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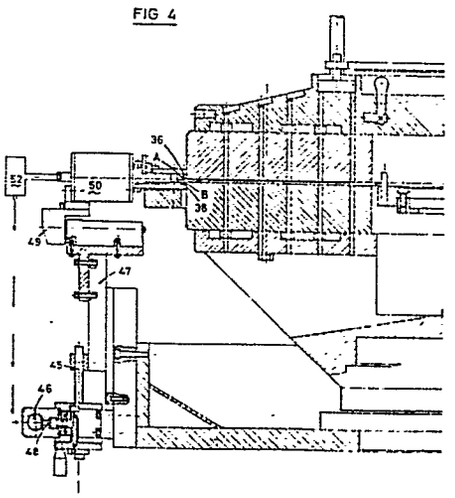
(54) **A two-plate lapping machine with comparator for continuously measuring the workpiece tichness.**

(57) In a lapping machine provided with two lapping plates with satellites rotated by a crown gear which is internal to the plate which satellites roll on outer ring gear along the periphery of the same plate, a comparator is mounted provided with two points between which, as between shears, in succession, a limb is taken of all the rotating satellites which all project from the lapping plate; at least a portion of a piece to be lapped being continued in said limb whereby the vertical thickness of said piece is measured.

Due to the suitable ratio being chosen between the number of teeth of the lapping plates and the number of the satellite teeth it is obtained that the measurement carried out on a workpiece for each satellite is continuously repeated.

A device is also provided for restorings the alignment of the two points of the comparator when the lower plate is worn; a device for facilitating the charging and the discharging of the satellites all filled of the workpieces being lapped is also provided.

FIG 4



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A TWO-PLATE LAPPING MACHINE WITH COMPARATOR FOR CONTINUOSLY MEASURING THE WORKPIECE THICKNESS.

Several lapping machines or superfinishing grinders have been on the market for a long time. Such machines are intended for lapping at the same time two faces of all workpieces they are able to machine, said workpiece being disposed between two lapping surfaces under the form of concentrical plates laying at a distance over each other, the upper plate acting as pressure means, the lower plate as supporting means.

Both plates having lapping surfaces are rotated contrariwise to each other, thus being subjected to wear together with the workpieces.

In order to cause the path of the workpieces to continuously change by approaching and moving away from the axis of rotation of both plates, the workpieces to be lapped are put on a predetermined number of circular jigs socalled "satellites" which are arranged about the axis of the lower plate at a constant angular phase to one another.

Of course, in order to cause the path of the workpieces to continuously change with respect to the plates, thus avoiding each workpiece be at a constant distance from the centre of the lapping plate during the lapping operation, the jigs should be rotated about their axis.

This is achieved causing the jigs to be engaged by an inner crown gear rotating about the central axis of the lower plate as well as to roll on an outer stationary rack.

Each jig is then constrained to an epicyclical motion about the axis of the lapping machine.

The main problem of these lapping machines is the setting of the thickness of the workpiece to be lapped, i.e. the vertical size thereof.

In fact, at the present status of art it is needed to stop the operation of the lapping machine so as to be able to carry out a millesimal measurement of a workpiece by manual check after having drawn it from the jig.

Even if this operation is made easier nowadays by the use of millesimal measuring instruments, the problem of worn out lapping plates is still laying heavy on said machines, as the wear cannot be quantified in the order of thousandths and involves several restarts always and exclusively relying on the capability of the operator.

A first object of this invention is to avoid this drawback by providing a two face lapping machine provided with means to automatically carry out a continuous millesimal measurement of the workpieces.

In order to carry out such measurement it should be appreciated that the jigs consist each of a circular plate and are arranged on the lapping surface of the lower lapping plate having the form of a circular crown, the central opening of which is defined by a rotating crown gear transmitting to the jigs the above mentioned epicyclical motion about the axis of the lapping machine.

The main object of this invention is to provide during the lapping operation the continuous measurement of the vertical size of the workpieces arranged on the jigs rotating by an epicyclical motion between the lapping plates.

In one preferred embodiment, when the workpieces to be lapped are small and numerous, if the ratio between the number of revolutions of each jig about its axis and

the number of revolutions of said jig about the axis of the machine is suitably chosen, it is known for certain that each measurement carried out on a first workpiece by the measuring device is carried out, after a revolution of the jig about the axis of the machine, on a second workpiece located in the same jig at a diametrally opposite position of said first workpiece.

Thus, when the thickness of a workpiece is measured it is known for certain that at the radially opposite position of said workpiece there is another workpiece which offers the same resistance to both lapping plates as the first workpiece being measured.

Unlike the known methods wherein the measurement of the workpieces is carried out by stopping the machine and manually measuring the size of one or more workpieces, the measurement according to this invention is much more precise and is carried out in a strongly reduced time and almost continuosly while the workpieces continue being lapped.

