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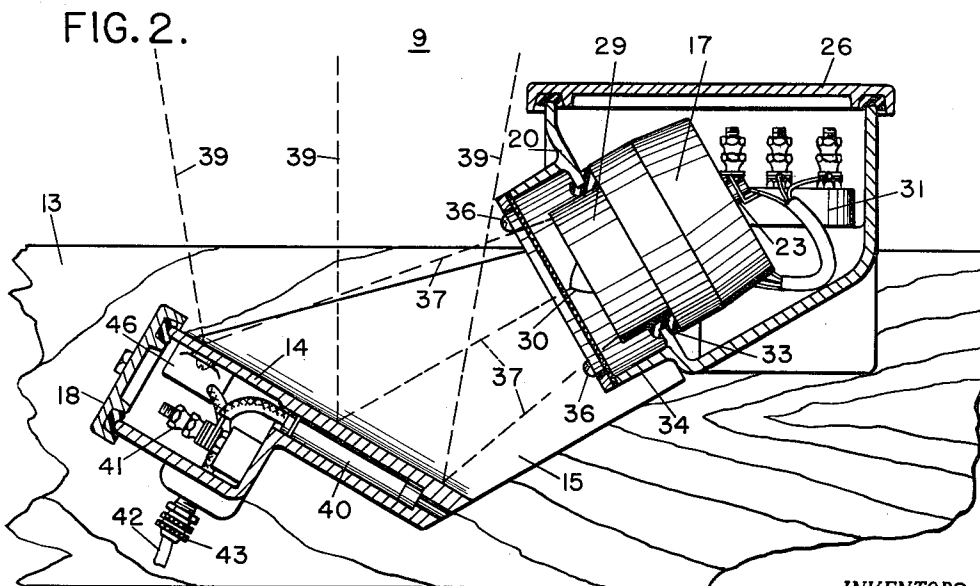
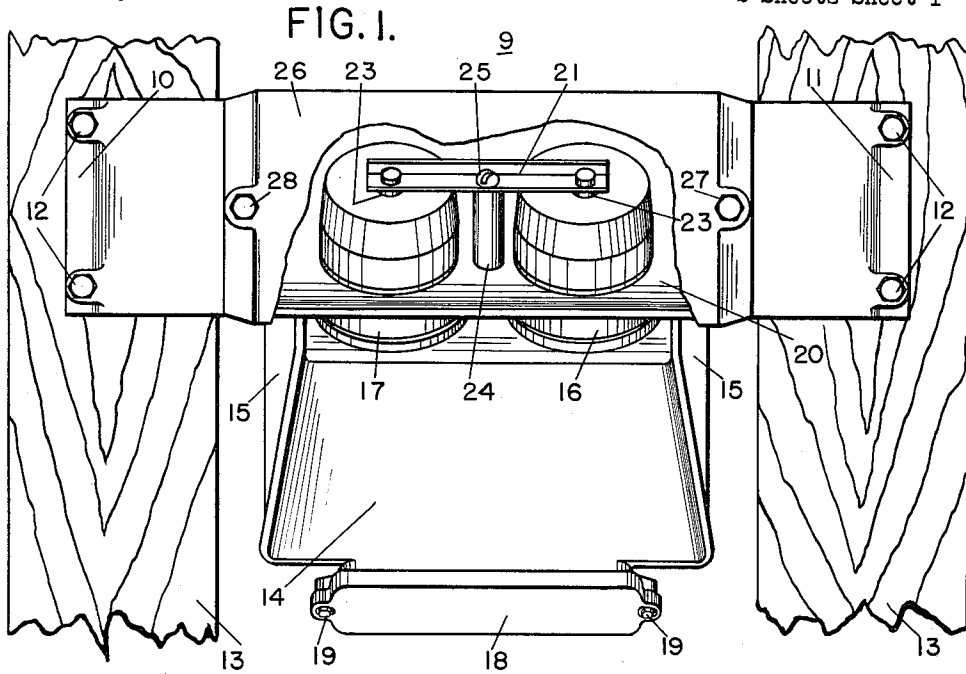
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PROTECTIVE CASING FOR ULTRASONIC TRANSDUCERS

