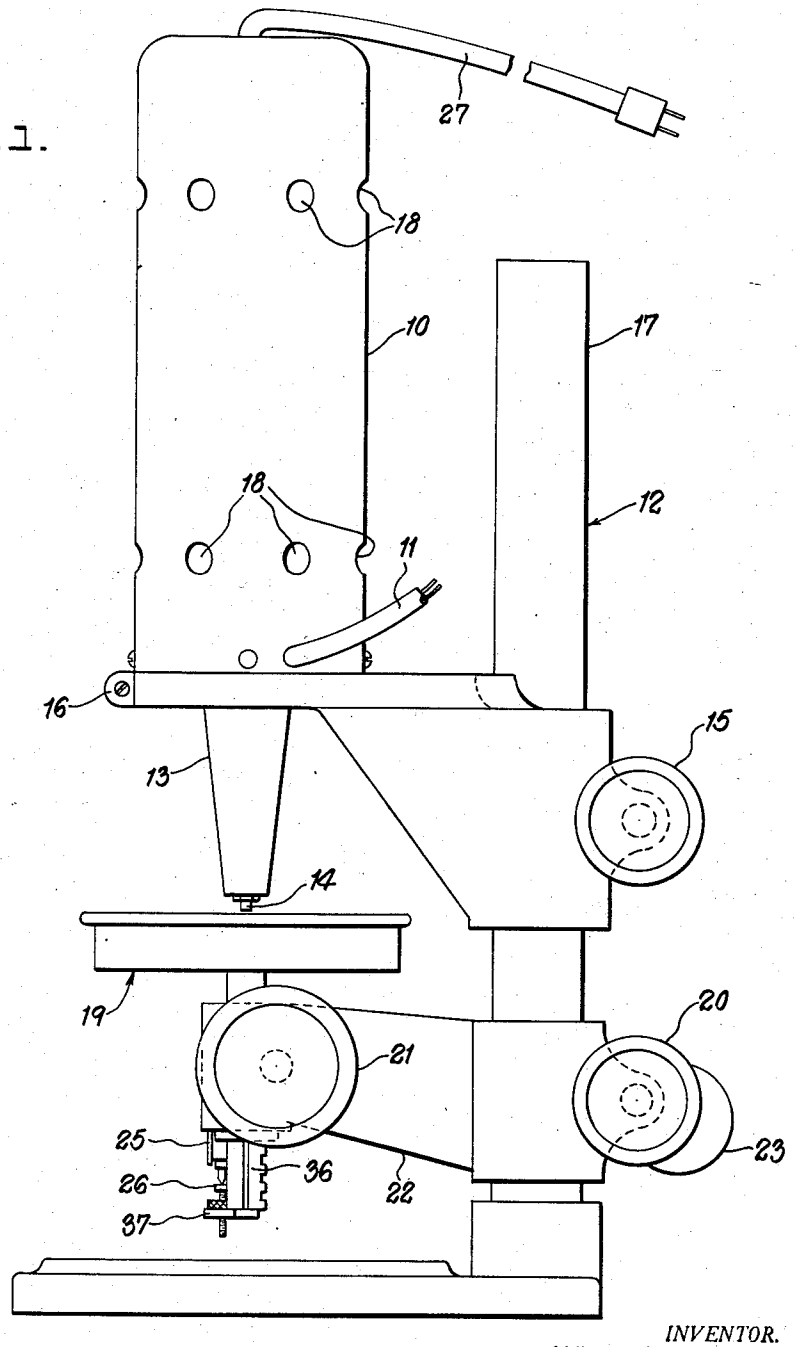
April 22, 1958 M. E. WEISS 2,831,295

ULTRASONIC DRILL

Filed Sept. 21, 1955 3 Sheets-Sheet 1

Fig. 1.



