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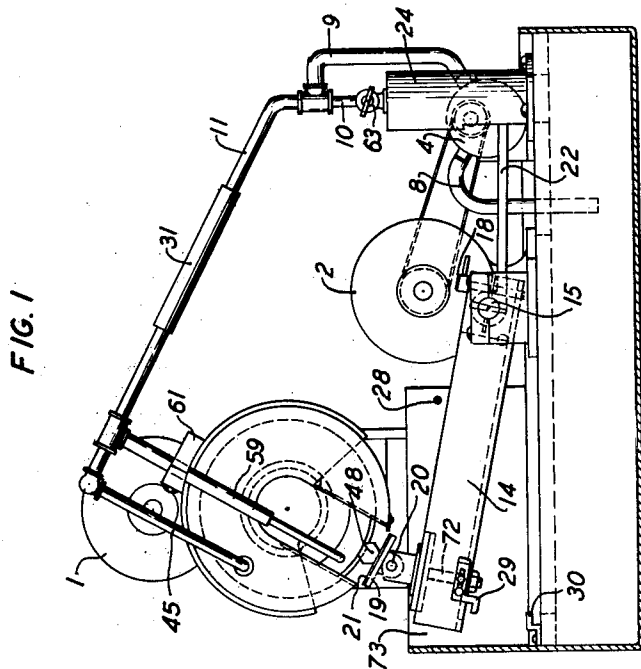
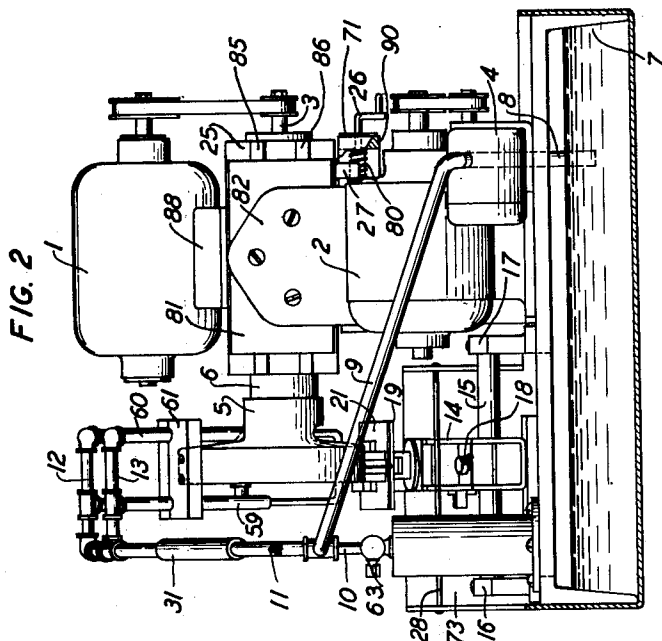
C. A. BIELING ET AL

