June 20, 1944.

F. J. KENT

2,352,105

LAPPING MACHINE

Filed Jan. 28, 1943

2 Sheets-Sheet 1

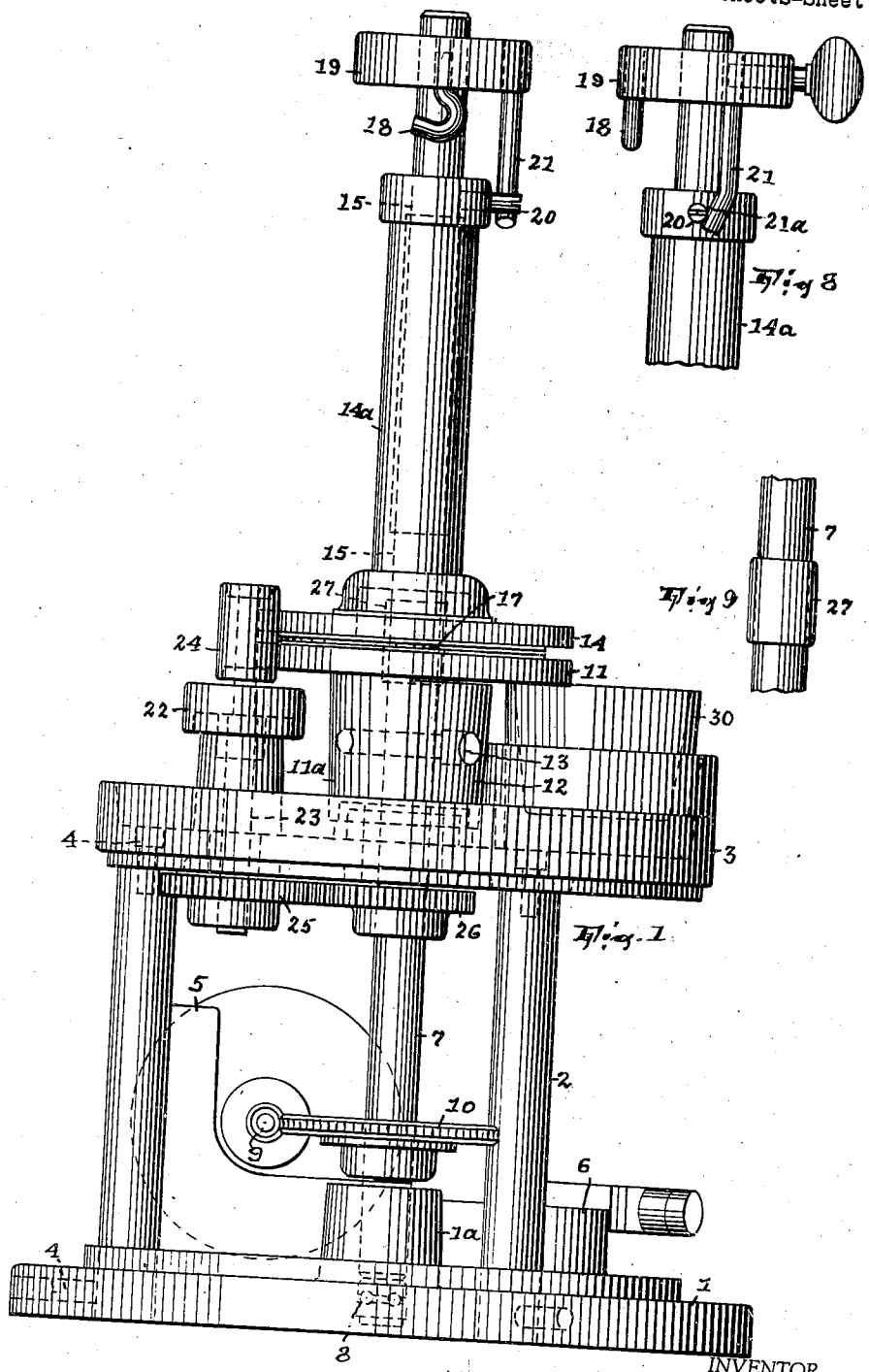


Fig. 8

Fig. 9

Fig. 1

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2 Sheets-Sheet 2

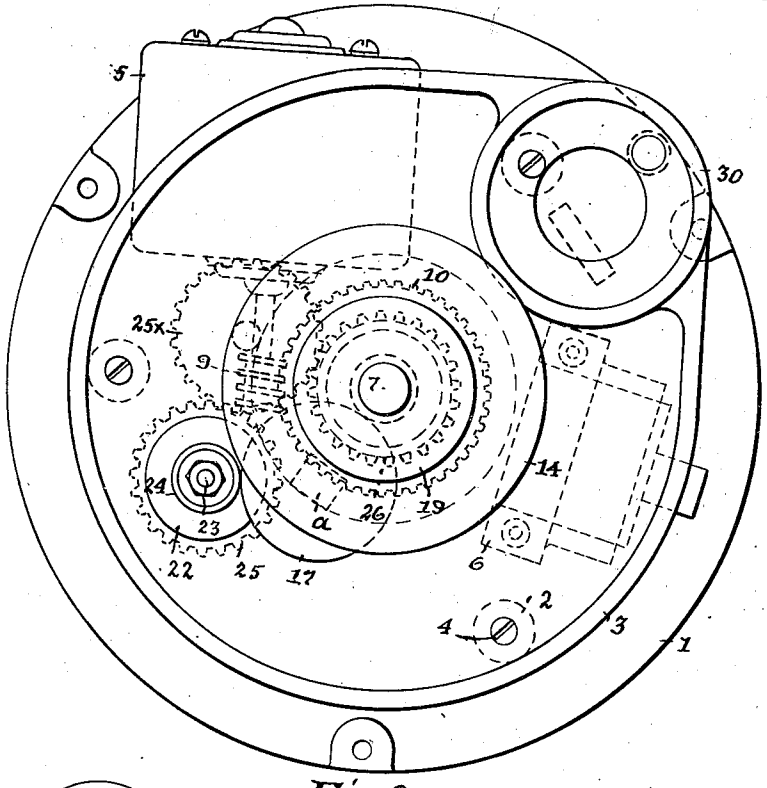


Fig. 2

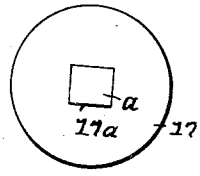


