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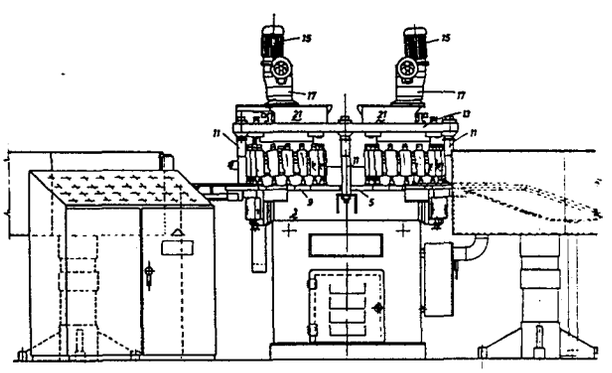
(54) **Improvements in lapping machines.**

(57) A lapping machine is disclosed wherein the workpieces whose surfaces to be lapped are held with a relatively light pressure on the surface of the lapping plate are drawn along a path alternately towards the rotation axis of said plate and away from it; a plurality of workpiece holders being provided at regular angular distances from one another at the periphery of at least one rotary disk with vertical axis and driven by said disk over the lapping surface of said plate along a circumferential path whose diameter is nearly equal to the plate radius and within which the plate axis is not included. Said holders in addition to firmly engaging each a workpiece are functioning for imparting thereto an adjustable pressure and a rotational movement about the center of figure of the contact area between the workpiece and the plate.



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IMPROVEMENTS IN LAPPING MACHINES

The present invention relates to improvements in lapping machines each provided with a horizontal and circular lapping plate which will be referred to as "circular plate".

In Italian Patent 836.761 to Melchiorre a lapping machine is disclosed by which small groups or lots of workpieces can be simultaneously lapped all having the same height. Such equal height pieces are fed to the lapping machine in small batches on a circular space of the lapping plate not including the plate vertical axis which space is surrounded by a cylindrical ring with vertical wall, the diameter of the ring being about one half the plate diameter; said ring being called reconditioning ring in as much as it functions for scraping the lapping surface of the plate and making it true flat. The workpieces are kept apart from one another within said ring by a flat jig vertically slidable along the wall of said ring, said jig being provided with through holes adapted for mating the periphery of the workpieces. A single pressing load is placed on top of all the workpieces within said ring which load is proportioned to the total area of all the workpieces contacting the plate.

The main drawback of the lapping machine according to the above mentioned pior art consists of the fact that

each of the pieces to be lapped is driven to constantly slide along the same circumferential path and as result the plate surface is worn along concentric circumferences. Another drawback originates from the fact that a single load is collectively applied on all the workpieces within the same ring which load could not be uniformly distributed due to slight differences of the piece heights.

Lastly the method of supplying the pieces to be lapped onto the plate and of withdrawing them at the end of the lapping work is time-consuming.

The present invention is aimed to eliminate the above drawbacks. In fact according to this invention each workpiece is moved over the lapping plate alternately towardds the rotation axis of the plate and away therefrom. In such a way the path length the workpiece for each revolution of the plate is the same for all the workpieces and not longer for the pieces which are farther from the plate axis as it occurs in the lapping machines of the cited prior art.

Further,according to an important feature of this invention, each workpiece, in addition to being drawn over the plate is also rotated about its own vertical axis which passes through the center of figure of its surface in contact with the plate.

It is further to be noted that the force by which each workpiece is pressed on the plate can be adjusted to a value different from the other pieces.

And lastly the system for feeding the workpieces to the machine and for withdrawing the lapped pieces therefrom is totally automatized whereby a great amount of labour is saved.

This invention will be now described with reference to the attached drawings which illustrate a preferred embodiment thereof by way of example.

