United States Patent

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[73] Assignee
the United States of America, as represented by the Secretary of the Navy

[54] **ELECTRODE CONFIGURATION FOR TUBULAR PIEZOELECTRIC HIGH-STRAIN DRIVER**
5 Claims, 2 Drawing Figs.

[52] **U.S. Cl.** **310/8.2;** 310/8.7; 310/9.6; 310/9.7

[51] **Int. Cl.** **H01v 7/00**

[50] **Field of Search** 310/8.6, 8.7, 8.3, 8.2, 8.1, 9.6, 9.7

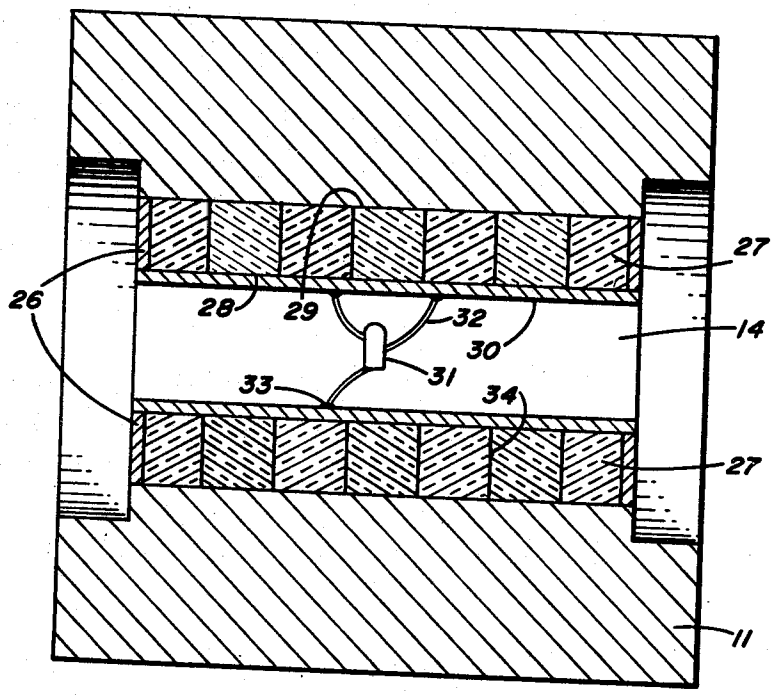
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ABSTRACT: A cylindrical piezoelectric high-strain ultrasonic driver made up of a plurality of ceramic rings is imbedded in the interior of a steel roller which is used in a rolling mill. Long service life is obtained from the ultrasonic piezoelectric transducer because of a close-fitting, thin-walled, brass tube epoxied into position inside the ceramic rings that make up the ultrasonic transducer. A spider facilitates connection between the brass tube and the power source.



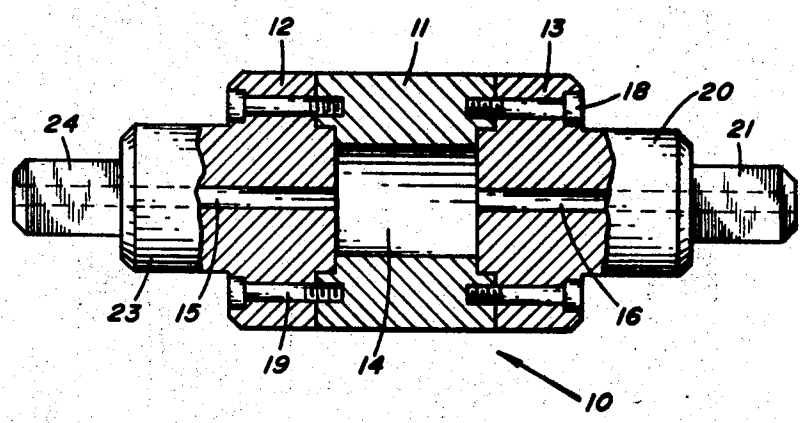


FIG. 1

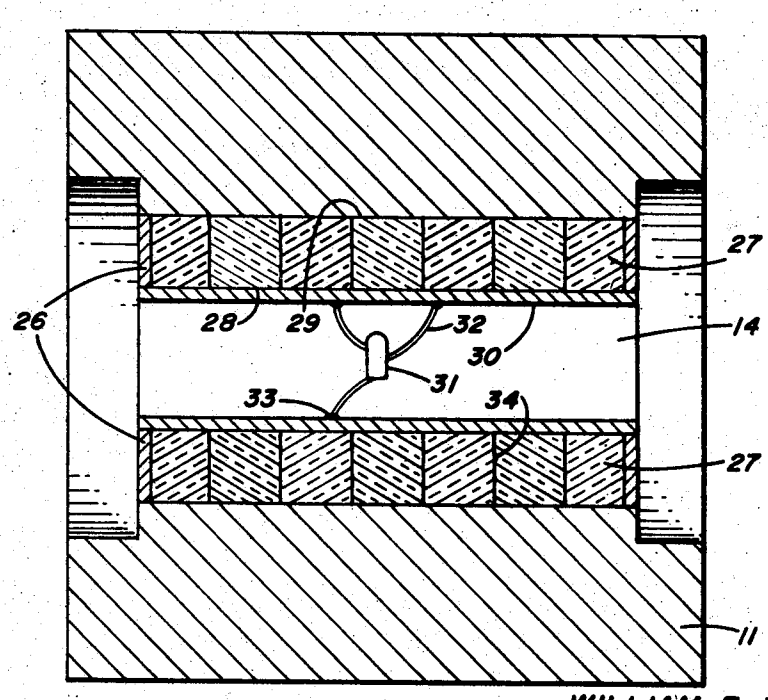


FIG. 2

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ELECTRODE CONFIGURATION FOR TUBULAR PIEZOELECTRIC HIGH-STRAIN DRIVER

STATEMENT OF GOVERNMENT INTEREST

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

This invention concerns ultrasonic piezoelectric transducers used in rolling-mill rollers, and more particularly, to the improvement of ultrasonic piezoelectric transducers by modifications which expand their useful working life.