Filed May 7, 1962

2 Sheets-Sheet 1



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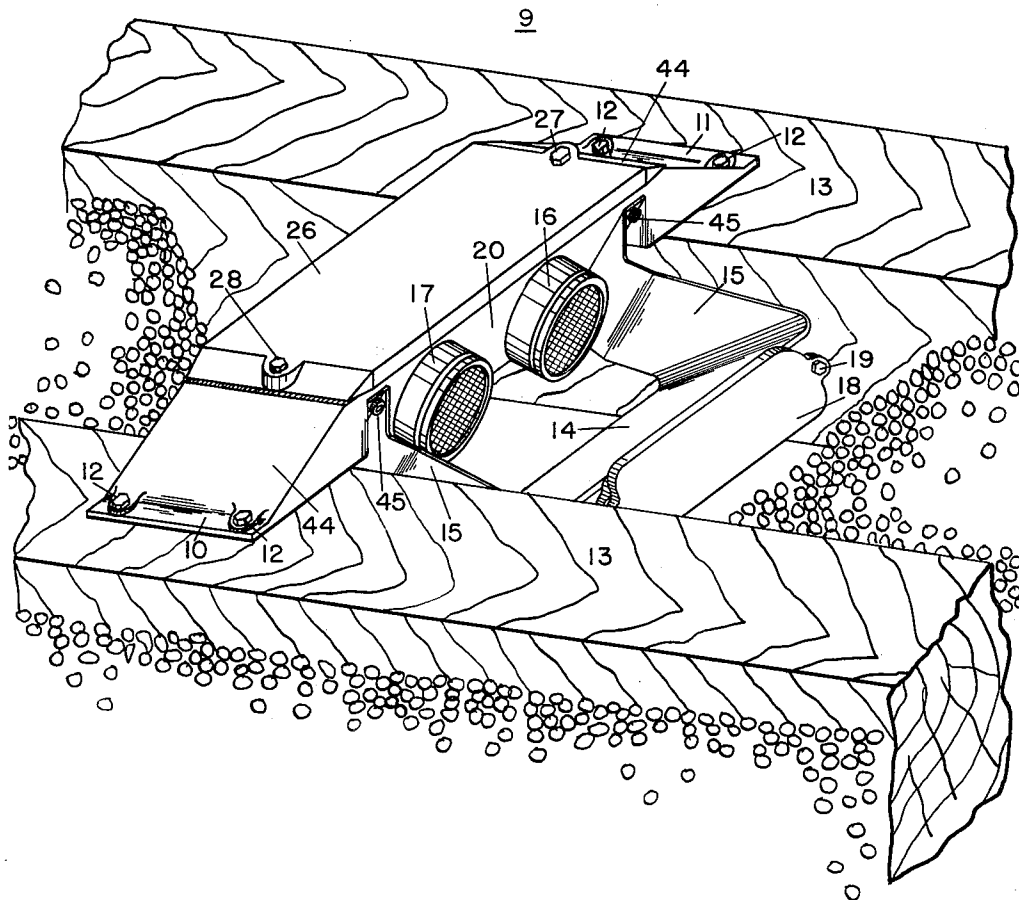
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2 Sheets-Sheet 2

FIG. 3.



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3,234,501

PROTECTIVE CASING FOR ULTRASONIC TRANSDUCERS

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Filed May 7, 1962, Ser. No. 192,770

2 Claims. (Cl. 340-1)

The present invention relates to a protective deflector casing for ultrasonic transducers and more particularly relates to such a casing wherein the arrangement of the transducers and the deflector element is of substantially open construction yet may be used out of doors.

A number of energy propagating and receiving systems are partially dependent for their operation upon the physical principle that certain energy forms when propagated onto a relatively plane surface are reflected therefrom at an angle equal to their angle of incidence. This characteristic is displayed among others by waves propagated in the extremely high micro-wave range, by light and sound waves. Many such systems, particularly in the field of detection of objects, employ this principle to direct the propagated wave in a selected direction and often to insure that an echo of useful strength is returned from the object to the source.

A number of problems arise when such detection systems are exposed to outside atmospheric conditions. An adequate protective casing must be provided to prevent damage to the components. The deflecting element must be kept free of snow, accumulated rainwater and must be constructed to allow foreign material, such as wind-blown dirt or the like, to flow from said deflector element.