In the drawings :

Fig.1a shows a front elevation of the lapping apparatus of the invention;

Fig.1b shows a side elevation of the apparatus of Fig.1a;

Fig.1c shows a top plan view of the apparatus of Fig.1a;

Fig.2 shows a diametrical cross section of the apparatus of the invention taken along line II-II of fig.1b;

Fig.3a shows a top plan view of the cam to be engaged by the roller bearing located at the upper end of the sliding barrel of the piece holder of the apparatus of this invention;

Fig.3b shows a side view of the cam of Fig.3a;

Fig.3c shows a cross section of the cam of Fig.3a taken along line III-III of the same figure;

Fig.3d shows a cross section of the cam of Fig.3a taken along line III'-III' of the same figure;

Fig.4a shows an elevation of a piece-holder according to the invention;

Fig.4b shows a vertical cross section of the piece-holder of Fig.4a taken along line IV-IV of Fig.4a.

With reference to the drawings, the lapping machine of this invention comprises a mounting structure 3 having a horizontal table 5 provided with an ample circular aperture from which the lapping plate 9 emerges which has a circular shape with the lapping surface upwards.

Plate 5 is rotated by a geared motor enclosed in the machine mounting structure 3 and not shown.

The lapping surface of plate 9 as in the above patent is provided with grooves 10 in a ray pattern for the uniform distribution of the abrasive mix.

Three columns 11 are affixed onto mounting structure 3 which extend upwards to sustain a support plate 13 on which two identical electric motors with vertical axes are mounted which are provided with variable-speed gears 17. Motors 15 drive each an identical mechanical assembly of which only one will therefore be described. A shaft 19 extends from each variable-speed gear 17 into a casing 21 and terminates with a pinion 23. Casing 21 rests on plate 13 being coupled thereto by means of key 25 which prevents any rotation of the casing with respect to mounting structure 3.

Casing 21 is partially protected by a cover 27 which can be opened by rotating it about a pin 29 for inspection of the casing inside. A stiff stationary structure 31 is firmly attached to plate 13, a cylindrical cavity 31' being provided at the structure center into which the shaft 32 of a rotary disk or rotor 35 extends which rotor is supported within stationary structure 31. by means of two roller bearings 37 and 39.

Output pinion 23 from variable-speed gear 17 engages a first gear wheel 41 on whose axis a pinion 43 is mounted which engages a second gear wheel 45. The shaft 47 of the latter extends downwards through plate 13 and stationary structure 31 and thereafter terminates with a pinion 49 which engages the internal toothing of which rotor 35 is provided. Rotor 35 at its periphery carries a circular row of workpiece-holders 51 (see Figs. 2, 4a and 4b) which function for getting hold of the workpieces and driving them along the surface of the lapping plate 9 and at the same time for imparting a rotary movement to each of them about

its own vertical axis.

Piece-holder 51 (figs.4a and 4b) comprises a bracket 73 which is attached by means of a dovetail joint 35' to rotor 35 at the periphery thereof. Bracket 73 is provided with a vertical through bore into which a hollow cylinder or barrel 53 is slidably but not rotatably fitted. In the central bore of barrel 53 a shaft 55 is rotatably supported by three ball bearings of which two, 57 and 59 at either end of shaft 55, are journal bearings and one, 61 at the lower end of the same shaft is a thrust bearing. The periphery of shaft 55, for about 1/3 of its length is provided with a straight toothing for engaging a toothed ring 65 which is fixedly mounted by means of a row of screws 67 on a peripheral flange 69 of stationary structure 31. Shaft 55, whose toothing engages the toothing of ring 65, is thus driven to rotate about its axis when rotor 35 and consequently the piece-holders are rotating. Shaft 55 at its lower end carries an adapter 71 for catching the workpiece to be lapped by means of suitable teeth engageable therewith; such adapter being consequently replaceable to fit different workpiece heads. Engagement of adapter 71 with the workpiece and disengagement therefrom is obtained through a vertical movement of barrel 53 .In fact barred 53 is vertically slidable along bracket 73 and shaft 55, which is axially secured to barrel 53 ,can follow it in its vertical movement due to the fact that its toothing which is engaged with the toothing of ring 65, is abundantly longer than the toothing 65. Barrel 53 is provided with an arm 53' which extends upwardly to a level higher than the upper end of shaft 55. At the upper end of arm 53' a ball bearing 75 is mounted on a small shaft extending from the upper end of arm 53' towards the axis of rotor 35 which bearing functions as