Fig. 4

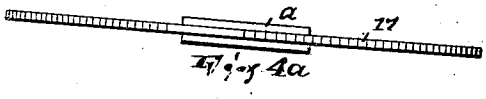


Fig. 4a

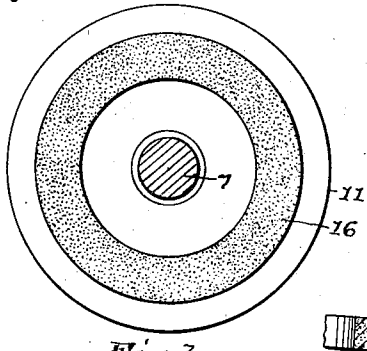


Fig. 3

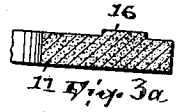


Fig. 3a

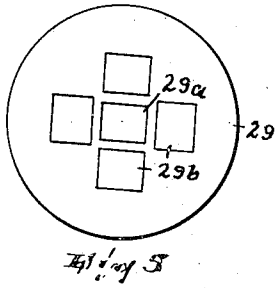


Fig. 5

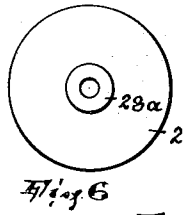


Fig. 6

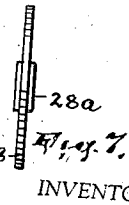


Fig. 7.