Two important and somewhat conflicting considerations have determined the structure of such protective deflector casings when used out of doors. In order to protect the propagating and/or receiving elements from the enumerated hazards of exposure to the atmosphere, box-like structures have been employed with the deflector element inside and with a suitable orifice located therein through which the propagated waves are deflected by the deflector element in the desired direction. The same path of travel is employed for the return echo. Under these circumstances, the more box-like the protective casing, the greater is the tendency for it to cause extraneous reverberations, i.e., the multiple reflection of the propagated or received wave throughout the interior of the protective casing and the creation of undesirable echos. Another problem to be considered in a box-like protective deflector casing concerns the orifice through which the propagated and return waves must pass. The smaller the orifice the more easily it may be blocked by wind-blown debris, and should a protective screen be used to protect said orifice, water and dirt particles forming on said screen tend to attenuate the wave energy. Additionally, the larger the orifice the greater the tendency for debris to be accumulated in the base portion of the protective case.

An open construction of the protective deflector casing eliminates many of the aforementioned disadvantages, but it must be of such construction that it cannot be damaged by passing objects, and the structure must be such that snow, dirt or other signal attenuating materials will not adhere to the deflector element. Also it should be of such construction that reverberations and undesirable signal echos are eliminated without the need for special sound-absorbent materials.

For example, when electro-ultrasonic detection systems are used out of doors for detecting railway cars travelling over a given section of track, it is often desirable to mount

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the protective deflecting casing containing the transducer elements between the rails and to connect the transducers to the electronic transmitting and receiving components of the system located at some remote protected location. When such transducers are used as trackway instruments, the ultrasonic waves emanating from the transmitting transducer are propagated upwardly by means of a deflector plate and railway car presence is indicated by a return echo reflected from the underside of the railway car passing overhead back to a receiving transducer. In order to protect the transducers from inclement weather and dirt, the receiving and transmitting transducers are generally made to face downwardly, and the spaced relationship between the transducers and the deflector plate must be such as to insure the propagation of an ultrasonic echo from the underside of a passing railway car of sufficient strength to exercise a desired control. Moreover, the protective casing structure should be arranged in such manner as to protect the transducers mounted therein from damage caused by equipment being dragged along beneath the underside of a railway car passing overhead.

In view of the above, the purpose of the present invention is to provide a protective deflector casing for ultrasonic transducers, the deflector element of which is of substantially open construction to eliminate undesirable echos caused by reverberations yet permit the unit to be used out of doors. In furtherance thereof, one object of the present invention is to provide a metallic protective deflector casing for one or more ultrasonic transducers which may be used out of doors.

A further object of the present invention is to provide a protective deflector casing of the type described, the deflector element of which is of open construction to eliminate the need for sound absorbent materials in order to prevent extraneous multiple reflections.

A further object of the present invention is to provide a protective deflector casing for one or more transducers wherein the transducers face downwardly and the propagated sound waves may be reflected in a selected path of travel.

Another object of the present invention is to provide a protective deflector casing for protecting one or more ultrasonic transducer elements from damage by equipment being dragged along the underside of a railway car when the ultrasonic transducers are used as track instruments.

Another object of the present invention is to provide a protective deflector casing of the type described, the deflector element of which is provided with an electric heating element to prevent the formation of ice and snow thereon.

Another object of the present invention is to provide a protective deflector casing of the type described, the deflector elements of which are made from a single casting which may be individually replaced if damaged by dragging equipment from the underside of a railroad car passing thereover.

A still further object of the present invention is to provide a protective deflector casing of the character described which is inexpensive to manufacture requiring few machining operations to construct.

Other objects, purposes and characteristic features of the invention will be pointed out as the description of the invention progresses with reference to the drawings, in which:

FIG. 1 is a top plan view of a protective deflector casing constructed according to one embodiment of this invention with portions cut away to show the attached transmitting and receiving transducers;

FIG. 2 is a sectional side view of the protective deflector casing and transducer assembly and the deflector plate and the heating unit contained therein;

FIG. 3 is an isometric view of the protective deflector casing and the deflector plate.

Referring to the drawings, a protective casing constructed according to one embodiment of this invention is generally referred to at 9 and is illustrated in FIGS. 1 through 3 as being a six-sided metallic structure of general trapezoidal construction integrally connected to base plates 10 and 11. The assembly 9 is shown as being removably attached to a rigid member such as a pair of railroad ties 13 as by means of bolts 12. The deflector element 14 is shown as being the bight portion of a U-shaped assembly which is removably secured to a side plate 20 of the protective casing by any suitable means such as bolts 45 affixed to the flanged end piece of the assembly. The side plates 15 of the deflector assembly are integrally connected to the deflector element at an angle less than 90°.