a cam follower being driven to roll on a circular race 77 integral with structure 31 and then stationary. A slope 79 is included in race 77 on which bearing 75, while traveling in the direction of arrow F of Fig.3a, rises on top of an elevated section 84 of race 77 which section extends through an arc of about 30° which corresponds about to the distance from the delivery point 81 of the final workpiece to the inlet point of a fresh workpiece to be lapped. Along with the ball bearing 75 the shaft 55 is also lifted and adapter 71 abandons the finished workpiece and subsequently engages the fresh workpiece when bearing 75 drops from the cam. A trapezoidal block 85 is mounted at the upper end of arm 53 which block has a horizontal lower base and a slant upper base with a 20 deg inclination to the horizontal, the side faces of the block being flat and vertical. One of the side faces is provided with a recess for receiving ball bearing 75 therein; both the latter bearing and block 85 being fastened to arm 53' by a single Allen screw 87.

The upper slant base of block 85 is intended for engaging a roller 86 (Fig.2) which is biassed downwards by an adjustable helical spring which is housed in a hollow cylinder fixedly attached to stationary structure 31. The purpose of the mechanism comprised of block 85, roller 86 and spring 89 is for applying an adjustable thrust on barrel 53 and consequently on adapter 71 against the workpiece at the moment when they meet and securely engaging each other for starting the circular movement over the lapping plate.

A second helical spring 91 is received in a cylindrical casing 73' for accurately adjusting the pressure to be applied on each workpiece during its travel over the lapping plate said casing being fastened to bracket 73 included in holder assembly 51 and then rotatable with rotor

35. Spring 91 which is biassed by a threaded plug 92 exerts, through a vertical cylinder 93 and a horizontal pin slidable along a vertical slit 99 of which the wall of casing 73' is provided, a downward force on barrel 53 and consequently on shaft 55 and on adapter 71 engaged with the workpiece.

According to the embodiment herein described the workpiece holders are driven to follow a circular path over the lapping plate and the paths of the two groups of holders are symmetrical with respect to a diametrical symmetry plane of plate 9 and each of them occupies only a quarter of the plate surface. The other half of the plate over which the holders do not travel is used for reconditioning that is for grinding the lapping surface of plate 9. To such purpose a ring 101 is disposed on the free half of the plate which ring is amply discussed in Patent 1.003.959, the position of said ring on the plate being controlled by an arcuate arm 103 already described in Italian Patent 751.572.

A preferred embodiment of the invention has thus been described. It is apparent that a number of modifications and changes thereof may be made by those skilled in the art. For instance, differently from the present embodiment, the paths of the workpieces over the lapping plate can be other than circular: for instance they may be elliptical, hypocycloidal etc. provided that the workpiece path leads it from peripheral points to central points of the lapping plate or from peripheral points to peripheral points but passing over the central area of the plate. It should therefore be understood that all the modification and variants which are made within the true spirit of the invention are protect by the following claims.

C L A I M S

1. A method for lapping a flat surface of metal pieces by means of a circular lapping plate rotating about its vertical axis on which plate the workpieces are pressed and which is spread with a liquid suspension of abrasive material which method consists of driving the workpieces with their surfaces to be lapped over said plate along such paths that lead them alternately towards the rotation axis of said plate and away therefrom.

2. An apparatus for carrying out the method of claim 1 which comprises for each workpiece that is for each piece being lapped a piece-holder adapted for engaging it and imparting it an adjustable pressure and a rotational movement about the vertical axis passing through the center of figure of the piece surface in contact with said plate.

3. An apparatus as claimed in claim 2 wherein a plurality of workpiece holders are mounted at regular distances at the periphery of at least one circular rotary disk or rotor (35) rotating about its vertical axis and driven to move over the lapping surface of said plate along a circumference whose diameter is about equal to the plate radius and within which the plate vertical axis is not included.