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CUTTING TOOL

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2 Sheets-Sheet 1



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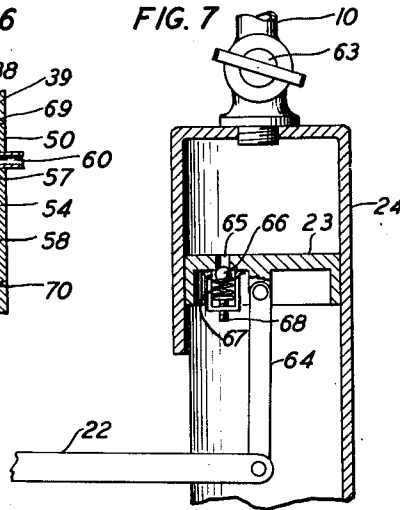
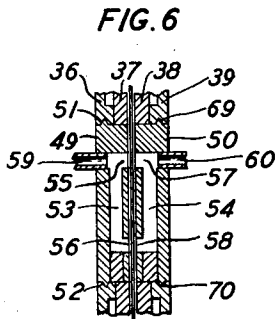
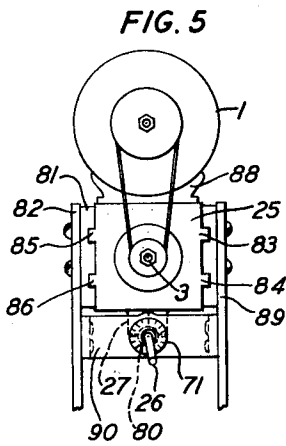
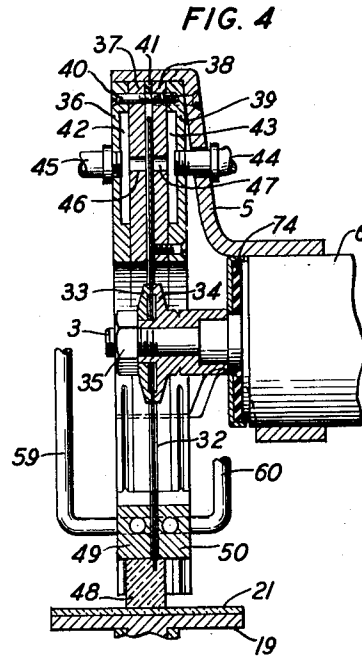
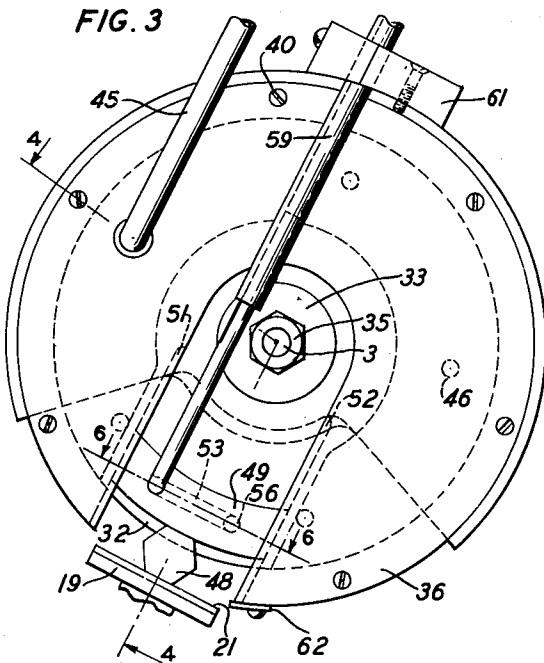
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2 Sheets-Sheet 2



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CUTTING TOOL

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9 Claims. (Cl. 125—12)

This invention relates to a tool having a movable element and particularly to a cutting tool having a movable blade for cutting thin plates.

An object of the invention is the stabilization of the movable element of such a tool when in motion.

A more specific object of the invention is the prevention, during movement of the element, of deleterious vibrations perpendicular to its plane of motion.

In accordance with a feature of the invention a fluid (liquid or gas) is maintained under pressure on each side of the movable element being introduced, preferably, through holes provided in flat plates positioned on each side of the movable element, the separation between the plates and the movable element being relatively small so that the fluid, upon passing through the holes, extends in the form of a film all the way across the surface of the plates, acting as a cushion, so to speak, and preventing appreciable motion of the movable element perpendicular to its plane.

According to another feature of the invention the fluid containing chamber is so arranged that the stabilizing medium may be applied to the very edge of the movable element of the tool at the start of the work, provisions being included whereby a section of the chamber is gradually withdrawn from the edge portion of the element as the work progresses.

It is well known that if a plate be cut from certain crystalline bodies such, for example, as quartz, in a definite manner with respect to the crystallographic axes of the body, the plate will exhibit the piezoelectric effect. Such plates, particularly those cut from quartz "mother crystals", are now commonly used in electrical circuits where a constant frequency is essential and are of increasing importance in connection with wave filters and other electrical networks.