This is provided according to this invention by a comparator having two arms facing each other, between which the edges of the jigs projecting from the lapping plate run after one another during the lapping operation, a workpiece to be lapped being at least partially arranged at said edges.

The upper arm is slidably mounted on a vertical guide and rests on the upper surface of the workpieces at the edges of the rotating jigs.

The lower arm is hinged at the opposite end of that brought into contact with the lower surface of said workpieces at the edges of the rotating jigs.

A self-setting system for the arms of said

comparator means is provided according to another feature of the invention.

The arms of the sensing means should be set for following reasons.

As a consequence of the lapping operation both lapping plates are subjected to wear, thus changing their positions with respect to both arms of the sensing means, between which the workpiece to be measured is running.

Both arms are perpendicular to the running workpieces at the beginning of the lapping operation, i.e. the upper arm to the upper surface of the workpieces, the lower arm to the lower surface of the same.

When the lower lapping plate has being lowered, the upper arm of the sensing means resting on the workpieces follows that lowering along the path of its vertical guide.

The lower arm, which is hinged at the opposite end far away from the end in contact with the workpieces, tilts about its hinge point.

At this moment the self-setting system is operated in order to cause said hinge point to be lowered, thus aligning the lower arm of the comparator under the vertical of the upper arm.

In a preferred embodiment of this invention anelectronic system is used for aligning both arms to each other.

Said electronic system operates an electromechanical device the operation of which is as follows.

The inclination of the lower arm with respect to the upper arm, which is always perpendicular to the workpiece to be measured, is sensed so as to provide an electrical signal at the output of a circuit connected to

the comparator. Such electrical signal is received by a suitable device generating a pressure in a fluid which acts on a piston and causes by a jack the rotation of a lead screw, which in turn causes the hinge point of the lower arm to be lowered, thus aligning both arms again in their positions perpendicular to the workpiece to be measured.

Therefore the vertical lowering of the upper ar, of the comparator provides the continuous check of the lapping operation and causes the lapping machine to be stopped when the desired thickness is reached.

At the same time the self-setting system provides for the alignement of the two arms of the sensing means when a limit inclination of the lower arm is reached.

According to a further feature of this invention a system for charging the jigs in the machine is provided.

Such jigs are arranged on a idling plate the same form of the lapping plate.

Such idling plate is approached to a chute connected to the lower lapping plate at an opening in the circular body of the lapping machine.

Thus each jig is caused by the operator to slide up on the chute and to reach the lower lapping plate.

Of course, in order to allow the jigs carrying the workpiece to be charged in the lapping machine the outer rack surrounding the lower lapping plate is lowered by the operator.

This invention will be described in further detail with reference to the accompanying drawing; in which:

Fig. 1 is a side view of the lapping machine of the invention;

Fig. 2 is a plan view of the machine of Fig. 1;

Fig. 3 is a top plan view of a jig having six

seats;

Fig. 4 is a partial section of the lapping machine of the invention including the comparator and the system controlling said comparator for the vertical alignment of the measuring arms;

Fig. 5 is a perspective view of the lapping machine with the jig loading plate;

Fig. 6 shows a detail of the comparator with two measuring arms and a workpiece to be lapped therebetween;

Fig. 7 is a vertical section of a detail of the system for the vertical alignment of the measuring arms; and Fig. 8 is a section along the line A-A of fig.7.

With reference to the figures ,in Fig.5 the machine of this invention comprises a mount 2 from which an upper presser 4 descends downwards.In an underlying position a round iron sheet bucket which surrounds a lower lapping plate 8 on which a certain number of piece-holders 10 or satellites are arranged at constant angle distances. Plate 8 has at its center a large circular cavity at the center of which a wheel is disposed which is provided at its periphery with a crown of vertical dragging studs or teeth 2 with which the peripheries 10a are engaged of the satellites disposed on the lower plate.

Satellites 10 are also surrounded by a crown of stationary studs 14 with which they engage always with the exterior periphery.

Such studs can be lowered below the plate plane for allowing the satellites to slip out.

Satellites 10 are pressed between the lower plate and the upper plate and are motor driven both about the axis of the machine and about their own center.

As indicated in Fig.1 the lapping machine 17 is

provided with a motor 18 which actuates the upper plate through belt 19 and by a motor 20 which actuates the lower lapping plate through belt 24.Motors 18 and 20 ,provided with gear reducers 26 and 28 drive each one of the two lapping plates and have therefore the same power.

Furthermore the upper lapping plate gives the pieces to be lapped, a downwards thrust which is generated in addition to the weight, by hydraulic pressure which thrust produces the rubbing that is the lapping of the pieces contained over the satellite.

Another motor which cannot be seen in the figure 1 rotates central crown gear 12 for actuating the satellites through belt 29.

In Fig.5 the manoeuvre is illustrated for charging the satellite on the lower plate.