4. An apparatus as claimed in claim 3 wherein said workpiece-holder comprises a bracket (73) firmly attached onto said rotor (35) at the perphery thereof; a vertically slidable barrel (53) being mounted within said bracket; a vertical shaft (55) being rotatably fitted in said barrel which shaft, at its lower end is provided with an adapter (71) for engaging the workpiece and at its the upper end

section for about 1/3 of its length is provided with a straight toothing for engaging a stationary toothed ring (65) coaxial with said rotor (35) whereby said shaft (55) and consequently the workpiece are rotated about the shaft axis when the rotary disk rotates; the toothed section of said shaft (55) being much longer than the teeth of said toothed ring so that the engagement of shaft with the toothed ring is maintained when the shaft is vertically displaced.

5. An apparatus as claimed in claim 3 which is provided with two rotors (35) the axes of which are symmetrical with respect to the symmetry plane of the apparatus and each of them is rotated by a motor (15) through a variable-speed gear (17) and two reducing gears in cascade (23 and 41) (43 and 45) .

6. An apparatus as claimed in claim 4 wherein each of said workpiece-holders is provided at its upper end with a ballbearing (75) which functions as a cam follower in as much as when said workpiece holder rotates about the axis of said rotor (35) it engages a cam adapted for lifting the workpiece-holder up enough for disengaging said adapter from the workpiece and then engaging a successive workpiece when said cam follower drops from the cam;said barrel (53) being provided at its upper end with a vertical arm (53')on top of which a block (85) is mounted which block has a slant upper surface adapted for engaging,at a proper rotation angle of said rotor,a roller (86) which is biassed downwards by an adjustable spring whereby an adjustable thrust can be applied on said adapter (71) for securely engaging a fresh workpiece to be lapped.

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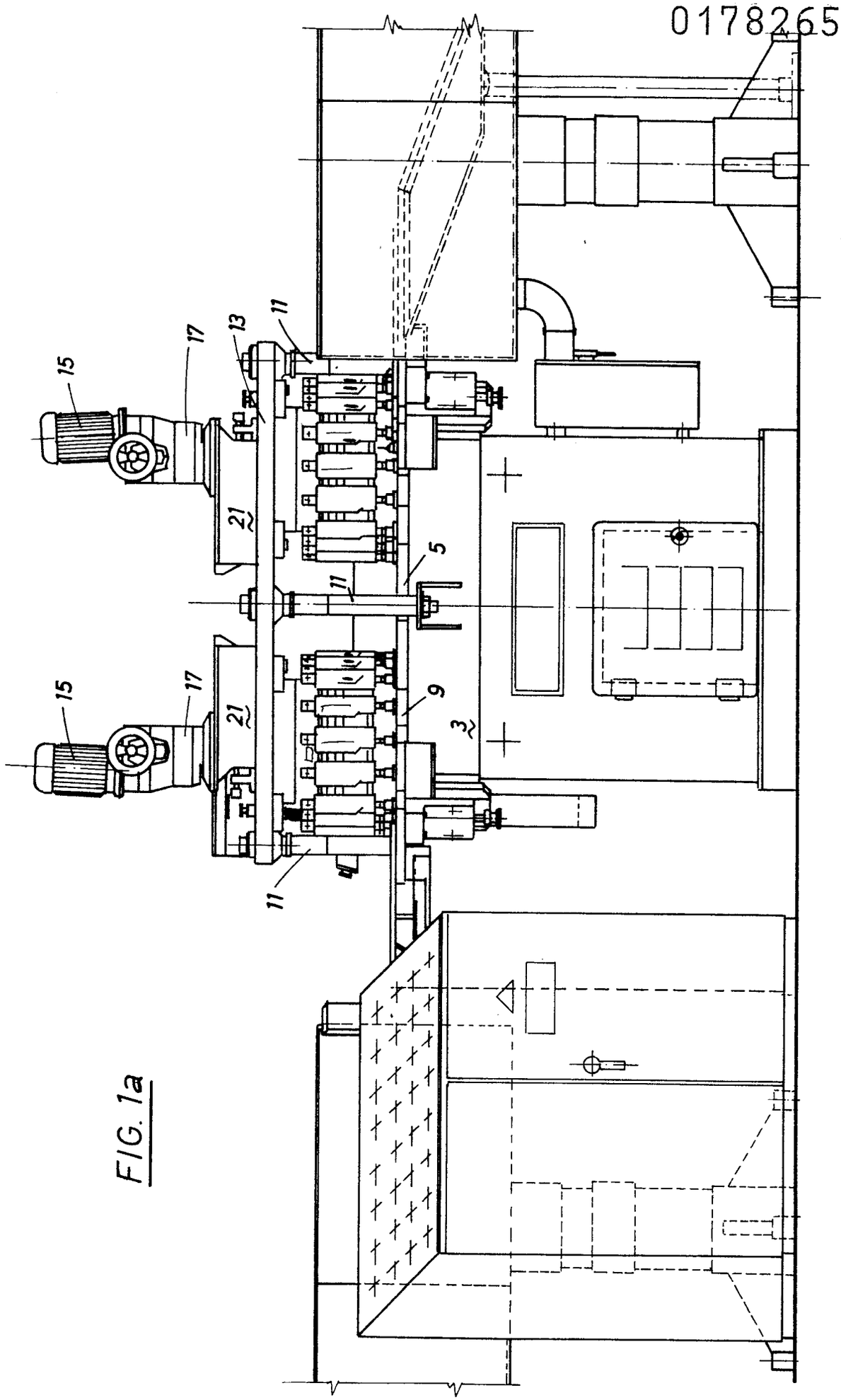