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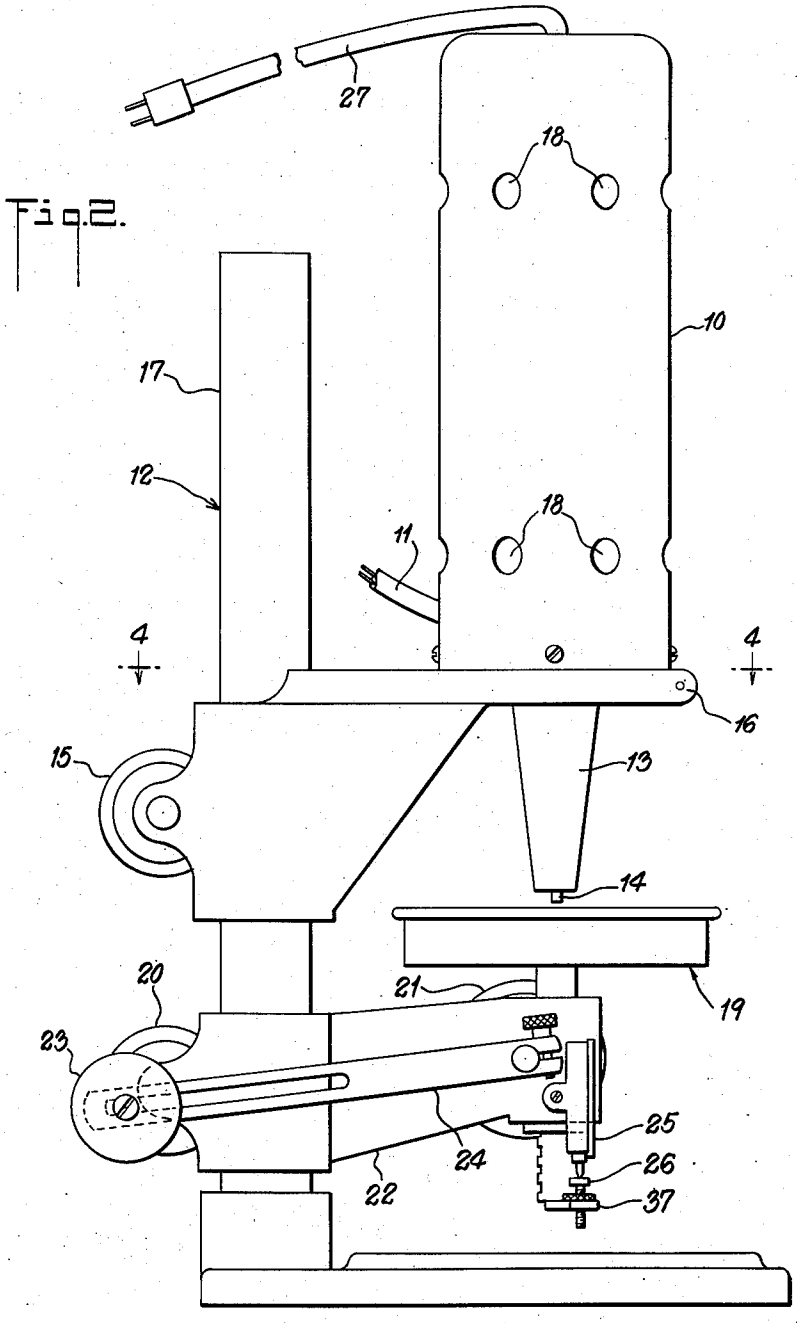
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Fig. 2.



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Fig. 3.

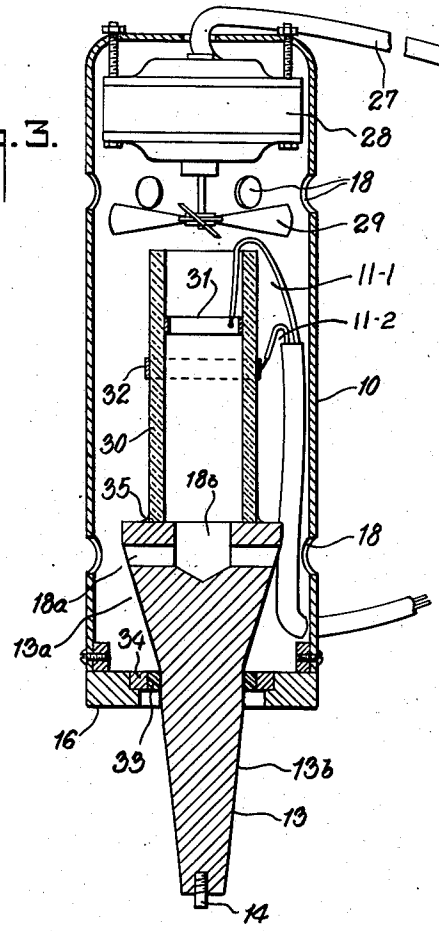
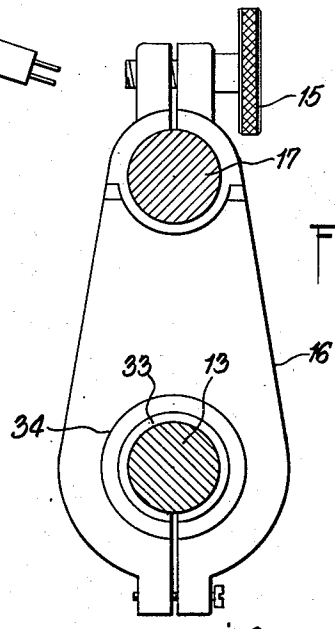