In correspondence of the opening which is provided along the circular guard wall which surrounds the lower plate a table 30 is approached which supports the satellites which table is rotatable about its own axis.

Suitable handles facilitate the operator's task for rotating the table in the suitable direction.Supposing that the lapping machine comprises six satellites as illustrated in Fig.5 the support table will have the capacity of seven satellites.

In correspondence to the charging and discharging opening 32 a plane 34 provided with a side slide 32 is inserted between the same support table and the lapping machine.

At the end of each cycle, while the upper plate 21 is kept lifted, the outer crown gear is lowered and one of the satellites with the lapped pieces thereon will be made to slide until the slide 35 and subsequently the support

table is rotated through a seventh of a turn whereby a satellite with the pieces to be lapped is offered to the opening of the machine on the plane 34 in lieu of the satellite precedingly withdrawn.

With consecutive operations all the lapped pieces will be extracted and only six satellites will be present on the support table with the finished pieces and only one place will be left void.

For measuring the thickness attained by each piece which takes part on the lot being machined,a device (Fig.4) is provided which is called comparator 50 adapted for measuring the distance between a point (pont A) of the tangential horizontal upper plane of the piece and the point (point B) which lies (at the beginning) on the same vertical but belongs to the tangential lower surface of the same piece.

Such device operates automatically only at the final stay of the working cycle.

The comparator 50 device (Fig.2 and 6) is provided with an upper point 36 and a lower point 38, both being diamond points which hold therebetween, as shears, a limb circularly projecting from each of the rotating satellites in which limb at least one of the pieces to be lapped is partially included. The comparator can for instance be located at the place of one of the studs or teeth 14 with which the outer periphery of each satellite is engaged.

It is to be kept in mind that while the upper point 36 (Fig.4) can be displaced only vertically, the lower point, because it is hinged at a distance from its point of contact with the lower surface of the piece it can rotate about said point thus forming an angle with respect to the straight line which passes through the upper point

when the contact point gets lower.

The comparator device verifies the lowering of the piece and then of its vertical dimension and consequently it interrupts the working cycle and at the same time it sums successive rotations, that is angular lowerings and activates the recovering of the plate wear device.

Such device, which allows the re-alignment of the two comparator points is illustrated in Fig.4,6,7.

It comprises substantially a transducer 52 which transforms an electrical signal at the output of the comparator 50 into a control for the piston 46 which,- through a jack 48 produces the rotation of a screw 45 which lowers the support assembly 47,49 of comparator 50.

It has been described as an example a preferred embodiment of the invention.However it is obvious that a number of variants can be introduced by those skilled in the art without sorting from the scope of the present invention as defined by the following claims.

CLAIMS

1) A lapping machine comprising a lower lapping plate and an upper pressing plate both superimposed concentrical and rotated each by a motor so as to rotate contrariwise to one another where the pieces to be lapped are subdivided in equal groups, each group being distributed within the limits of a satellite which is fed into the lower plate, said satellites being distributed over the lower plate so as to cover at least a space equal to the surface included between the maximum circle and the minimum circle of the same lapping plate, each satellite being provided with a peripheral circular crown engaged with a crown of studs or teeth stationary with respect to said satellites and with a crown of studs located at the inside of said satellites crown and driven by a third motor means, characterized by the fact of further including

at least a means adapted for measuring the vertical dimension of a piece to be lapped by means of two opposed points between which a circular limb projecting from each satellite is passing in succession during the lapping operation, at least a piece to be lapped being contained in said limb;

a device adapted for restoring the alignment of said two points of the comparator for compensaring the wear of the lower lapping plate;

a device for facilitating the charging and discharging of the pieces to be lapped along a handling plane of the piece-supporting satellites.

2) A lapping machine as claimed in claim 1 wherein said comparator means is a gauge provided with two points an upper one and a lower one with respect to the piece to

be lapped for measuring the vertical dimension of a piece being lapped, the upper point being bound to follow a rectilinear path and the lower point being hinged upon a spot which is exterior with respect to the lapping plates and at a distance with respect to the latter and subjected to rotate in a vertical plane about such spot or vice-versa.

3) A lapping machine as claimed in claim 1 wherein said toothed circular satellites are all included in a single turn around the axis of the machine.

4) A lapping machine as claimed in claims 1 and 3 wherein the ratio among the teeth of the inner crown, the teeth of the outer crown of the lower lapping plate and the teeth of the satellites is chosen in such a way that the measurement by the comparator on a piece is repeated after a turn of a satellite around the axis of the machine on a piece which was located on the same satellite in a diametrically opposed position with respect to that position where the measurement is actuated.