In accordance with methods heretofore followed in connection with the production of a piezoelectric plate from the natural crystal, considerable waste results. The greatest part of this waste results from the cutting and grinding operations. For example, plates used in wave filters are ordinarily about .5 millimeter in thickness and to obtain such a plate a slab 4 to 5 millimeters in thickness is usually cut from the "mother" crystal. The plate is then ground down to the exact thickness. Since the width of the cut produced by the saw of the type heretofore used in the operation is about 2 millimeters, it is obvious that considerable waste results from the cutting and grinding operations.

It has been recognized that this waste could be largely eliminated if thinner slabs could be cut and that the grinding operation could be eliminated entirely if the plate could be cut to the exact desired thickness, i. e., in the above example, .5 millimeter. To accomplish this, it has been proposed to use a very thin disc saw instead of the thicker saw heretofore used. It has been found, however, that the use, for this purpose, of thin disc saws of the type heretofore known, is impractical due to the fact that such saws are, due to their thinness, unstable in their motion and subject to vibrations perpendicular to the plane of the blade. Such vibrations render the saw useless for cutting piezoelectric plates not only because an irregular cut results but because fracture of the plate is apt to occur as such plates are not able to support any appreciable motion along their smallest dimension.

A thin disc saw stabilized in accordance with the features of this invention has been found to be particularly valuable for cutting piezoelectric plates as deleterious vibrations perpendicular to the plane of the blade are prevented and the invention is therefore being described in connection with such use. It should be understood, however, that the invention is by no means limited to this specific use but is applicable wherever it is desirable to stabilize the movable element of a tool. Further, the use of water as a damping medium is being described but it should be understood that the invention contemplates the use of other fluids as well.

A complete understanding of the invention and an appreciation of its various features may be obtained by considering the following detailed description in connection with the annexed drawings in which:

Fig. 1 is a side elevation of a machine for cutting piezoelectric plates which embodies features of the invention;

Fig. 2 is a rear elevation of the machine;

Fig. 3 is a side elevation of a portion of the machine showing the blade and plate assembly in greater detail;

Fig. 4 is a sectional view of the blade and plate assembly taken on lines 4—4 of Fig. 3;

Fig. 5 is a side elevation of a part of the machine (taken from the side opposite to that shown in Fig. 1) showing an end view of one of the motors and associated driven and adjusting mechanisms;

Fig. 6 is a sectional view of the blade and plate assembly taken on line 6—6 of Fig. 3; and

Fig. 7 is a sectional view of a part of the feed-

ing mechanism which controls the movement of the crystal against the cutting blade.

Referring now to the drawings, two driving motors 1 and 2 are shown, motor 1 connected to drive spindle 3 by means of a belt, and motor 2 driving liquid pump 4 also by means of a belt.

A guard member 5 is mounted on spindle housing 6 and serves to position and support the stabilizing plates which will be described presently. A water reservoir 7 is provided in the base of the machine from which the pump, when in operation, draws water through pipe 8 and supplies it under pressure through pipe 9 to pipes 10, 11, 12 and 13.

Feeding member 14 is clamped at one end to bar 15 which, in turn, is rotatably supported by members 16 and 17. By releasing clamping member 18, the frictional contact between members 14 and 15 is reduced and member 14 may then be moved horizontally along member 15. A table 19 is mounted on the free end of member 14. This table may be provided with a glass face 21 the purpose of which will be subsequently described.

Bar 15 is rotated (thereby resulting in movement of member 14) by movement of bar 22 the movement of which, in turn, is controlled by piston 23 which is movably positioned within chamber 24. The construction and operation of this portion of the assembly will be described more in detail presently.

A stop bar 28 is provided which limits the upward movement of member 14 while bracket members 29 and 30 may be used to hold 14 in lowered position when the machine is not in use.

