July 19, 1955 C. F. SAYERS 2,713,339

CIRCULAR SAWS

Filed June 3, 1953 2 Sheets-Sheet 1

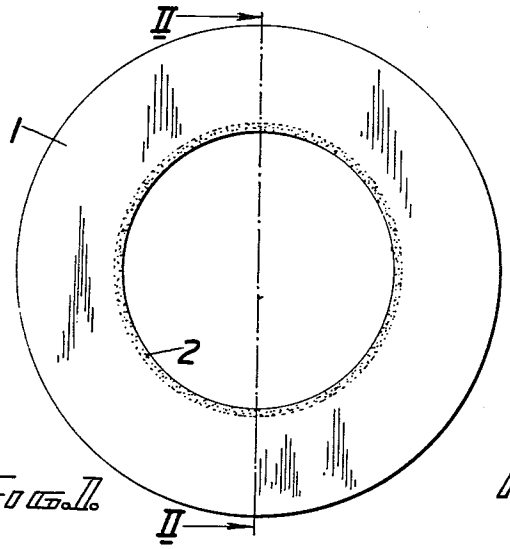


FIG. 1.



FIG. 2.

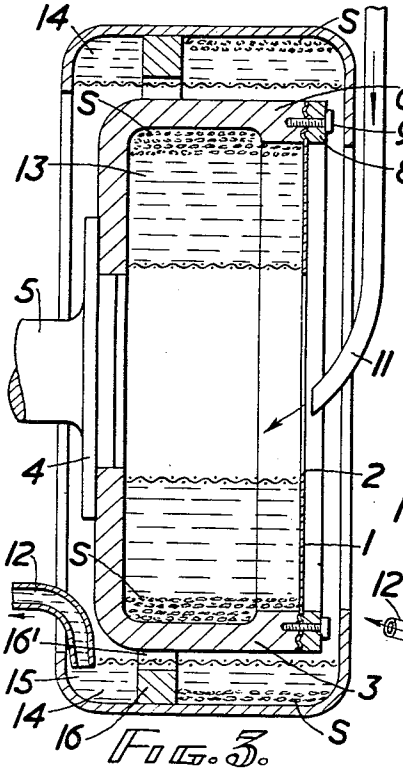


FIG. 3.

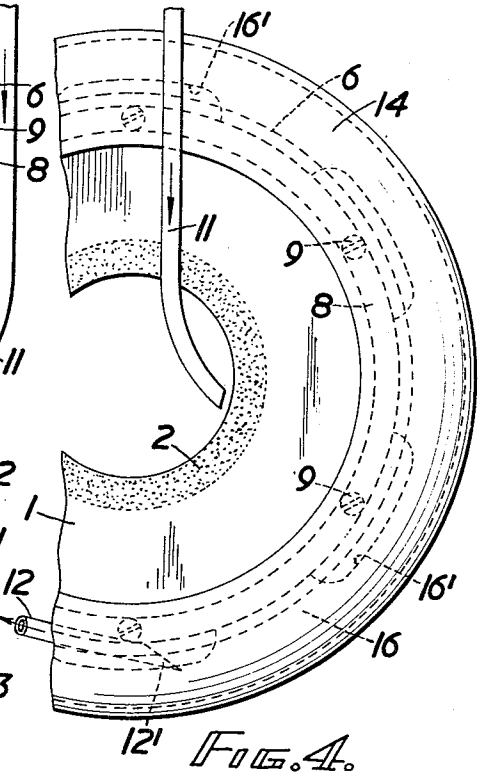


FIG. 4.

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CIRCULAR SAWS

Filed June 3, 1953 2 Sheets-Sheet 2

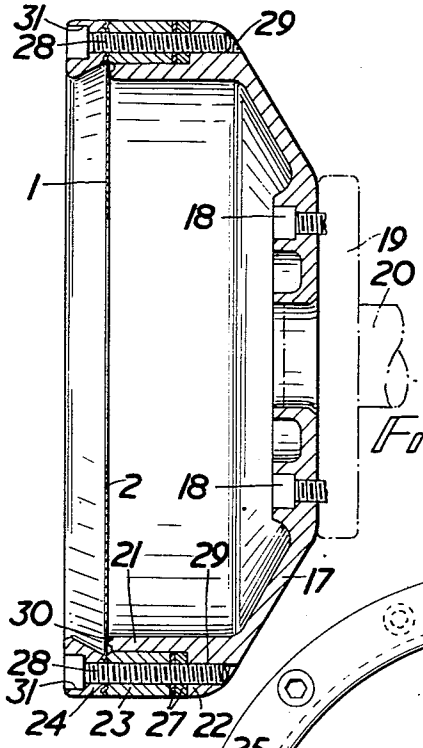


FIG. 6.