5) A lapping machine as claimed in the preceding claims characterized by the fact that the device for restoring the alignment between the comparator points comprises a transducer whereby the outcoming electric vertical disalignment signal of the comparator points issuing from the latter is transformed into the pressure of a liquid which acts on a piston through a pawl which rotates a screw for lowering the support assembly of the comparator, so that the points are restored to their vertical position that is aligned and perpendicular to the piece.

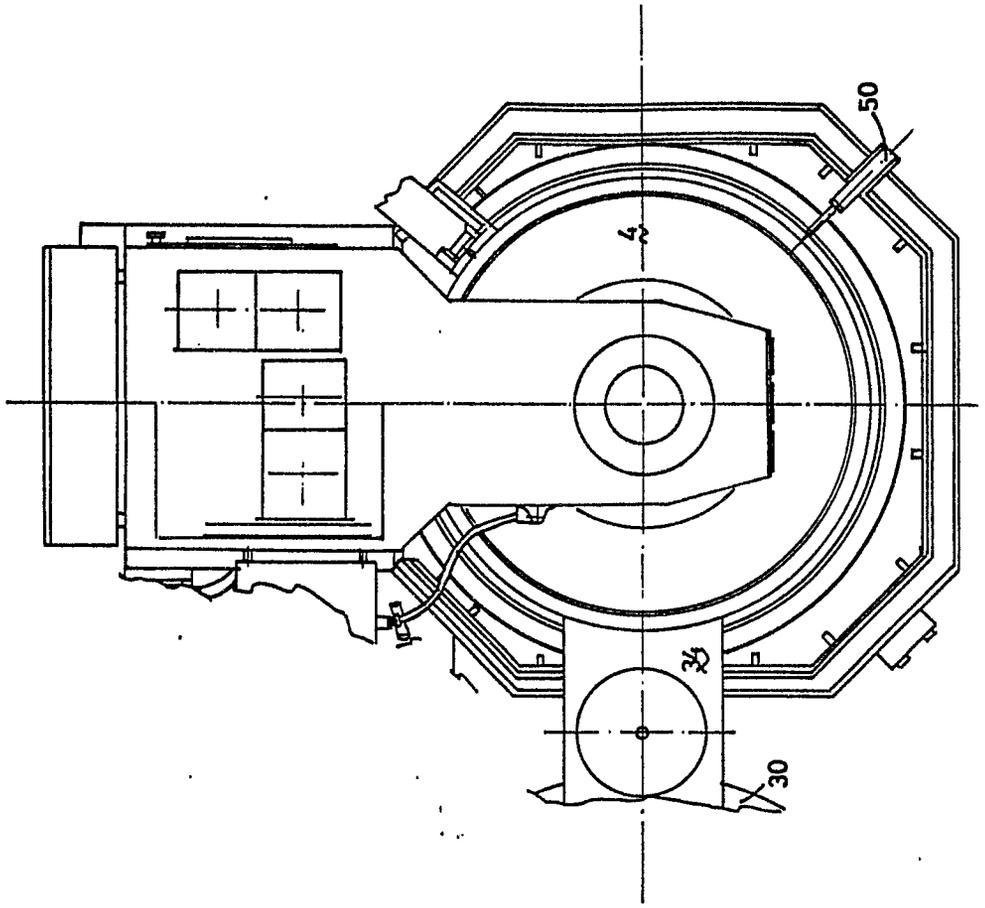
6) A lapping machine as claimed in the preceding claims wherein said machine includes also a loading device

for loading the satellites on the lapping machine which device comprises a circular plane where as many places are provided as are the satellites to be loaded on the lapping machine plus one whereby, whereever a circular satellite with lapped piece is to be withdrawn from the lower lapping plate the device is approached to the lapping machine in front of an opening provided at the circular vertical wall by which the machine lapping plates are guarded and a satellite with lapped pieces is made to slide towards said one empty place of the loading device, this being then rotated in order that a novel satellite with pieces to be lapped be made to slide into the place left free on the lower lapping plate by the withdrawn satellite.

7) A lapping machine as claimed in claim 2 wherein said satellites project all around said lapping plate in a measure which is sufficient for obtaining that said pieces being lapped can become inserted in succession, when the machine is rotating, between said two comparator points at least for a portion of said piece.

8) A lapping machine as claimed in claim 6 which machine includes also a supporting plane having a lateral flat slide interposed between the lower lapping plate and the satellite loading plane, at the opening of which a circular wall is provided as a protection of the lapping machine.