FIG. 1a

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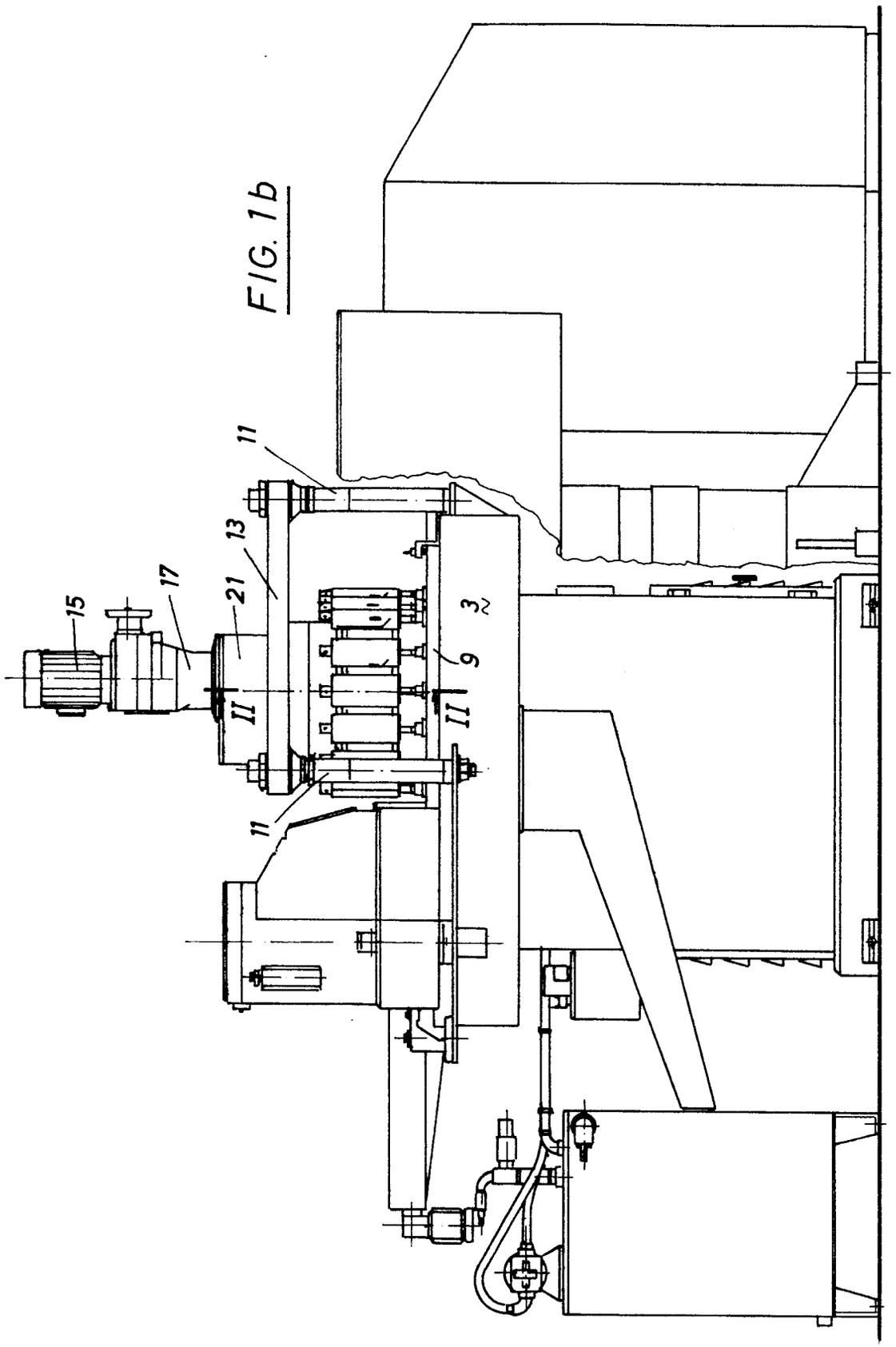
FIG. 1b