As shown in Figs. 2 and 5, motor 1 is mounted on base 88 which, in turn, is supported on member 25. Member 25 is slidably supported by member 81, being provided with four rectangular projecting members 83, 84, 85 and 86 which are positioned in corresponding grooves provided in 81, member 25 being capable of longitudinal movement with respect to member 81. Member 81 is rigidly supported from the base of the machine by flanges 82 and 89. These flanges also serve as a mounting for bracket 90 which supports lead screw 80 and handle 26, by means of which the screw may be operated. The lead screw assembly is rigidly supported so that no longitudinal movement of the screw can take place. A threaded member 27 is rigidly attached to movable member 25, its thread engaging with the thread of lead screw 80 so that rotation of the screw causes a longitudinal movement of member 27 resulting, of course, in a similar movement of member 25 to which it is attached. It will be clear that, as member 25 is moved longitudinally, motor 1 as well as guard 5 (and the plate and blade assembly and pipes supported thereon,) will be moved in a corresponding manner. A flexible portion 31 is provided in pipe 11 in order to allow for movement of the part of the pipe line which is attached to guard 5.

As more clearly shown in Figs. 3 and 4, a diamond charged cutting disc 32 is attached to spindle 3 by flanges 33 and 34 and nut 35. A pair of plates is positioned on each side of the disc comprising respectively plates 36 and 37 and plates 38 and 39. The pair of plates are fastened together by a number of screws 40, a washer 41 serving to provide the proper separation between the disc 32 and the adjacent plates. The assembled plates are rigidly attached to and supported by guard 5.

The outer plate of each pair, i. e. 36 and 39, is

recessed so that, when the pairs of plates are assembled, fluid chambers 42 and 43 are formed. Fluid is supplied to these chambers through branches 44 and 45 of pipe 12. The inner plate of each pair, i. e. 37 and 38, is provided with a series of holes 46, 47, which are equally spaced over the area of the plates and which act as jets and allow the fluid to pass from the chambers and contact with the disc 32.

As shown in Fig. 3, the plates just described do not enclose the entire surface of the disc, a gap being provided so that the crystal 48, which is being cut, may be brought into contact with the cutting disc. In order, however, that the stabilizing force may be applied to substantially the entire area of the disc, retractile plates 49 and 53 are provided. These plates are supported in grooves 51 and 52 and 59 and 60 provided in plates 36 and 39. The separation between these plates and the disc is the same as that between plates 37 and 38 and the disc.

Fluid chambers 53 and 54 are provided in plates 49 and 50, respectively while holes 55, 56, 57 and 53 act as jets and allow the fluid from the chambers to contact with the disc. Fluid is supplied to these chambers through branches 59 and 60 of pipe 13. These branches are supported in clamping block 61 which is in turn supported on guard 5. A telescoping section is provided in branches 59 and 60 so that they may "shorten" as plates 49 and 50 are retracted. These plates normally rest in their "extended" position, i. e. with their outer edges flush with the edges of plates 36 and 39, and rest against member 62.

Referring now particularly to Fig. 7, the piston 35 and chamber used in controlling the movement of feeding member 14 are shown in section. Water is supplied under pressure to chamber 24 through pipe 10, shut-off valve 63 being provided therein. When water is supplied to the chamber, piston 23 is forced downward and, due to the pivoted connection of piston arm 64 and arm 22, causes movement of feeding member 14 to bring the table 19 closer to cutting position. A hole 65 is provided in the face of piston 23 being normally closed 45 by ball 66 which is held in position by spring 67. The tension in spring 67 is controlled by screw 68 and is so adjusted that, should any unusual resistance be produced in the feeding linkage and be transmitted to the piston as "back-pressure" 50 resisting further downward movement thereof, the water will force ball 66 away from the hole 65 and escape therethrough thereby allowing the piston to remain stationary and preventing further motion of the crystal towards the edge of the disc. 55