Prior art piezoelectric ultrasonic transducers were very sensitive to both excessive driving power and vibrational energy. The application of these prior art transducers as a vibrational source for vibrating a roller used in rolling mills for rolling metal stock into sheets has presented many problems. Primary among these has been the problem of developing a piezoelectric transducer that has at least a reasonably long working life. Not until this invention has this problem been solved.

SUMMARY OF THE INVENTION

A machined close-fitting thin-walled brass tube is inserted inside a plurality of ceramic rings and cemented into place with conducting epoxy. This brass tube functions as the high potential electrode for all the ceramic rings used in making up the ultrasonic transducer. A spider connected to the brass tube at its center functions as the terminal for this electrode and facilitates connection between the transducer and power source.

OBJECTS OF THE INVENTION

An object of this invention is to provide an ultrasonic transducer for use in rolling-mill rollers that will be virtually immune to deterioration because of vibrational energy.

Another object of this invention is to provide a vibration-immune high-potential electrode for an ultrasonic transducer used in rolling-mill rollers that also acts to uniformly distribute the excitation potential.

A still further object is to provide a vibration-immune high-potential electrode that has a vibration-immune terminal for facilitating the connection of a power source to the electrode, which does not distract from the resonant efficiency of the transducer.

Other objects, advantages and novel features of the invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates, partly in broken away section, the interior of a standard roller used in a rolling mill within which the ultrasonic transducer of this invention would be placed; and

FIG. 2 illustrates in diagrammatical form the ultrasonic transducer of this invention, including the electrode construction, placed within the roller.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A piezoelectric transducer placed within the center portion of a roller as shown in FIG. 1, obviously encounters severe vibrations when it is called upon to produce displacement along the roller surface. As can be seen from FIG. 1, opening 14 is where the circular ceramic transducer would be placed. The central portion, 11 of the roller 10 is bored out along the axis of rotation of the roller to provide the opening 14. The

end portions 12 and 13 also have openings 15 and 16 bored into them. These openings provide for cable lead-in from a power source. Each of the end sections have shoulder sections 23, 24 and 20, 21, respectively. Shoulder sections 24 and 21 are of a square shape so they will fit into a standard rolling mill in a driveable fashion. Shoulders 23 and 20 are circular and have the same axis of rotation as the rest of the roller. The three sections of the roller; central section 11, and the two end sections 12 and 13 are kept together by a plurality of bolts 18 which are circumferentially placed about the axis of rotation of the roller.

FIG. 2 illustrates, in a diagrammatical form, the placement of a ring piezoelectric transducer within the opening 14 of the central section 11 of a roller constructed in the manner illustrated in FIG. 1. Ceramic rings 27 may comprise a ceramic material of lead-zirconate-titanate. These rings are placed in a stacked manner, as shown in FIG. 2, and are epoxied into position at the ground electrode side 29, to the interior of roller 11. The rings are machined to a very close tolerance so as to provide a very close fit between them. The boundary between each ring such as boundary 34 is filled with an epoxy cement. Teflon spacers 26 are placed at each end of the stack so as to provide electrical insulation between the rings and the end sections. The high-potential side of the ceramic rings 28, is connected to the power source by means of a thin-walled brass tube, 30, which is machined to very close tolerances for intimate contact with the inside of the ring stack. It is silver epoxied into place. The tube 30 thus functions as one high-potential electrode for the entire stack of ceramic rings. Besides providing a vibration-immune electrode and terminal for the high potential side of the piezoelectric transducer, the brass sleeve facilitates uniform distribution of excitation current to all the piezoelectric ceramic rings. A spider 31 having legs 32 is connected to the interior side of the brass tube by means of legs 32 which are soldered to the tube by silver epoxy joints 33. The spider facilitates connection of excitation leads to the power source. The leads from the power source are attached to the spider at its center which is the approximate nodel point of the entire assembly when the ceramic rings are resonating in a hoop mode. It can thus be seen that besides providing a more efficient ultrasonic transducer for this application, the brass-tube electrode in conjunction with the spider virtually eliminates high-potential electrode deterioration because of high vibrational energy generated by the transducer itself.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings.

We claim:

1. A cylindrical ultrasonic piezoelectric transducer disposed within a central opening extending axially through a solid roller comprising:
   - a plurality of ceramic rings in intimate contact with each other bonded to said roller by an epoxy joint; and
   - a tube of conducting metal bonded to the inside of said plurality of rings.

2. The ultrasonic piezoelectric transducer recited in claim 1 wherein said tube of conducting metal comprises thin-walled brass, machined for intimate contact with the inside of said plurality of rings.

3. The piezoelectric transducer of claim 1 wherein said tube is bonded to the inside of said ceramic rings by conducting epoxy.

4. The piezoelectric transducer of claim 3, further comprising a spider soldered to the center of said tube for facilitating connection of a power source to said tube.

5. The piezoelectric transducer of claim 4 further comprising an electrical cable from said power source connected to the center of said spider at the approximate nodel point of the transducer assembly.