Fig. 4.



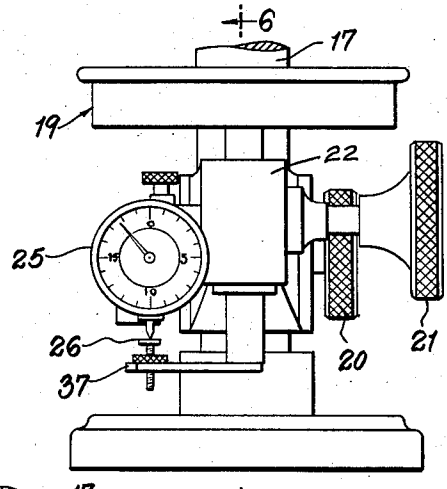
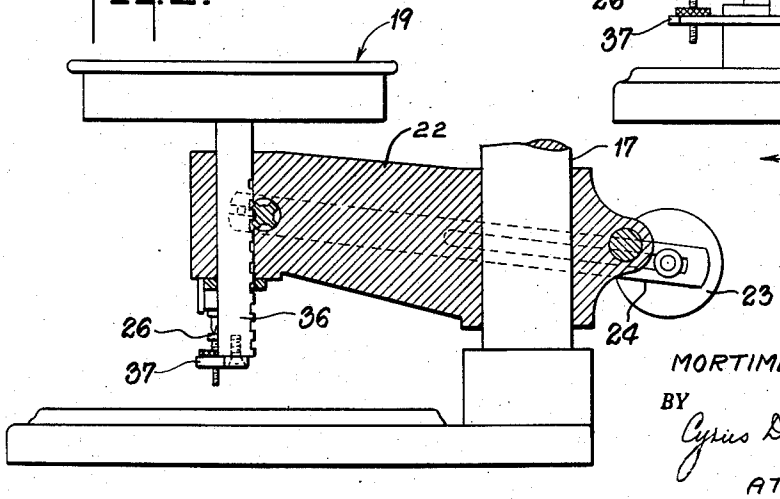


Fig. 6.



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Fig. 5.

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2,831,295

ULTRASONIC DRILL

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Application September 21, 1955, Serial No. 535,677

2 Claims. (Cl. 51—59)

My invention relates to ultrasonic drills and cutting equipment and in particular to those ultrasonic drills and cutters which are driven by piezoelectric elements.

A principal object of my invention is to provide means for coupling the piezoelectric element to the velocity transformer of the drill.

A further object of my invention is to provide means for mounting the velocity transformer so that the entire assembly is rigidly supported without restricting the operation of the machine.

A still further object of my invention is to provide means for attaching various tools to the velocity transformer.

A still further object of my invention is to provide means for cooling the piezoelectric element.

A still further object of my invention is to provide means for accommodating various sized velocity transformers to the same drill unit.

Other objects and advantages of my invention will be apparent during the course of the following description.

In the accompanying drawings, forming a part of this application, and in which like numerals are employed to designate like parts throughout the same,

Figure 1 is a side elevation of a preferred embodiment of my invention,

Figure 2 is a side elevation of the embodiment of Figure 1, viewed from the opposite side from that of Figure 1,

Figure 3 is a vertical sectional view of the housing of the preferred embodiment of Figure 1,

Figure 4 is a cross-sectional view along the line 4—4 of Figure 2,

Figure 5 is a front elevational view of the work table of the preferred embodiment of Figure 1, and

Figure 6 is a cross-sectional view along the line 6—6 of Figure 5.