FIG. 2



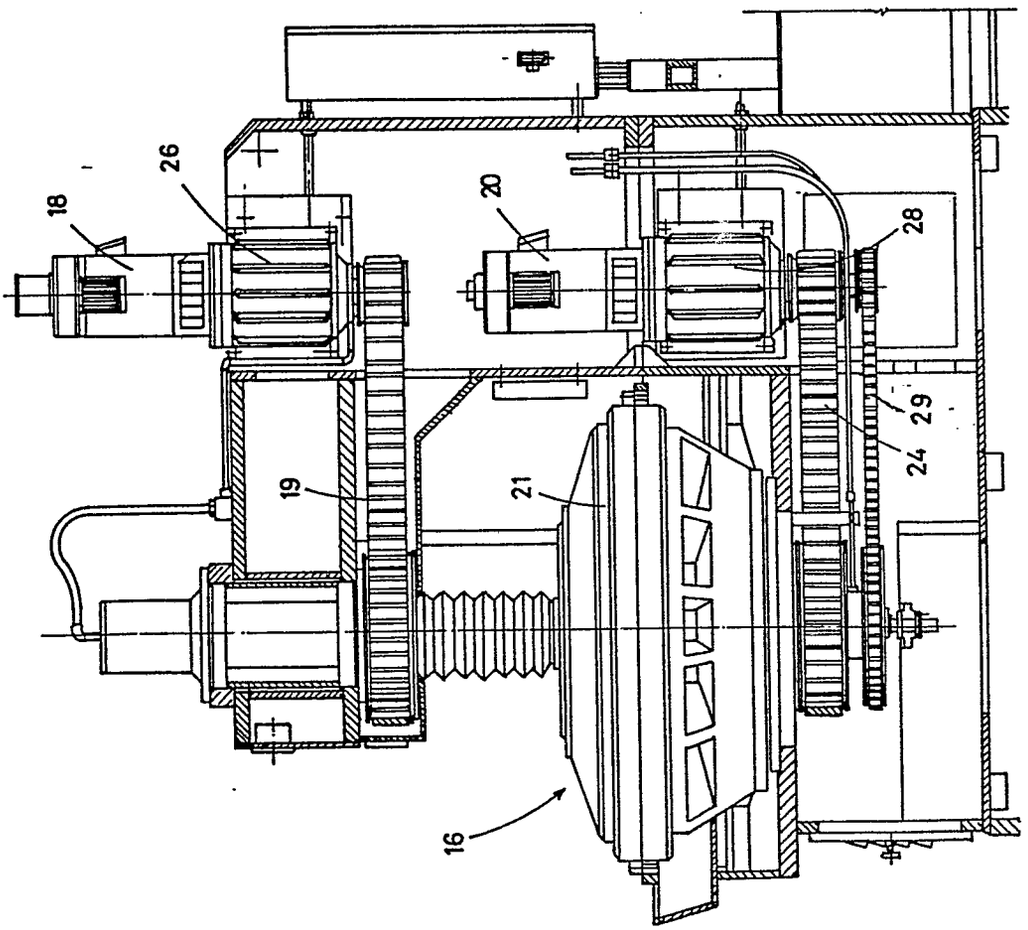
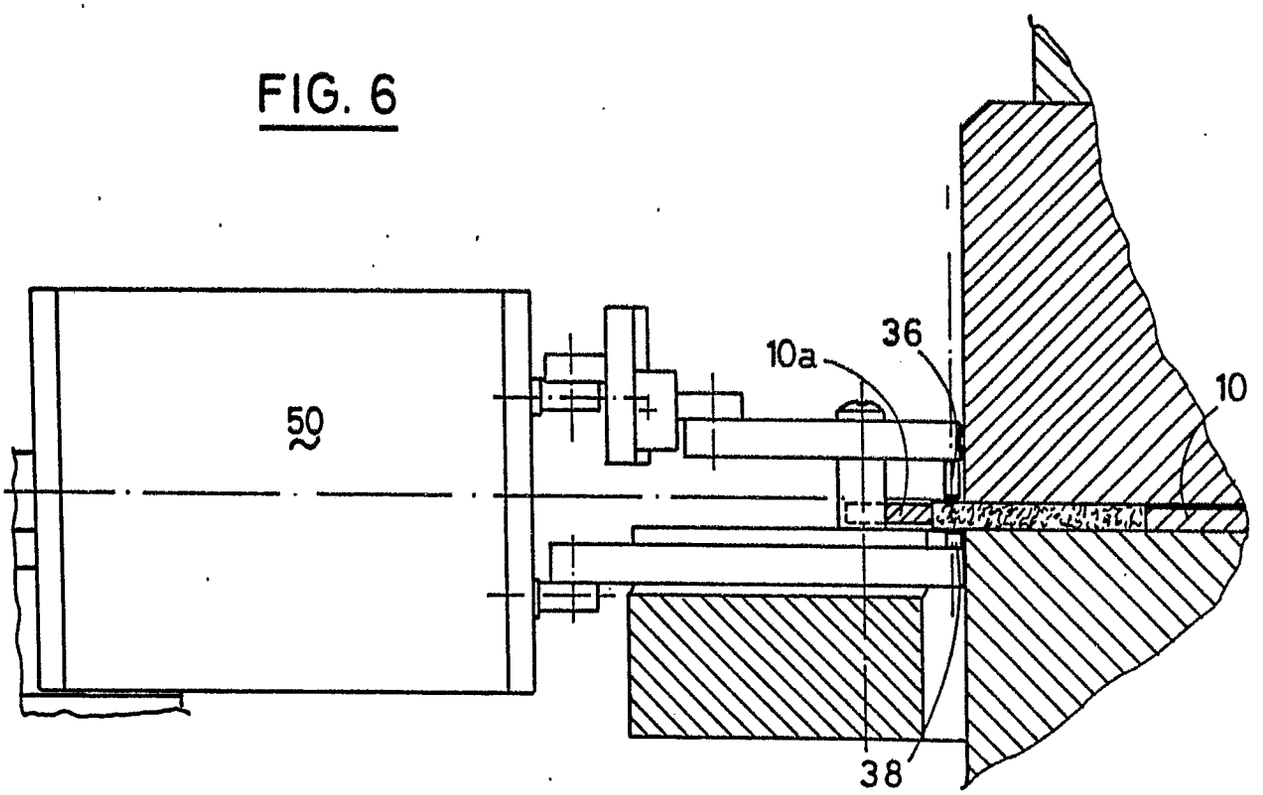