It is believed that a description of the machine in actual operation may further complete understanding of the features of the invention. Assuming therefore that all parts of the machine are in normal position, feeding member 14 being in lowered or horizontal position and held by members 29 and 30, plates 49 and 50 in lowered position and resting against member 62, shutoff valve 63 in closed position and so on. Assuming, further, that it is desired to cut a number of thin piezoelectric plates from crystal 48; the crystal is mounted on table 19, the orientation of the crystal section first having been determined and the crystal properly aligned with regard thereto. Various methods of mounting the crystal on the table may be followed. For example, it may be cemented to a glass plate 21 affixed to the surface of table 19. The table is properly lined up with respect to disc 32 by releasing clamping member 18 and moving 14 horizontally along bar 15 to the

desired point whereupon member 14 is again clamped to bar 15 by rotation of member 18. Adjustment of the position of the crystal itself with respect to member 14 may be obtained by rotation of table 21 about its pivot 20 and bolt 72. Further relative adjustment of the crystal and cutting disc may be obtained, if desired, by operation of crank 26, which, as previously pointed out, results in a horizontal movement of the disc itself.

The proper relative location of crystal and disc now having been obtained, motor 2 and pump 4 are set into operation. Water is now supplied under equal pressure to chambers 42 and 43 and to chambers 53 and 54 and, passing through the equally spaced holes in plates 37 and 38 and holes 55, 56, 57 and 58 in plates 49 and 50, strikes each side of disc 32 with equal force causing it to take up a position midway between plates 37 and 38. This "centering" operation before the disc has been started is desirable as, if it were not carried out, the disc might start rotating when in actual contact with either one of the adjacent plates which would result in undue friction and possible damage to the edge of the disc.

Motor 1, which, as previously mentioned, drives the cutting disc is now set into operation. Since the separation between the disc and the adjacent surfaces of the plates is relatively small, a film of water now extends all the way across the plate surfaces which are adjacent to the disc. This film of water tends to resist any motion of the blade which is perpendicular to its plane as, if the blade be forced over on one side suddenly, it compresses the film of water on that side and a large restoring force is imposed on the blade which tends to shove it back to the center position midway of the plates. At low frequencies this force is mainly resistive and is due to the fact that the film of water is caused to flow out between the disc and the surface of the plate, which flow is resisted by the viscosity of the water. This effect is directly proportional to the viscosity of the water and inversely proportional to the square of the separation of the blade and the plates. Another force, due to the static pressure of the water, is also effective to restore the blade to mid-position for it is apparent that if the blade be pushed to one side, the water will flow out more freely on the opposite side and the static pressure becomes higher on the side having the smaller separation than on the other side. This force, due to the difference in static pressure, is equivalent to the stiffness reaction and also tends to keep the blade in the central position.

The cutting blade now being in operation and its stable performance having been assured, holding members 29 and 30 are disengaged and cut-off valve 63 is opened. Water entering chamber 24 under pressure forces piston 23 downward and due to the linkage connection with the pivoted end of member 14 causes table 19 to be raised and crystal 48 to be forced against the edge of retractile plates 49 and 50. A certain resisting force is encountered to the retraction of the plates due to the pressure of the water in pipes 59 and 60 and in the fluid chambers 53 and 54 but the valve (ball 66 and spring 67) in the face of piston 23 is so adjusted that, under normal conditions, this resisting force is overcome and the upward movement of the crystal continues forcing the retractile plates upward along grooves 51, 52, 69 and 70. This movement continues as the blade contacts the crystal and makes the cut therein. As the cut progresses water is forced into it on

both sides of the blade edge thereby assisting in stabilizing its motion. This stabilizing fluid at the same time performs another valuable function, that is, it cools the edge of the blade.

Should any unusual resistance to the advancement of the cut be encountered due, for example, to the presence of foreign material in the crystal the valve in the piston will, as previously pointed out, open and allow escape of the water through hole 65 thereby interrupting forward motion of the crystal and possible damage to the blade.

As the cut is completed, further forward motion of member 14, which might result in damage to the table and blade, is prevented by stop bar 28.

In order to bring the blade into proper position for the next cut, crank 26 may be rotated. A dial 71 is provided, suitably graduated, to indicate the amount of rotation of 26 necessary to produce desired longitudinal movements of the blade.