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Patented June 20, 1944 2,352,105

UNITED STATES PATENT OFFICE

2,352,105

LAPPING MACHINE

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Application January 28, 1943, Serial No. 473,822

4 Claims. (Cl. 51—118)

In the art of lapping, as the abrading of a broad face of a quartz crystal piece either to develop said face perfectly planiform or reduce the piece to a given thickness, the piece is positioned with its face against the planiform abrading surface of an abrading implement and one of them is rotated relatively to the other around an axis perpendicular to said surface.

For this purpose according to the present invention there are two structures, one of which I term the "abrading structure" because it provides said planiform abrading surface and the other what I term the "work-abutted structure," and one is rotative relatively to the other around a fixed axis penetrating and perpendicular to said surface. Having these two structures, the assembly they contribute to form includes, cut by the plane of said surface, work abutments spaced apart less than the diameter of the work and one of which as a whole is eccentric of, and further than the other from, said axis and projects from and provides a work-abutted portion of the work-abutted structure. Thereby, with said assembly also including means to hold the work (assumed to be substantially circular and of a diameter somewhat greater than that of the spacing of said abutments) in contact with and with its own axis perpendicular to said surface and in an orbit concentric with said structures and extending between the abutments, the work will in a novel way be confined, during the abrading, against displacement relatively to the work-abutted structure by resistance applied, i. e., by the abutments, to its periphery. Preferably the abrading structure is rotative and the other structure fixed whereby the work will during abrading be in a constant position.

If, during the abrading, at least one of the abutments is rotated around its own axis it may by tractive effort applied to the periphery of the work rotate the latter around its own axis, thereby uniformly to disperse the abrasion; if both are rotated, as in the same direction, the tractive effort will be increased to insure rotation of the work.

The abrading structure may have the part thereof having the abrading surface in the form of a circular disk whose axis is the axis of relative rotation of said structures, in which case the abutment first-above mentioned is eccentric of the disk. Thereby access to the work for rotating it is had even though the means to hold the work in contact with the abrading surface takes the form of a disk of approximately the same diameter as that of the abrading structure—to wit, so that each disk may limit the flexion of the work toward such disk in the case where the work is quite flexible.

In the example said means to hold the work in contact with said surface itself provides an abrading surface, being incidentally confined against rotative displacement relatively to the abrading structure. This, however, is immaterial to the invention as above broadly outlined. And it is also immaterial how relative rotation as between the two aforesaid structures is effected, i. e., whether or not by the same means which rotates one or both of the abutments.

In addition to the foregoing the invention provides for relief of the pressure to which the work is subjected by the abrading structure and the means for holding the work in contact with the abrading surface in the event one or the other of these acts to dog the work.

In the drawings,

Fig. 1 is a side elevation of an apparatus or machine embodying the invention;

Fig. 2 a plan thereof;

Fig. 3 a plan of the abrading side of, say, the lower lap;

Fig. 3*a* is a fragmentary sectional view of a lap;

Figs. 4 and 4*a* are, respectively, a plan and a side elevation of what is here taken as the work, Fig. 4*a* being enlarged;

Fig. 5 is a plan of a modified form of said assembly;

Figs. 6 and 7 are, respectively, a plan and side elevation of work in the form of a reconditioning unit;

Fig. 8 is an elevation of the peak portion of the machine, as seen from the right in Fig. 1; and

Fig. 9 is a side elevation of a portion of the main shaft.

A frame or supporting structure is formed by a base 1, standards 2 and a table 3 rigidly held together by screws 4. On the base are an electric motor 5 and a switch 6 for controlling the motor. A main shaft 7 is stepped in a socket 1*a* in the base on a ball-bearing 8 and has a bearing in the table, being confined by the base and table to a fixed axis of rotation therein. By a worm 9 on the motor shaft and a worm-wheel 10 on the main shaft, intergeared with each other, such shaft is driven by the motor.