A receiving transducer 16 and a transmitting transducer 17 are mounted normal to a wall of the protective casing assembly 9. The relative positioning of the lateral axis of the transducer heads and the deflector plate 14 is such that the transmitted ultrasonic waves are beamed at the undersurface of a railway car passing overhead, and the return echo is deflected from the deflector plate 14 to the receiving transducer 16 in order to exercise a suitable control. The deflector plate assembly is of completely open top and bottom construction in order to provide suitable drainage for rain water and debris.

The side plates 15 of the deflector plate assembly are flared outwardly to integrally join the deflector plate 14. This is necessary because the ultrasonic waves propagated by transmitting transducer 17 are generally conic shaped having a base portion the perimeter of which is on the order of 10° larger than the perimeter of the circular output portion of the transmitting transducer. Thus, the outward flaring of the side plates 15 generally follows the sides of the conic-like output wave, preventing the attenuation of the energy in the output wave and also preventing extraneous reflections of the wave from the side plates 15 from developing unwanted signal echos in the receiving transducer 16.

The junction of the side plates 15 and the deflector plate 14 is a curved section which is at an angle less than 90° in order to avoid certain characteristics inherent in the propagation of ultrasonic waves having quasi optical properties into square corners. Under these conditions, a wave projected onto the side plate of a square corner has a tendency to be reflected onto the base portion of the square corner in such a manner that the wave reflected from the base portion has a reflected angle equal to the incident angle of the wave propagated against the side plate. Thus, it can be seen with square corners there would be a tendency for some of the energy in the ultrasonic wave to be reflected back to the receiving transducer 16 again causing an unwanted echo. At one end of the deflector plate 14 is shown a compartment like structure having a removable upper plate 18 which is attached to a base portion cast into the deflector plate. This compartment houses a heating element and control thermostat for maintaining the deflector plate 14 at a substantially constant temperature.

The receiving transducer 16 and transmitting transducer 17 are mounted to the interior of the side-wall 20 of the protective casing by means of back plate 21 (FIG. 1) affixed to the base plates of the transducers by means of a suitable shock absorbent material such as the rubber washers 23. The back plate 21 is affixed to the interior of the side wall of the protective casing by means of a suitable support element such as the cylindrical support 24 affixed to the interior of the side wall of the protective casing by means of screw 25. As the specific mounting means for the receiving and transmitting transducers forms no part of the present invention, any suitable means for retaining the elements in registry with the side wall of the casing in such a manner that the lateral axis of the transducer heads faces the deflector plate 14 the desired angle

may be utilized. One such suitable means is shown in the pending application of John H. Auer, Jr., et al., Ser. No. 8,314, filed February 12, 1960, now Patent No. 3,046,544, issued July 24, 1962.

The casing 9 is preferably made from a strong metal having good heat radiating qualities yet which is light in weight. One such metal is Tenzoloy, an alloy of aluminum. The metallic casing is provided with a removable top plate 26 which is connected to the upper side plates by means of bolts 27 and 28 providing easy access to the remotely located electronic components of the ultrasonic detection system.

Referring to FIG. 2 of the drawings, it can be seen that the transmitting transducer 17 which may be of any standard configuration has a ring portion 29 and a centrally located inner member 30 spaced from the ring portion 29. The ultrasonic waves are transmitted in a generally diverging pattern from the space between the inner member 30 and the ring portion 29. Similarly, the receiving transducer 16 (not shown) receives the waves deflected from the underside of the railway car passing overhead in the space surrounding the inner member. A suitable terminal block is shown at 31 for operatively connecting the transmitting transducer 17 to the transmitting components of the system.

The transmitting transducer 17 is mounted normal to the side wall 20 of the protective casing preferably by means of a channeled shock absorbent resilient circular member 33 for retaining the transmitting transducer 17 normal to the face of the side wall of the protective casing. A circular flanged member 34, over which a protective debris screen is affixed by means of screws 36, is shown as being integrally connected to the side wall 20. The transmitted waves generally follow the conic shape pattern indicated by the lines 37 and are reflected from the deflector plate 14 as indicated by the lines 39. As the structure for disposition of the receiving transducer 16 within the side wall 20 is the same as that of the transmitting transducer 17 the above explanation will suffice as a description of both mounting arrangements.