In the drawings, wherein for the purpose of illustration, is shown a preferred embodiment of my invention, the numeral **10** designates the drill housing, the numeral **11** designates the generator cable and the numeral **12** designates the drill stand, generally. Velocity transformer **13** is a dual cone, the larger diameter cone being designated as **13***a* and the small diameter cone being designated as **13***b*. Tool tip **14** is suitably attached to the end of **13**. Transducer support **16** is held in place on drill stand post **17** by transducer support adjustment clamp **15**. Ventilation holes **18**, **18***a* and **18***b* serve to air cool piezoelectric element **30**, the air being kept in circulation by fan **29** which is driven by fan motor **28** whose power is supplied through cable **27**. The inner electrode connector **31** is electrically connected to electrical lead **11–1** and outer electrode connector **32** is electrically connected to electrical lead **11–2**. Electrical leads **11–1** and **11–2** together form the electrical elements of operator cable **11**. Bushing **33** is placed in flange mounting **34** of transducer support **16**. Bond **35** mechanically bonds **30** to **13**.

Ultrasonic drills and cutting tools, produced in accordance with my invention, are more stable in operation and produce better results than previously used equipment.

My design overcomes many of the disadvantages which existed heretofore.

To prevent stresses and possible fracture of the ceramic piezoelectric element **30**, I provide a bond **35** between **30** and velocity transformer **13** which possesses some compliance. This compliance permits a slight movement of **30** radially without appreciable attenuation of its desired longitudinal vibration. Bond **35** is composed preferably of an epoxy plastic or polymer or other suitable polymer with proper adhesive and acoustical properties. Other agents of similar bonding and compliance characteristics may also be employed. The longitudinal vibrations are utilized to drive velocity transducer **13** whose motion takes place along its axis.

Velocity transformer **13** is fabricated from a single piece of material with the basic shape consisting of two cones **13***a* and **13***b* with differing slopes, so combined that the nodal surface of **13** is located at the plane at which the transition from **13***a* to **13***b* takes place. The surface of velocity transformer **13** is cylindrical at this transition plane so that clamping of the assembly may be accomplished at the nodal surface.

Bushing **33** is placed on **13** at the nodal surface and mounting flange **34** is placed around **33**. Mounting flange **34** has a slot which may be aligned with the slot in transducer support **16**, thereby permitting the tightening means of **16** to suitably tighten both **16** and **34**. This mounting method permits the entire assembly to be clamped rigidly in place simply and easily and also makes it possible for a single transducer support **16** to be used for clamping variously-sized velocity transformers **13**. This may be accomplished by the use of suitably sized mounting flanges **34** with their outside diameters properly dimensioned so as to fit into transducer support **16**.

Bushing **33** is made of nylon or a like thin compliant material. Its function is to acoustically isolate the horn from the drill stand and its size may be changed within reasonable limits, thereby increasing the flexibility of the mounting so that varying sizes of velocity transformers **13** may be used in conjunction with a single transducer support **16**.

In operation, piezoelectric element **30** will get hot and crack after long service unless steps are taken to cool it. I choose to air-cool **30** by means of fan **29**, motor **28**, and ventilation holes **18**, **18***a* and **18***b*. The blades of fan **29** and its direction of rotation is so arranged that the air is drawn in through the lower holes **18** in housing **10** and out through the upper holes **18** in housing **10**. This draws cooling air along the outside surface of **30**. In addition, I have provided holes **18***a* and **18***b* in velocity transformer **13** which permits cooling air to be drawn up inside **30** and out through upper holes **18**. In this manner, greater cooling of **30** is achieved than is possible with outside air-cooling only, thereby providing sufficient cooling and eliminating the expense and inconvenience of liquid cooling.

Work table **19** is arranged so that it may be moved vertically along drill stand post **17** and clamped in places by tightening work table adjustment clamp **20**. The level of **19** is determined by work level adjustment **21** which cooperates with rack **36**. Limit screw **26** is now set so that **19** will move upward under the urging of extension arm **24** and weight **23** only as far as the setting of **26** will permit. This upward motion of **19** keeps moving the work toward tool tip **14** rather than requiring the tool tip to be moved down as the drilling takes place in the work. More accurate drilling and cutting is possible when the work is moved toward the tool tip because it is possible to mount the drill housing **10** rigidly and thereby accurately position **13** and **14**. Dial indicator **25** is employed to set limit screw **26** and to read the depth of cutting or drilling directly. Limit screw arm **37** serves to mechani-

cally couple the action of limit screw **26** to the resultant level of **19**. Limit screw arm **37** is rigidly attached to work table rack **36** and indicator **25** is fixedly attached to work table support **22**. **36** moves up and down with relation to **22** and it cannot move beyond the setting of **26** because as **36** rises, **26** also rises and depresses the element of **25** with which it is in contact. When this element of **25** is pushed completely into the housing of **25** under the urging of **26**, the upward motion of **26**, **36** and **19** with respect to **22** will stop.