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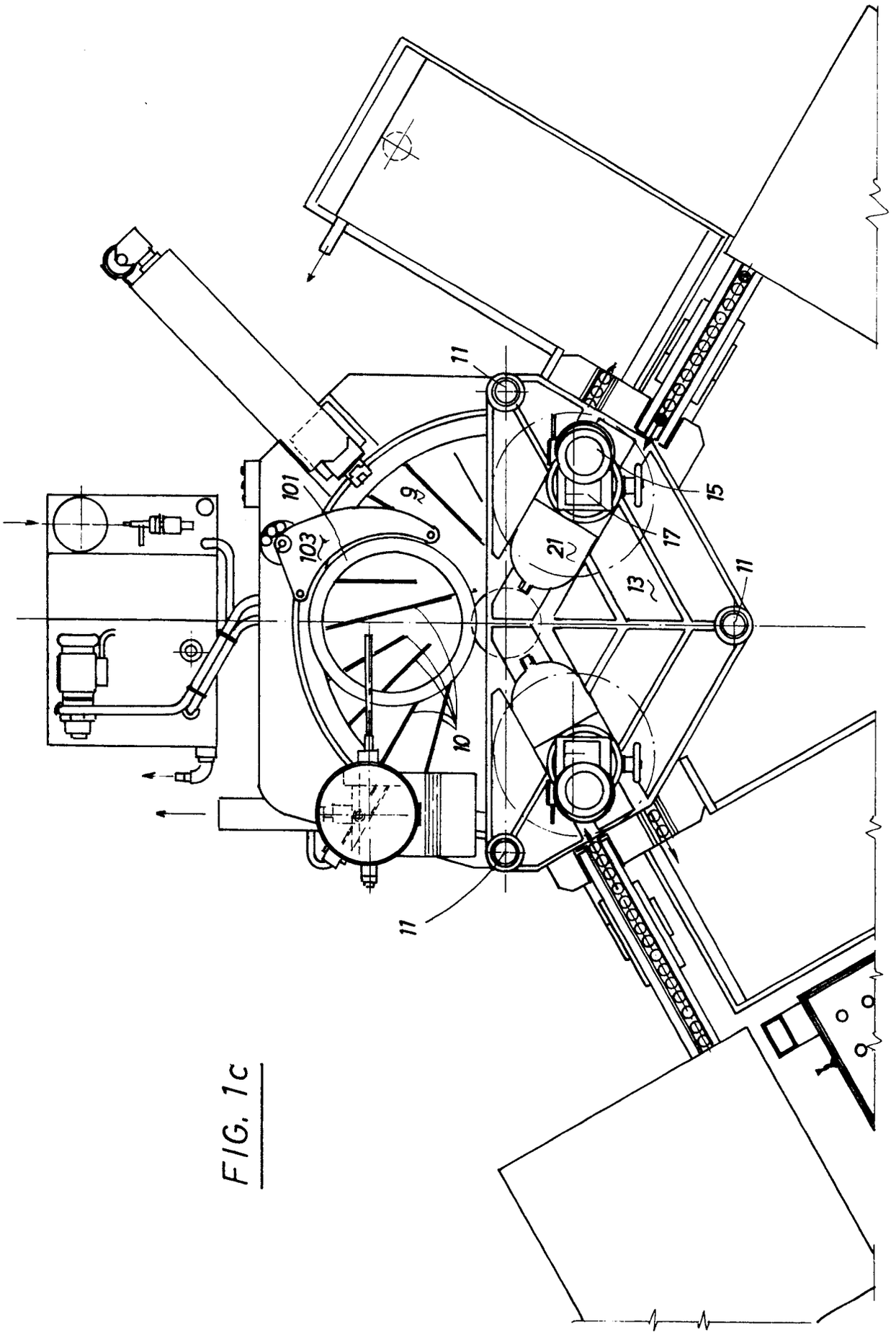