The heater element 40 is inserted in a recess cast into the interior of the deflector plate 14 at the time of its manufacture and connected to an outside source of power by means of the terminal 41 electrically connecting the heating element with an outside source of power by means of the input cable 42 and the connector 43. The input cable 42 and the connector 43 are mounted on the underside of the deflector plate 14 to protect the cable from projections which might be hanging from a railway car passing overhead.

Also shown at 46 is a thermostat affixed to the interior wall of the heater compartment for maintaining the deflector plate 14 at a substantially constant temperature. The heater unit 40 heats the deflector plate 14 by conduction and the side plates 15 and protective casing 9 by means of conduction from the deflector plate. However, the conducted heat in the side plates 15 and the protective casing 9 is quickly radiated to the atmosphere by the broad areas of the casing which are exposed to the outside atmosphere and consequently, the deflector plate is heated to melt any snow or ice which might form thereon immediately and yet the receiving and transmitting transducer components are not affected by the heat. In other words, the open construction assembly is such that the thermal energy tends to be localized to the deflector plate 14 and does not affect the operation of the transducers or the other internal components.

If electrical power conservation becomes a factor, a thermostat which renders the heater element operative only when the outside temperature falls to a specified low value may be utilized. Thus it can be seen that in the first instance falling snow would be melted as a flake by flake basis and in the second instance a certain tolerable amount of snow might fall upon the deflector plate before it was melted and drained away by means of the

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inclined deflector plate 14 and the open bottom construction of the deflector element.

FIG. 3 of the drawing illustrates the trapezoidal configuration of the metallic protective deflector casing. It can be seen that the casing 9 is formed to have two upper side walls 44 which present a ramp-like structure in either direction of railway car passage in order to insure that equipment dragging from the underside of the passing railway car or the like will not damage the metallic casing or the dragging equipment by catching onto the protective deflector casing. It can also be seen that the side plates 15 of the deflector plate assembly are cast to be angled downwardly and are recessed below the level of the ties. This is to further insure that the deflector plate assembly will be completely protected from obstructions on the underside of a railway car. The U-shaped deflector plate assembly is removably connected to the side wall of the metallic protective casing by bolts 45 so that in the event the assembly is damaged or needs replacement for any reason, it may be quickly removed and another deflector plate assembly used to replace it. The open top and bottom construction of the deflector plate assembly also insures good drainage during inclement weather conditions and that wind blown paper and other debris will not be retained by the assembly. The absence of an inclosed deflector plate assembly also insures that extraneous reverberations caused by multiple reflections of the ultrasonic waves are minimal.

Thus, a compact metallic casing for one or more ultrasonic transducers has been provided with a deflector plate of substantially open construction in order to eliminate unwanted echos without the presence of special sound absorbent material in or about the deflector plate assembly. The protective deflector casing is also such that damage resulting from equipment being dragged along the underside of a railway car is minimal and the construction of the deflector assembly is such that it is adequately protected and yet is easily replaceable. Additionally, the deflector assembly has been provided with a heater unit internal to the deflector plate and the open construction of the unit insures adequate radiation of heat conducted from the deflector plate thereby insuring

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proper operation of the transducer equipment contained in the protective casing. The construction of the deflector plate is such that maximum propagation and reception of the ultrasonic signal occurs. Moreover, the open construction of the deflector plate assembly insures adequate drainage and a sufficient reflecting surface which is free from debris.

What we claim is:

1. Apparatus for mounting an electro-acoustic transducer below the path of vehicles and for providing an acoustical transmission path along the major energy axis of said transducer and also along a substantially vertical axis directed at the undersides of passing vehicles and comprising in combination, means for mounting said transducer with its major energy axis directed downwardly between the horizontal and vertical, a planar reflector plate, and means positioning said reflector plate substantially perpendicular to the angle bisector of the said major energy axis and said vertical axis, said positioning means consisting essentially of two substantially rigid members connected respectively between spaced portions of said reflector plate and said transducer mounting means, whereby said transducer is protected from the weather and said positioning means provides substantially no surfaces upon which snow and obstructions can accumulate.

2. The apparatus of claim 1 wherein each said rigid member comprises a substantially flat plate which is positioned in a substantially vertical plane to minimize the amount of surface upon which said snow and obstructions can accumulate, each said substantially flat plate forming an acute angle with said reflector plate.

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CHESTER L. JUSTUS, *Primary Examiner.*