Tool tip **14** is hard soldered onto a screw stud or is shaped from the screw stud itself. Various shapes of **14** may be used. This drilling method is particularly advantageous for cutting holes with sharp corners such as squares, triangles, etc. I have preferred to tap the end of **13** and to screw **14** into the tapped hole until the end of **14** "bottoms" firmly into the tapped hole. When **14** is made of a capped screw, namely one in which the working end of the tool is larger in cross-section than the threaded portion, it is necessary for the end of the tool tip **14** to "bottom" firmly and for the cutting end of the tool to be seated firmly against **13**. When the tool **14** is to be subjected to long, continued use, it is advisable to melt a small amount of shellac or similar material onto the threads of **14** and in the tapped hole of **13** before screwing of **14** into **13**. This serves to securely bond **14** to **13**.

In addition to the special techniques, herein described, standard ultrasonic drilling and cutting processes may be employed during use of ultrasonic drills produced in accordance with my invention. Examples of the standard ultrasonic drilling and cutting processes referred to above are those which employ liquid solutions of abrasive particles to accomplish the cutting and those in which the drill moves toward the work which is held in a stationary position.

While I have described my invention by means of specific examples and in a specific embodiment, I do not wish to be limited thereto, for obvious modifications will occur to those skilled in the art without departing from the spirit of my invention or the scope of the subjoined claims.

Having thus described my invention, I claim:

1. An ultrasonic drill comprising a hollow, piezoelectric ceramic, cylindrical body, a velocity transformer bonded to said cylindrical body by compliant bonding means, tool means attached to said velocity transformer, housing means containing said cylindrical body and said velocity transformer, air circulation means within said housing means, housing support means, work carrying means and support means supporting said housing support means and said work carrying means, said velocity transformer being formed of two joined truncated cones of differing base radii and with a common axis, the base of said cone with smaller base radius being of substantially the same dimensions as the smaller base of said cone with larger base radius and joined to said smaller base of the cone with larger base radius at the nodal surface of said velocity transformer, said velocity transformer being supported at said nodal surface, said velocity transformer carrying openings therein, one of said openings being in the larger base of said velocity transformer adjacent said cylindrical body, at least one opening being in the surface of revolution of said velocity transformer, said openings being connected within said velocity transformer, said air circulation means being positioned so as to circulate cooling air over the surfaces of said cylindrical body, the inner surface of said cylindrical body being cooled by air drawn through said openings carried by said velocity transformer by said air circulation means.

2. An ultrasonic drill comprising an electro-mechanically sensitive body, a velocity transformer bonded to said electro-mechanically sensitive body by compliant bonding means, tool means attached to said velocity transformer, housing means containing said electro-mechanically sensitive body and said velocity transformer, air circulation means within said housing means, said air circulation means being positioned so as to circulate cooling air over the surfaces of said electro-mechanically sensitive body, housing support means, work carrying means and support means supporting said housing support means and said work carrying means, said velocity transformer being formed of two joined truncated cones of differing base radii and with a common axis, the base of said cone with smaller base radius being of substantially the same dimensions as the smaller base of said cone with larger base radius and joined to said smaller base of the cone with larger base radius at the nodal surface of said velocity transformer, said velocity transformer being supported at said nodal surface, said work carrying means comprising a table, a weight, extension arm and travel limiting means such that when said ultrasonic drill is operated in its normal and intended manner said weight and extension arm urge the object being worked upon toward said tool means, said travel limiting means limiting such travel to a predetermined amount.

References Cited in the file of this patent

UNITED STATES PATENTS

2,423,306	Forbes	July 1, 1947
2,497,172	Kean	Feb. 14, 1950
2,580,716	Balamuth	Jan. 1, 1952
2,616,223	Jonker	Nov. 4, 1952
2,632,858	Calosi	Mar. 24, 1953
2,651,148	Carwile	Sept. 8, 1953

OTHER REFERENCES

"Design News," volume 9, No. 20, October 15, 1954 pages 38 and 39.