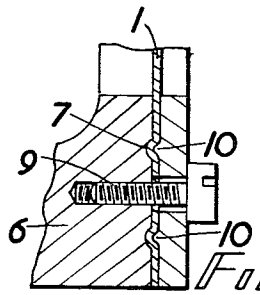


FIG. 5.

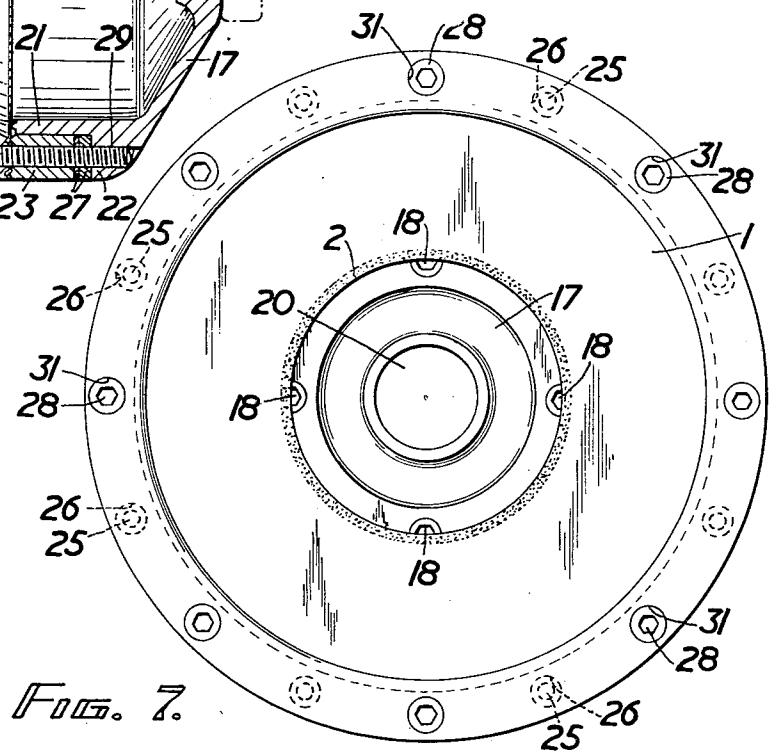


FIG. 7.

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CIRCULAR SAWS

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Application June 3, 1953, Serial No. 359,280

Claims priority, application Great Britain June 9, 1952

8 Claims. (Cl. 125—15)

This invention relates to circular saws particularly but not exclusively intended for cutting thin slices or plates from quartz crystals.

Quartz crystal plates need to be made very thin when they are to be used as vibrators in high frequency oscillators. Whereas quartz vibrators have hitherto been made approximately 15 mm. square by 0.5 mm. thick, much smaller quartz vibrators are now being considered; for instance, as small as 5 mm. diameter and 0.55 mm. thickness. In cutting such thin plates from quartz crystals undue crystal wastage occurs due to limitations in the normal type of circular saw or cutting disc employed. With the use of existing saws, the width of the saw cut is usually about 1.25 mm. Furthermore existing saws cannot be used to cut very thin slices without fracturing the slice and if very thin slices are required it is necessary to cut comparatively thick slices with the saw and then reduce the thickness to the required amount by other means involving further wastage. Wastage is an undesirable factor when natural quartz crystals of high quality are employed. Large size quartz crystals are comparatively expensive so that the wastage factor is of some importance.

The normal type of circular saw employed for crystal cutting comprises a thin metal disc centrally mounted between rigid flanges or otherwise centrally supported on a spindle so that its plane is perpendicular to the axis of rotation, the outer periphery of the disc comprising the cutting edge. A saw of this type cannot be reduced in thickness for reducing the width of the cut to an adequate extent without encountering difficulties. For instance, it is difficult to produce a thin disc which is sufficiently flat or which has sufficient resistance to deflection as it penetrates a work piece of irregular shape in the cutting operation. This latter difficulty cannot be overcome by reducing the diameter of the cutting disc without reducing the depth of cut. Moreover, a reduction in the diameter of the cutting disc is accompanied by a reduction in the peripheral speed unless a corresponding increase in the speed of the spindle is provided for. Further, the cutting surface available is reduced in proportion to the reduction in diameter of the disc. Finally, the arc of contact of the saw with the work increases with such reduction so that difficulties may arise in connection with the access of coolant to the cut to wash away swarf and to cool the work.

An object of the present invention is to provide an improved construction of circular saw which can be made thinner than existing circular saws, thereby reducing loss of material due to the width of the saw cuts and accordingly permitting a greater number of plates to be cut from a given size crystal than has hitherto been possible with said existing circular saws, said improved saw having adequate resistance to deflection as it penetrates the work.