FIG. 1

FIG. 6



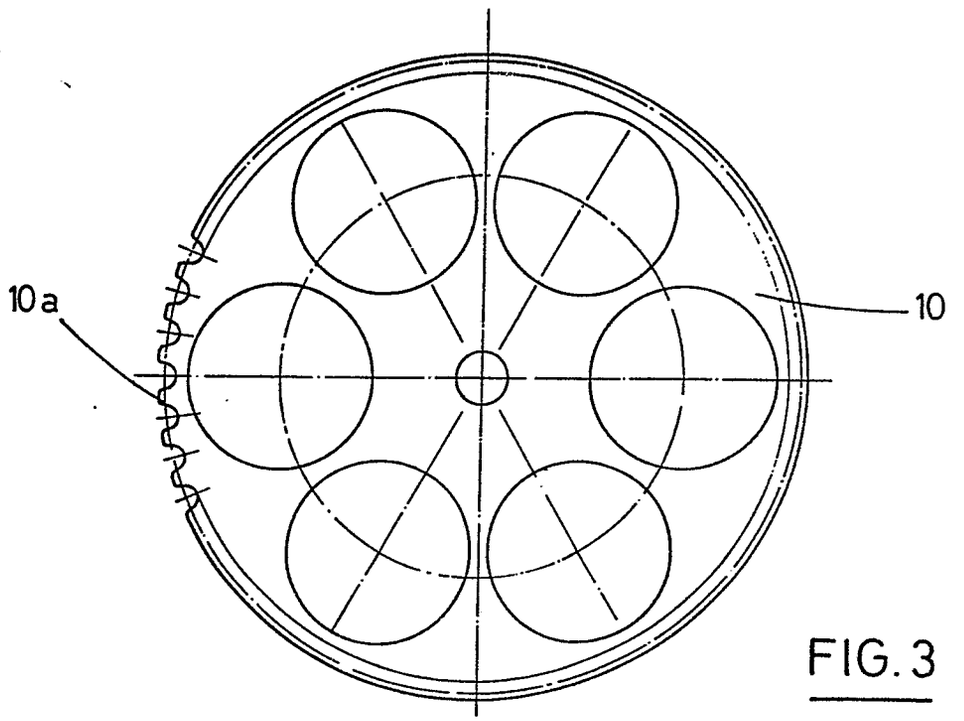


FIG. 3

FIG. 4