FIG. 1c

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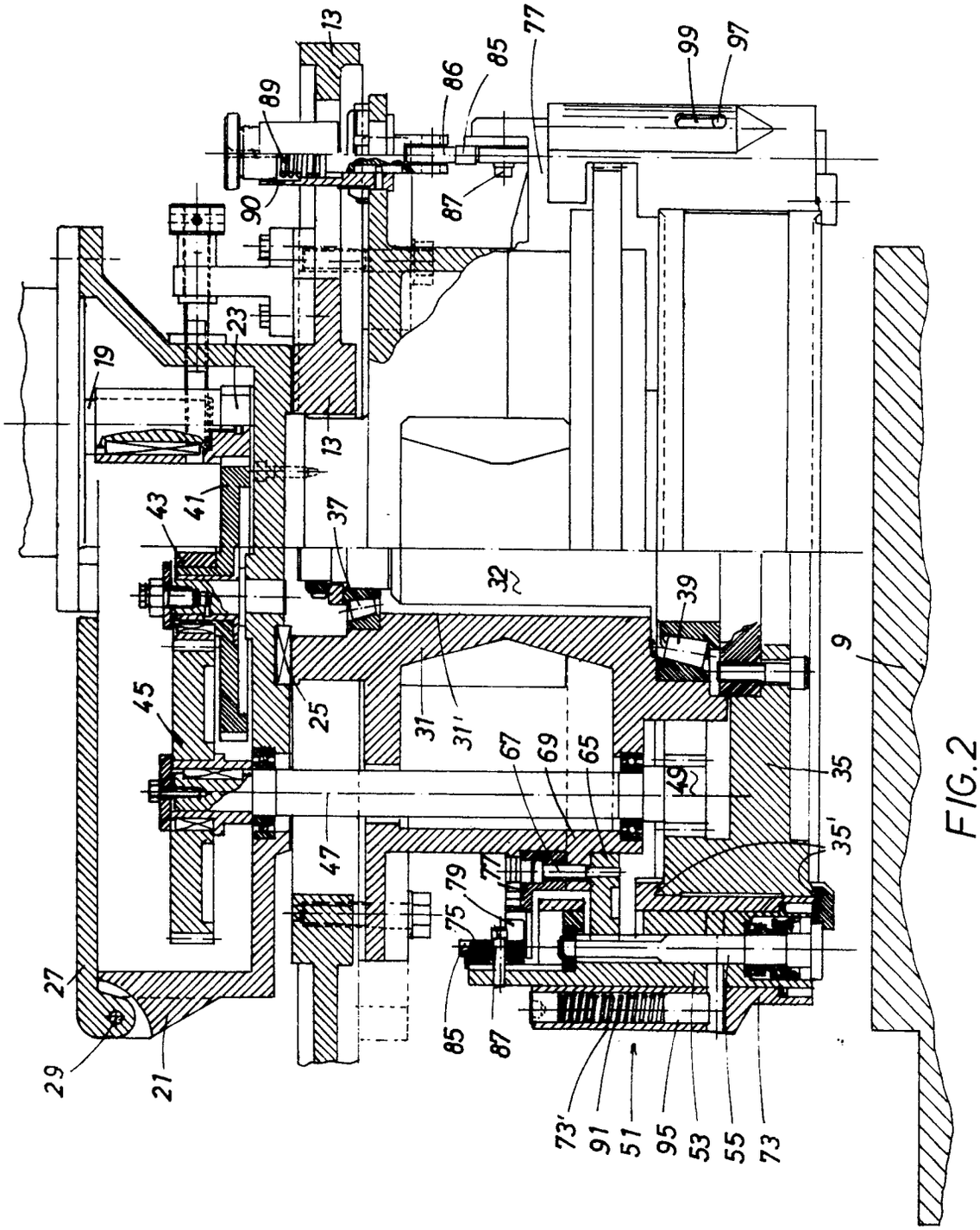