A circular saw according to the present invention comprises a flat annulus of strong thin material such as metal provided or formed at its inner periphery with a cutting edge.

According to an important feature of this invention the circular saw is rigidly supported around its outer periphery by means constructed to apply outward radial tension to the annulus to ensure that the cutting edge is maintained in a desired plane or to ensure that when the saw is being rotated by a carrier on which it is mounted and is being used to cut plates or slices from a quartz crystal or other work piece, the radial tension provides a powerful restoring force to or opposes deflection of the cutting edge in a direction perpendicular to the plane of the saw.

This radial tension may be imparted to the saw by clamping the saw at its periphery between rings having interengaging grooves and projections, means preferably being provided for increasing or decreasing the radial tension at will.

In order that the invention may be more fully understood reference will now be made to the accompanying drawings, in which:

Fig. 1 is a front elevation of a circular saw according to the invention.

Fig. 2 is a sectional elevation taken on the line II—II of Fig. 1.

Fig. 3 is a side sectional elevation of a rotatable chuck or carrier to which is applied a circular saw according to Figs. 1 and 2.

Fig. 4 is a front elevation partly broken away corresponding to Fig. 3.

Fig. 5 is a fragmentary sectional view illustrating a mounting means for applying outward radial tension to the circular saw.

Fig. 6 is a side sectional elevation illustrating a modified form of chuck or carrier incorporating means to enable the outward radial tension applied to the circular saw to be adjusted.

Fig. 7 is a front elevation corresponding to Fig. 6.

The circular saw illustrated in the drawings will be described by way of example in connection with cutting thin plates or slices from natural or artificially grown quartz crystals to serve as piezo-electric vibrators. It will be hereinafter appreciated, however, that the circular saw according to the invention may be successfully used in producing, accurately and with minimum waste, thin plates or slices from other work pieces.

The circular saw illustrated in Figs. 1 and 2 comprises a flat annulus 1 of thin metal, for example copper, the inner periphery 2 of which comprises the cutting edge of the saw. The inner periphery 2 of the annulus carries a cutting agent which may comprise, for example, small particles of diamond pressed into the metal with a hard steel tool or cemented to the metal with a material such as that known under the registered trademark "Araldite" or by other known means. Other abrasive material may, however, be applied to the cutting edge 2 according to the nature of the work piece from which thin plates or slices are to be cut. The zone of the cutting edge provided with the cutting agent is shaded with dots in Fig. 1.

For cutting from small quartz crystals thin plates having for example, a thickness of 0.4 mm. the circular saw may have an effective diameter of 3" and a thickness of approximately 0.010". The cutting agent may comprise diamond dust having a grain size of 170 to 200 for a saw annulus composed of hard copper.

One form of rotatable carrier for the circular saw is illustrated in Figs. 3 and 4. The carrier illustrated in these figures comprises a cup-shaped chuck 3 secured by means, not shown, to the plate 4 of a rotatable spindle 5. This chuck and spindle unit is mounted in a machine, in a manner well understood in the art, and is adapted to be driven at the desired speed. The chuck 3 has a peripheral rim 6 formed, as more clearly illus-

trated in Fig. 5, with rounded grooves 7 extending around the outer face of the rim 6. A clamping ring 8 is removably secured to the rim 6 by means of a plurality of screws 9 which pass through apertures provided in the periphery of the circular saw which is located in use between the rim 6 and clamping ring 8. The ring 8 has rounded projections 10, shown more clearly in Fig. 5, for co-operation with the grooves 7 in rim 6 when the ring 8 is tightened up by means of the screws 9. The projections 10 force the flat contacting areas of the periphery of the saw annulus 1 into the grooves 7, thereby placing the annulus under outward radial tension. As clearly illustrated in Figs. 3 and 4, the annulus is disposed perpendicularly to the axis of the spindle 5. A work piece, for example a quartz crystal, is held in the central aperture of the annulus and presented to the cutting edge 2 thereof and advanced in a known manner during rotation of the spindle at the requisite speed. To enable a saw, dimensioned as above described, to cut thin plates or slices accurately from a quartz crystal the spindle 5 is rotated to impart to the saw a peripheral speed of about 2000 feet per minute.

The outward radial tension applied to the annulus holds the cutting edge 2 in the desired plane and resists deflection of the annulus, particularly the cutting edge thereof, in a direction perpendicular to the plane of the annulus.

