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RAIL FLAW DETECTION DEVICE

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RAIL FLAW DETECTION DEVICE

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This invention relates to flaw detection in railroad rails by ultrasonic wave reflection techniques and more particularly to a device for supporting and guiding along the rail the vibrating electro-mechanical transducer which generates the ultrasonic waves, which may, for example, be a piezoelectric crystal.

In the drawings:

Fig. 1 is a vertical cross section through a rail showing the device positioned thereon;

Fig. 2 is a similar view showing the device tilted sideways;

Fig. 3 is a side elevation corresponding to Fig. 1;

Fig. 4 is a side elevation showing the device tilted rearwardly;

Fig. 5 is a sketch illustrating a track inspector examining a rail within the joint-bar limits;

Fig. 6 is a diagrammatic illustration showing how flaws are detected by changes in an audible signal;

Fig. 7 is a perspective view of the vibrating crystal unit separated from its holder; and

Fig. 8 is an edge elevation of the crystal unit on a larger scale.

For a better understanding of the device of the invention, the principles of flaw detection in rail joints by means of an audible signal generator will first be explained.

Referring to Fig. 6, a quartz crystal, designated X, X₁, X₂ or X₃, according to its placement, is applied to the center of a rail and vibrated by means of a suitable oscillator at a frequency of several megacycles. A film of oil is spread on the rail to be tested, to furnish good transmission of the ultrasonic waves, and the crystal is placed in contact with the oiled surface. The waves travel downwardly through the steel in a column corresponding approximately to the width of the crystal and are reflected from the first surface they strike. When the reflected surface is substantially parallel with the top surface of the rail, the waves are reflected back to their point of origin and a standing wave is set up in the rail. The electronic circuit which vibrates the crystal is so designed as to produce an audible tone in headphones worn by the operator, as shown in Fig. 5.

When the ultrasonic waves travel the full depth of the rail and are reflected from its bottom surface, as indicated in connection with the crystal X, the audible tone may have a frequency, for example, of 1000 cycles per second.

If the crystal is positioned over a bolt hole, as shown in connection with crystal X₁, the waves

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will be reflected sooner and a proportionately lower pitched tone of, for example, 500 cycles will be heard. If a crack exists in the web of the rail immediately under the head, as shown in connection with crystal X₂, a still lower pitched tone will be heard. The nearer the reflecting surface is to the top of the rail the lower the tone will be. Bolt holes are readily distinguished from cracks and other flaws because their position is always known from observation and the operator moreover quickly learns to recognize their characteristic tones. An oblique bolt hole crack such as that indicated in connection with the crystal X₃ is identifiable by the absence of a tone immediately next to a bolt hole, such absence being due to the fact that the reflecting surface is not parallel to the top surface of the rail and the waves will be reflected at an angle. Since they do not return to their point of origin there will be no standing wave and no tone other than the slight background noise inherent in the apparatus.

Certain other defects will also make it impossible to hear the characteristic tone observed over a good rail. This includes "shelly" spots on the top center of the rail, horizontally split heads and chipped or badly battered rail ends.

The electrically vibrated crystal used to produce vibrations in the rail may be a flat wafer-type X-cut quartz crystal as illustrated in Figs. 7 and 8. This crystal X has electrical terminals in the form of a silver-plated area 10 on its upper or top surface and another silver-plated area on its lower or under surface which preferably extends up one side as indicated at 11. Connections in the form of fine wires 12 are soldered to these separated plated areas which, in effect, make the crystal the dielectric of a two-plate condenser. To protect the bottom or working surface of the crystal and its silver plating from wear, a thin plate 14 of quartz is attached to the under surface by cement 15. A quartz wear-plate is preferred because of its hardness and long-wearing qualities but other long-wearing dielectric materials, such as synthetic resins or glass, may be used. The terms "transducer unit" and "crystal unit" are to be taken as including the wear plate, if any, which is affixed to the crystal or other transducer.

In testing rails by this method it is absolutely essential that the flat under surface of the crystal unit be centered on the rail and maintained flat thereon. Heretofore the crystal has been mounted in a hand-held head which is capable of resting flat on the rail of its own weight. This,

however, has required that the operator stoop over to apply it to the rail. This is not only tiring to the operator but reduces the number of rail joints which he can effectively inspect in a day.

It is the principal object of this invention to provide a transducer-holding device with a long handle so that the operator can test rail joints in a standing position as he walks along the track. The use of a long handle however introduces, by reason of its leverage, difficulties in properly applying the crystal in its necessary flat centered relation to the rail. If the crystal is cocked in any direction so that it does not lie absolutely flat on the rail, audible indications such as are produced by flaws will result. With a long handle on the crystal holder slight movements of the operator's hand will result in such cocking. The difficulties introduced by the use of the long handle attached to a crystal are eliminated by the novel crystal unit holder hereinafter described.

Referring to Fig. 5, the operator carries on his back in a knapsack 21 the battery-powered apparatus to which the headphones 21 are connected, through which he hears the audible signals. Extending from the knapsack is a cable 22 which is attached to the hand grip 23 of an adjustable, telescoping handle comprising the parts 24 and 25. These parts may be made of metal tubing and may be utilized as one of the conductors connected to the crystal. The other conductor is a rigid wire 26 extending from the hand grip 23 to an insulating block 28 and spaced from the tube 24. From the end of the wire 26 an extensible flexible wire 29 carries the high frequency current to the head 30 attached to the end of the tube 25. Within the head these two conductors are flexibly attached to the wires 12 connected to the crystal unit.