A lower disk or lap 11 has an integral depending half-hub 11*a* which coacts with another half-hub 12, when the two half-hubs are secured together by screws 13, to clamp the lower lap rigidly to the main shaft, said shaft being perpendicular to the upper or abrading side of the lap, or at

least to its actual abrading surface, and central thereof.

14 is the upper lap having an elongated upstanding hub 14*a* which at each of its upper and lower ends, as at 15, obtains a limited bearing on the shaft, the lower side of lap 12, or at least its actual abrading surface, being thus confined to parallelism with the actual lapping surface at the lower side of the lower lap as well as concentric and coincident therewith.

The actual lapping surface (by which I mean a planiform surface) of each lap is a relief surface (or one that adjoins at each long side thereof a surface extending relatively back from it) such as is shown at 16 in Figs. 3 and 3*a*; the two such relief surfaces are here continuous and of the same width and diameter.

The work proper *a*, which is here assumed to be a quartz crystal oscillator or resonator of quite little thickness, as but a small fraction of an inch thick, is to be received in a work-holder 17 so that its broad face or its opposite broad faces to be abraded may undergo abrading independently of the work-holder, which is therefore of thinner but stiff material here in the form of a circular disk having a central aperture 17*a* of such conformation, as rectangular, that when the work is received therein complete rotation of either of the parts of the assembly, or work they form relatively to the other is prevented.

For entering the work between the laps the upper lap may be elevated, to be supported temporarily in elevated state by a hook 18, pivoted to a collar 19 fixed on said shaft, and to be engaged with a radial stud 20 on the hub 14*a*.

When the main shaft and, with it, the lower lap is driven a depending pin 21 fast to said collar engages said stud to drive the upper lap in synchrony with the lower lap.

The work, while the laps undergo rotation, is to be rotated around an axis penetrating and preferably central of the work and its advance with the laps opposed. For this purpose there is journaled in a pedestal 22 upstanding from the table a rotary member comprising a spindle 23 parallel with the main shaft, and a traction roller 24 fast to the spindle and supported on the pedestal; a gear 25 is fixed to the spindle below the table and geared through a gear 25*x* with a gear 26 fast to the main shaft. In effect one with the shaft is preferably an axial or traction portion, as a sleeve 27, both it and the roller being cut by a plane between and parallel with the actual abrading or lapping surfaces of the two laps when they are in lapping relation to the work. The work is (here) of a diameter greater than the space between the traction elements 24—27. The roller, sleeve, and actual lapping surface of each lap should all be so proportioned that when the work abuts said roller and sleeve the axis of rotation of the work will penetrate said actual lapping surfaces and also be in an orbit coaxial with the laps and extending between the roller and sleeve.

When the machine is operating to lap the work, assumed to have been interposed between and subjected to compression by the laps incident to (here) the weight of the upper (or yielding) lap, the laps tend to advance the work around the main shaft, but this is opposed by the traction elements, and meanwhile the work is made by the gearing 25—25*x*—26 to undergo rotation around an axis penetrating it. The work being thus opposed it is not indispensable whether either or both of said traction elements actually impel said assembly, but to insure constant impelling, with consequently a uniform dispersion of the lapping action on the work, it is preferable that both be rotated.

Instead of abrasive action being made to affect the work it may be caused, as in reconditioning one or both lapping surfaces, to affect one or both of the latter. Thus in Figs. 6 and 7 is shown a circular disk 28 of the same diameter as disk 17 and having a circular central flat raised abrading portion 28*a* at each face thereof and of a diameter at least not less than the width of the relief surface of either lap.

In Figs. 1 and 8 the pin 21 has its lower end portion bent off to provide a cam surface 21*a* engaged by a stud 20 and arranged to cam the upper lap-including member 14—14*a* from the other such member, formed by the main shaft and lower lap, in the event that the work and one of the laps dog each other in such a way that, in the absence of the camming to induce lifting of the upper or yielding lapping member, injury to the work or the lapping surface would occur.