Figs. 3 and 4 illustrate in a somewhat diagrammatic manner the employment of an inlet pipe 11 and an outlet pipe 12 for a liquid coolant and lubricant. The inlet pipe 11 directs the coolant onto the work piece and into the interior of the chuck 3 through the central aperture of the annulus. Under centrifugal action, an annulus 13 of the coolant liquid is formed within the chuck 3 and over-flows through the aperture of the annulus or through holes specially provided in the chuck body or the saw blade, into an outer bowl 14 in which by centrifugal action another annulus 15 of the coolant liquid is formed. The bowl 14 is connected to the chuck 3 by a ring 16 having a series of spaced slots 16', Fig. 4. The coolant is removed from bowl 14 through the scoop 12' at the inner end of the outlet pipe 12. The swarf removed in the cutting operation is largely confined under centrifugal action within the chuck 3 and bowl 14. Swarf layers S are diagrammatically shown in Fig. 3.

Figs. 6 and 7 illustrate a modified design of chuck which may be used in place of the chuck 3 in Figs. 3 and 4. According to Figs. 6 and 7 a chuck body 17 is secured by screws 18 to a plate 19 carried by a rotatable spindle 20. The chuck body 17 has a cylindrical rim 21 surrounded by a flat circumferential seating 22 for a ring 23 forming part of a mounting means for a circular saw 1 having a cutting edge 2 similar to the saw illustrated in Figs. 1 and 2. Another part of this mounting means comprises a clamping ring 24. The rings 23, 24 have co-operating rounded projections and grooves similar to those illustrated in Figs. 3–5. The periphery of the saw annulus is firmly clamped between these rings by means of clamping screws 25, Fig. 7, the heads of which are located in recesses 26 formed in the rear face of the ring 23.

The unit comprising rings 23, 24 and the saw annulus 1 marginally clamped there-between is applied over the rim 21 of the chuck body 17, two or more packing rings or washers 27 being interposed between the rear face of ring 23 and the seating 22. A plurality of clamping screws 28 are then pushed through registering holes in the rings 24 and 23 and screwed into screw-threaded holes 29 formed in the chuck body 17. These screws pass through apertures formed in the periphery of the saw annulus 1 and in the washers 27. When these screws

28 are tightened up, the flate part of the annulus 1 near its periphery is forced into engagement with the rounded edge 30 of the chuck rim 21, thereby placing the annulus outward radial tension. If, in use of the circular saw in the manner described with reference to Figs. 3–5, it is found that adjustment of the outward radial tension is required it is merely necessary to remove the unit comprising rings 24, 23 and annulus 1 in order to exchange the packing rings 27 for thinner or thicker rings which enable the required outward radial tension to be obtained in the saw when the unit is reapplied to the chuck and tightened up by means of the screws 28, the heads of which are accommodated in recesses 31 formed in the outer face of clamping ring 24.

A circular saw constructed and mounted on a rotatable chuck as hereinbefore described is not limited for use in cutting plates or slices from quartz crystals. It may, for example, be employed for accurately cutting thin slices with minimum waste from other work pieces, such as for example germanium ingots, synthetic sapphire boules or tungsten rod. The saw may also be used for cutting narrow slots in miniature screw heads. Further, the invention is not limited to a cutting edge 2 carrying a cutting agent in the form of an abrasive material. Depending upon the particular application of the saw, the cutting edge 2 of the annulus may comprise saw teeth. The annulus may be made of steel or other material according to particular requirements.

I claim:

1. A circular saw comprising a flat annulus of strong thin material provided at its inner periphery with a cutting edge, and a saw mounting means which applies outward radial tension to the annulus.

2. A circular saw according to claim 1, wherein said mounting means comprises co-operating rings, the opposing surfaces of which have interengaging grooves and projections between which the outer margin of the annulus is clamped.

3. A circular saw according to claim 2, wherein the rings are removably secured to a circular rim of a rotatable carrier or chuck.

4. A circular saw according to claim 3, wherein a unit comprising the rings with the annulus clamped there-between is placed over a circular rim on the chuck and clamped into engagement with a seating on the chuck body.

5. A circular saw according to claim 4, wherein the outer edge of the chuck rim is positioned for tight frictional engagement by an outer marginal part of the annulus when the unit is firmly clamped in position, whereby the annulus is placed under outward radial tension.

6. A circular saw according to claim 5, wherein interchangeable packing rings are interposed between the inner ring of the unit and said seating, for the purpose herein set forth.

7. A circular saw according to claim 1, wherein the cutting edge of the flat annulus carries an abrasive medium.

8. A circular saw according to claim 1, wherein for the purpose of cutting slices or plates from quartz crystals or similar work pieces, the cutting edge of the annulus carries particles of diamond dust embedded in or cemented to the inner margin of the annulus.

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