Referring to Figs. 1-4, the head 30 has spaced apart, downwardly-extending side members 31 and 32 between which a cradle 34 is suspended on centered pivots 35 so that it is free to rotate on a transverse axis. As shown, this cradle is shaped like an inverted rectangular box but may be otherwise formed. A crystal holder 36 is suspended in the cradle on pivots 38 so that it is free to rotate on a longitudinal axis which is at right angles to the aforesaid transverse axis. Thus, in effect, the crystal unit 39 is mounted in the head 30 in a gimbal. Preferably, the cradle 34 and the crystal holder 36 are mounted for limited rotation on their respective pivots so that they cannot turn so far as to place the crystal unit in an inoperative position. The bottom faces 40 and 41 of the crystal holder 36, fore and aft of the crystal unit 39, are beveled so as to slope upwardly away from the lower face of the crystal unit, as may be seen in Figs. 3 and 4, to facilitate sliding and prevent catching on surface irregularities. As may also be seen in these figures, the flexible wire connection 29 is removably attached to the head 30 through a binding post 42 which is internally connected to the crystal unit. This enables quick detachment of the entire head assembly by uncoupling the two sections of the handle.

To maintain the head 30 centered on a rail, an adjustable centering guide is provided in the form of an angular arm 44 slidably mounted in a transverse hole in the head 30, in which it may be secured by the thumb screw 45. The lower end of the guide extends downwardly below the bottom of the holder 36 at one side thereof and at

its lower end may be provided with a wear-resisting sleeve 46 which bears against the side of the rail head 48. This guide may be positioned on either side of the head for right or left hand operation.

While it forms no part of the invention and is not shown in the drawings, a switch may be incorporated in the hand grip 23 to control the power supply of the electrical equipment carried in the knapsack 20, the switch leads being included in the cable 22, so that the operator can easily turn the power on or off.

It will thus be seen that the device provides means for guiding a crystal unit along the head of a rail so that it is always maintained directly over the web 48 and so that it is always flat on the top surface of the rail, notwithstanding considerable up and down or sidewise movements of the operator's hand. The operator is thus enabled to proceed with great speed to make accurate tests of the rails without fatigue. The telescopic construction of the handle makes it possible to adjust the length thereof for the most comfortable operation.

It is to be understood that the details of the embodiment above particularly described are merely illustrative of the invention which is to be construed broadly within the purview of the claims.

What is claimed is:

1. A hand-operated ultrasonic rail inspection device comprising a handle of such length as to extend from the rail to the hand of an operator standing beside the rail, a head rigidly attached to said handle and having a pair of downwardly extending side members, a cradle pivotally supported on and positioned between said members for rotation about an axis, said cradle having a second pair of downwardly extending side members, a holder pivotally mounted on and positioned between the side members of said cradle for rotation on an axis substantially at right angles to said first mentioned axis, and a flat-faced electro-mechanical transducer unit which alone directly contacts the rail mounted in the bottom face of said holder and adapted to rest upon the top surface of a rail, the lowermost portions of said cradle and said holder terminating a sufficient distance above the bottom of said unit to permit substantial tilting of said head in all directions without bringing said portions into contact with the rail.

2. A hand-operated ultrasonic rail inspection device comprising a handle of conductive material of such length as to extend from the rail to the hand of an operator standing beside the rail, a head rigidly attached to said handle and having a pair of downwardly extending side members, a cradle pivotally supported on and positioned between said members for rotation about an axis, said cradle having a second pair of downwardly extending legs, a holder pivotally mounted on and positioned wholly between the legs of said cradle for rotation on an axis substantially at right angles to said first mentioned axis, a flat-faced electro-mechanical transducer unit which alone directly contacts the rail mounted in the bottom face of said holder and adapted to rest flat upon the top surface of a rail, the lowermost portions of said cradle and said holder terminating a sufficient distance above the bottom of said unit to permit substantial tilting of said head in all directions without bringing said portions into contact with the rail, and a pair of electrical conductors extend-

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ing from said transducer unit to the upper end of the handle, one of said conductors including the handle as a current carrying element.

3. A hand-operated ultrasonic rail inspection device comprising a handle of such length as to extend from the rail to the hand of an operator standing beside the rail, a head rigidly attached to said handle and having a pair of downwardly extending side members, a cradle pivotally supported on and positioned between said members for rotation about an axis, said cradle having a second pair of downwardly extending legs, a holder pivotally mounted on and positioned wholly between the legs of said cradle for rotation on an axis substantially at right angles to said first mentioned axis, a flat-faced electro-mechanical transducer unit which alone directly contacts the rail mounted in the bottom face of said holder and adapted to rest flat upon the top surface of a rail, the lowermost portions of said cradle and said holder terminating a sufficient distance above the bottom of said unit to permit substantial tilting of said head in all directions without bringing said portions into contact with the rail, said head having an adjustable centering guide extending downwardly below the bottom of said unit at one side thereof for engagement with a side of the rail to center the unit thereon.

4. A hand-operated ultrasonic rail inspection device comprising a handle of such length as to extend from the rail to the hand of an operator standing beside the rail; a head rigidly attached

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to said handle and having a pair of downwardly extending side members; an inverted-box-shaped cradle pivotally supported on and positioned between said members for rotation about an axis; a holder pivotally supported from and positioned within said cradle for rotation on an axis substantially at right angles to said first mentioned axis; and a flat vibratable crystal unit which alone directly contacts the rail mounted in the bottom face of said holder and insulated therefrom, said crystal unit comprising a crystal, separate electrically conductive coatings applied to the opposite flat surfaces of said crystal, and a wear plate attached to the coating on the lower face of the crystal for engagement with the top surface of said rail; the lowermost portions of said cradle and said holder terminating a sufficient distance above the bottom of said unit to permit substantial tilting of said head in all directions without bringing said portions into contact with the rail, and said cradle having limited rotative movement in said head and holder having limited rotative movement in said cradle.

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