Water escaping from around the plates and blade enters tray 73 and drains back into reservoir 7. Packing material 74 is provided to prevent the water from entering the mechanism of transverse 25.

While features of the invention have been described as being incorporated in a machine provided with a thin cutting disc for cutting piezoelectric plates, it is not of course intended to indicate that these features are applicable only to a machine of this nature. It is believed obvious that the features of the invention would be equally valuable in connection with a cutting tool having a reciprocating blade or in tools for other purposes having either rotating or reciprocating members. Furthermore, the invention contemplates the use not only of water as a stabilizing medium in the manner described, but of any fluid, either liquid or gas. The apparatus described is illustrative of the invention rather than restrictive thereof.

What is claimed is:

1. A tool having a movable element, a chamber normally enclosing substantially the entire surface of the element, a fluid introduced under pressure into said chamber for stabilizing the motion of said movable element, a section of the chamber being retractile to expose a portion of the movable element.

2. A tool having a rotatable element, a chamber normally enclosing substantially the entire surface of the element, a fluid introduced under pressure into said chamber for stabilizing the motion of said rotatable element, a section of the chamber being retractile to expose a portion of the rotatable element.

3. A tool having a movable element, a chamber normally enclosing substantially the entire surface of the element, water introduced under pressure into said chamber for stabilizing the motion of said movable element, a section of the chamber being retractile to expose a portion of the movable element.

4. A cutting tool having a relatively thin rotatable blade, a pair of plates positioned on each side of said blade, a chamber in each pair of plates, each of the plates adjacent the blade being provided with a series of holes, means for supplying a fluid under pressure to the chambers, the holes in the plates being so located and the plates being so positioned with respect to the blade that the fluid passes from the chambers through the holes and spreads out in the form of a thin film between each side of the blade and the adjacent plate surface.

5. A cutting tool having a relatively thin ro-

rotatable blade, a pair of plates positioned on each side of said blade, a chamber in each pair of plates, each of the plates adjacent the blade being provided with a series of holes, means for supplying a fluid under pressure to the chambers, the holes in the plates being so located and the plates being so positioned with respect to the blade that the fluid passes from the chambers through the holes and spreads out in the form of a thin film between each side of the blade and the adjacent plate surface, the plates being so shaped and assembled that a gap is provided exposing a portion of the surface of the blade and a pair of retractile plates slidably supported in the edges of the first mentioned plates which define said gap.

6. A cutting tool having a relatively thin rotatable blade, a pair of plates positioned on each side of said blade, a chamber in each pair of plates, each of the plates adjacent the blade being provided with a series of holes, means for supplying a fluid under pressure to the chambers, the holes in the plates being so located and the plates being so positioned with respect to the blade that the fluid passes from the chambers through the holes and spreads out in the form of a thin film between each side of the blade and the adjacent plate surface, the plates being so shaped and assembled that a gap is provided exposing a portion of the surface of the blade, a pair of retractile plates slidably supported in the edges of the first mentioned plates which define said gap, each of said retractile plates being pro-

vided with a chamber, means for supplying a fluid under pressure to the last mentioned chambers and holes in said retractile plates through which the fluid may flow from the last mentioned chambers to contact with the blade.

7. A cutting tool comprising a relatively thin rotatable blade, a chamber on each side of said blade, means for supplying a fluid under pressure to each of said chambers, and means for causing said fluid to spread out in the form of a thin film along each side of said blade.

8. A tool comprising a movable element, a chamber on each side of said movable element, means for supplying a fluid under pressure to each of said chambers, and means for causing said fluid to spread out in the form of a thin film along each side of said movable element.

9. A tool having a movable element, a pair of plates positioned on each side of said movable element, a chamber in each pair of plates, each of the plates adjacent the movable element being provided with a series of holes, means for supplying a fluid under pressure to the chambers, the holes in the plates being so located and the plates being so positioned with respect to the movable element that the fluid passes from the chambers through the holes and spreads out in the form of a thin film between each side of said movable element and the adjacent plate surfaces.

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