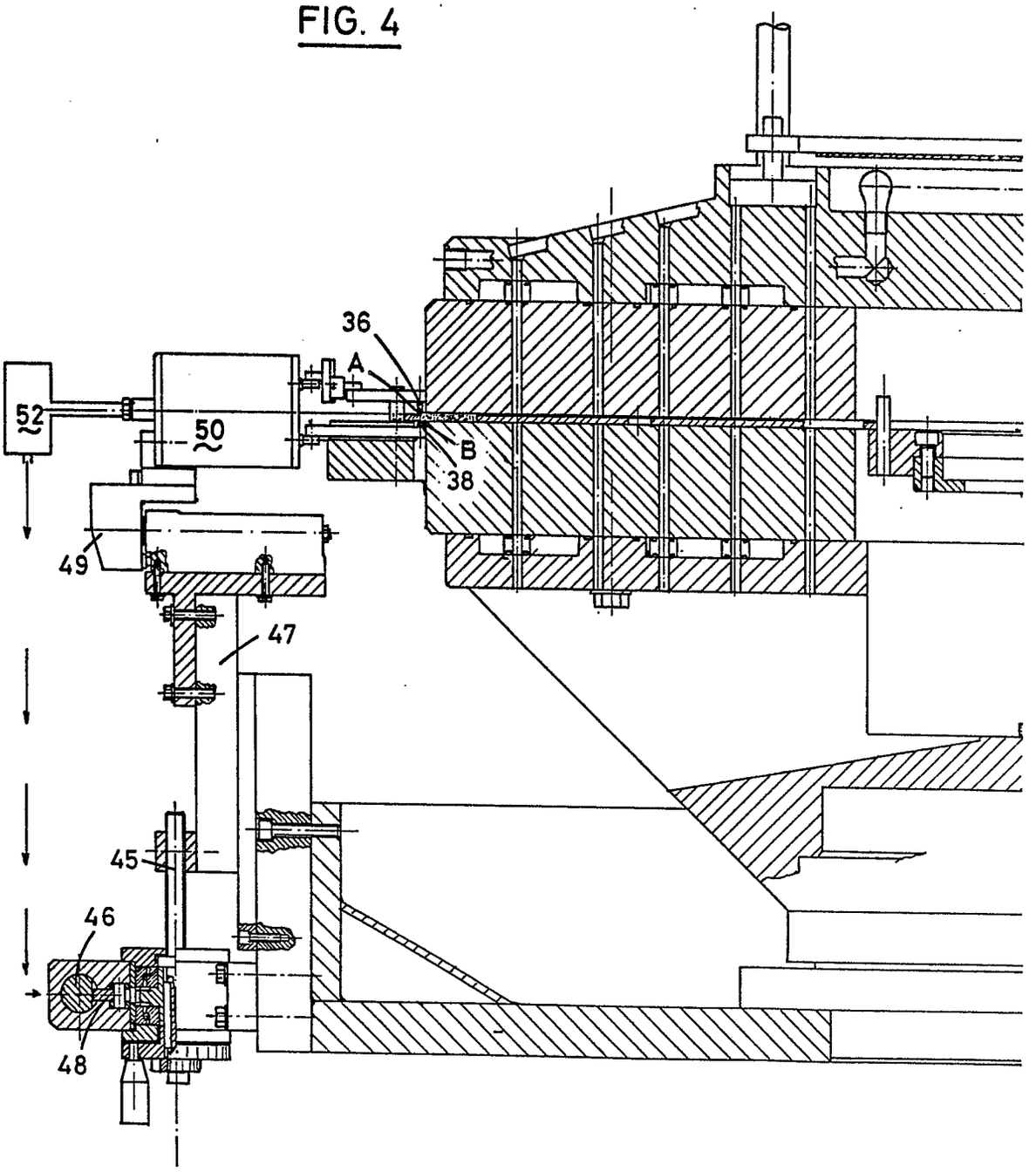


FIG. 5

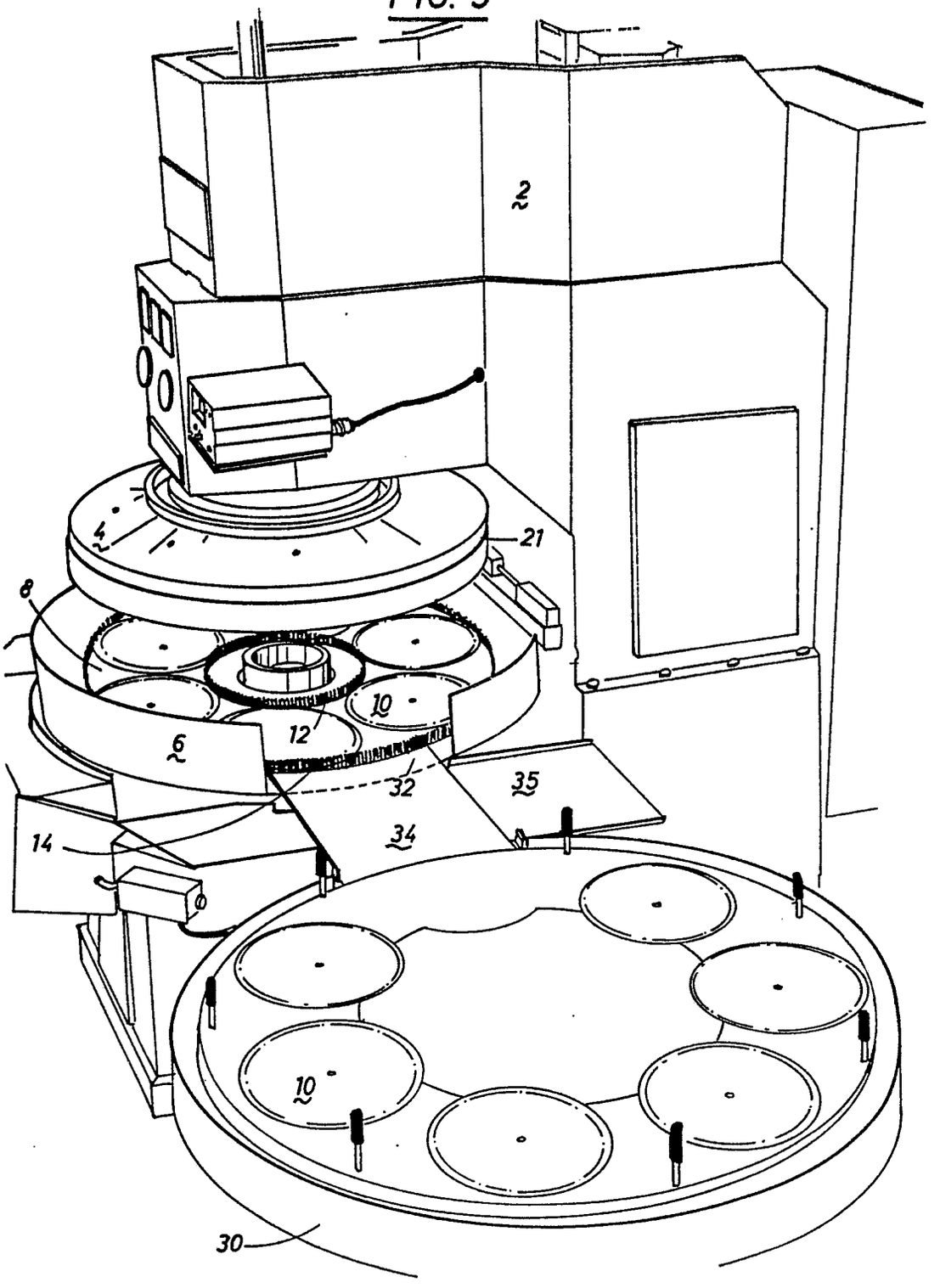