In some instances the work-holder, besides having a central aperture for a single piece, may have supplemental apertures. Thus in Fig. 5 29 is the work-holder having, besides the central aperture 29*a*, other apertures 29*b* arranged around the central aperture.

The part shown at 30 is a receptacle for a mixture of water and comminuted abrasive material.

In the example, the aforementioned abrading structure is afforded by the lap 11; the work-abutted structure by the frame formed by parts 1—2—3 and 22; the abutments by the member 23—24 and sleeve 27; and the means to hold the work in contact with the abrading surface of the abrading structure by the upper lap. The means to rotate the abutments is afforded by the train of gears and shaft 7. Parts 20 and 21 are termed "contacts" in the appended claims.

It will be apparent to anyone skilled in the art of lapping an article such as a quartz crystal oscillator or resonator, so that in the finished article the abrading of each face thereof as treated will be perfectly parallel with the face thereof as it comes to the treatment, that the lapping surfaces of the two laps should be definitely confined to parallelism. Hence, whatever may be the maximum diameter of the area of so much of said surfaces as are directly opposite to each other, the bearings 15 are spaced apart according to my invention a distance not substantially less than such diameter and they confine the lapping members with their common axis in constant perpendicular relation to said surfaces.

Having thus fully described my invention, what I claim is:

1. An assembly for lapping the herein-defined work, said assembly including an abrading structure and a work-abutted structure one of which is rotative relatively to the other around a fixed axis, the abrading structure providing a planiform abrading surface perpendicular to and extending around said axis and said assembly also including, cut by the plane of said surface, work abutments spaced apart less than the diameter of the work and one of which is as a whole eccentric of, and further than the other abutment from, said axis and projects from and provides a work-abutted portion of the work-abutted structure, in combination with means to hold the work in contact with said surface when positioned thereagainst and with its own axis substantially

perpendicular to said surface and in an orbit coaxial with said structures and extending between said abutments.

2. An assembly for lapping the herein-defined work, said assembly including an abrading structure and a work-abutted structure one of which is rotative relatively to the other around a fixed axis, the abrading structure providing a planiform abrading surface perpendicular to and extending around said axis and said assembly also including, cut by the plane of said surface, work abutments spaced apart less than the diameter of the work and one of which is substantially circular and rotative around an axis penetrating it substantially centrally and perpendicular to said surface and one of which abutments is as a whole eccentric of, and further than the other abutment from, the first-named axis and projects from and provides a work-abutted portion of the work-abutted structure, in combination with means to hold the work in contact with said surface when positioned thereagainst and with its own axis substantially perpendicular to said surface and in an orbit coaxial with said structures and extending between said abutments, and means to rotate the rotative abutment around its own axis.

3. An assembly for lapping the herein-defined work, said assembly including an abrading structure and a work-abutted structure one of which is rotative relatively to the other around a fixed axis, the abrading structure providing a planiform abrading surface perpendicular to and extending around said axis and said assembly also including, cut by the plane of said surface, work abutments spaced apart less than the diameter of the work and each of which is substantially circular and each of which is rotative around an axis penetrating it substantially centrally and one of which is as a whole eccentric of, and further than the other abutment from the first-named axis and projects from and provides a work-abutted portion of the work-abutted structure and the other of which abutments is also circular and penetrated centrally thereof by and rotative around the first-named axis, in combination with means to hold the work in contact with said surface when positioned thereagainst and with its own axis substantially perpendicular to said surface and in an orbit coaxial with said structures and extending between said abutments, and means to rotate both abutments around their respective own axes in the same rotative direction.

4. The assembly set forth in claim 1 characterized by the part of the abrading structure having said surface consisting of a substantially circular disk whose axis is the first-named axis and by the first-named abutment being eccentric of the disk.

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