such as crack 31 occurs, it will reflect the transmitted beam sometime during the interval T and the indication in the form of a signal voltage coming out of amplifier 22 will pass through coincidence gate circuit 41, delay gate generator 45, contacts 47 of relay 46, and operate the indicating means 48, 49.

Since the time T is a function of the rate of movement of the transducer 15, the delay interval of the delay gate generator 45 may be made a function of such rate of movement, as for instance by causing the movement of the transducer 15 to actuate a voltage generator 50 to apply a biasing voltage to the gate generator. The voltage generator 50 may be moved by the movement of the transducer 15, or in the case where the transducer is mounted on a carriage the generator 50 may be driven from the carriage wheels.

Having described our invention, what we claim and desire to secure by Letters Patent is:

1. In a rail flaw detector mechanism, said rails having bolt holes in the joint areas, means for detecting cracks originating at the bolt holes, said means comprising means movable relative to the rail for periodically transmitting ultrasonic wave trains into the rail and receiving reflections from reflecting surfaces in the rail, said bolt holes forming reflecting surfaces, indicating means normally maintained ineffective, a bolt hole gate generator adapted

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to be energized periodically in synchronism with said wave train transmitting means to generate a signal gate voltage after the termination of said transmitted pulse, a coincidence gate circuit adapted to be rendered effective by the coincidence of signal voltages from said bolt hole gate generator and from said receiving means in response to a reflection from a bolt hole, a delay gate generator rendered effective by the signal voltage from the coincidence gate circuit, said delay gate generator generating a signal voltage after a predetermined delay corresponding to the time that the transmitting and receiving means travels past the bolt hole, said delayed signal gate voltage continuing for a time corresponding to the travel of the transmitting and receiving means between bolt holes, and means whereby the signal voltage from the delay gate generator renders said indicating means effective.

2. A device as specified in claim 1, in which means are provided for generating a voltage which is a function of the rate of movement of the transmitting means, and means whereby said last-named voltage is applied to said delay gate generator to vary the duration of the delay period inversely as the rate of movement of the transmitting and receiving means.

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