FIG. 7

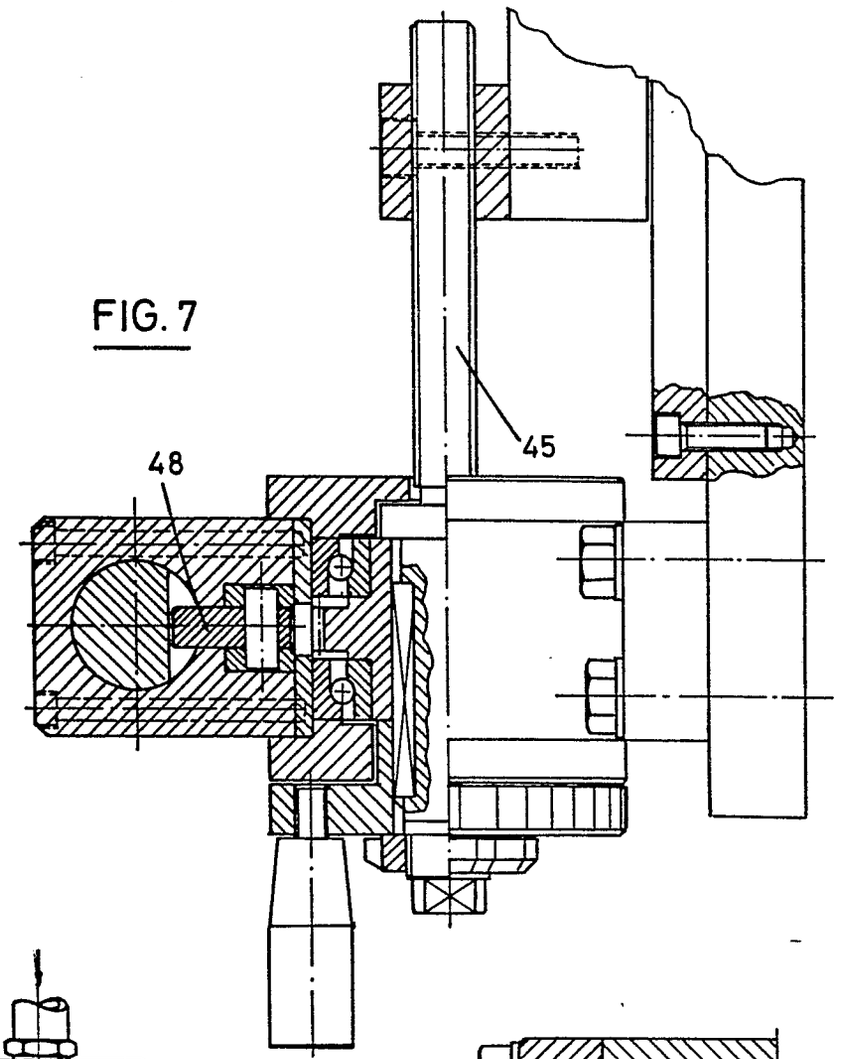


FIG. 8