FIG.2

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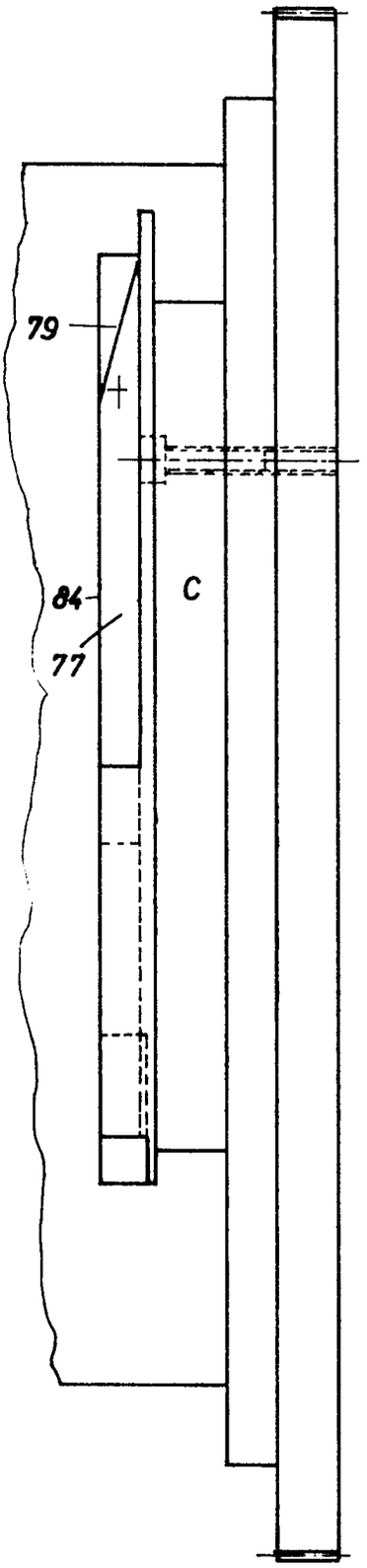

FIG. 3b

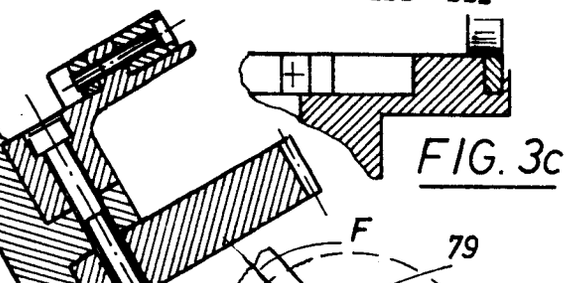

FIG. 3c

FIG. 3 d

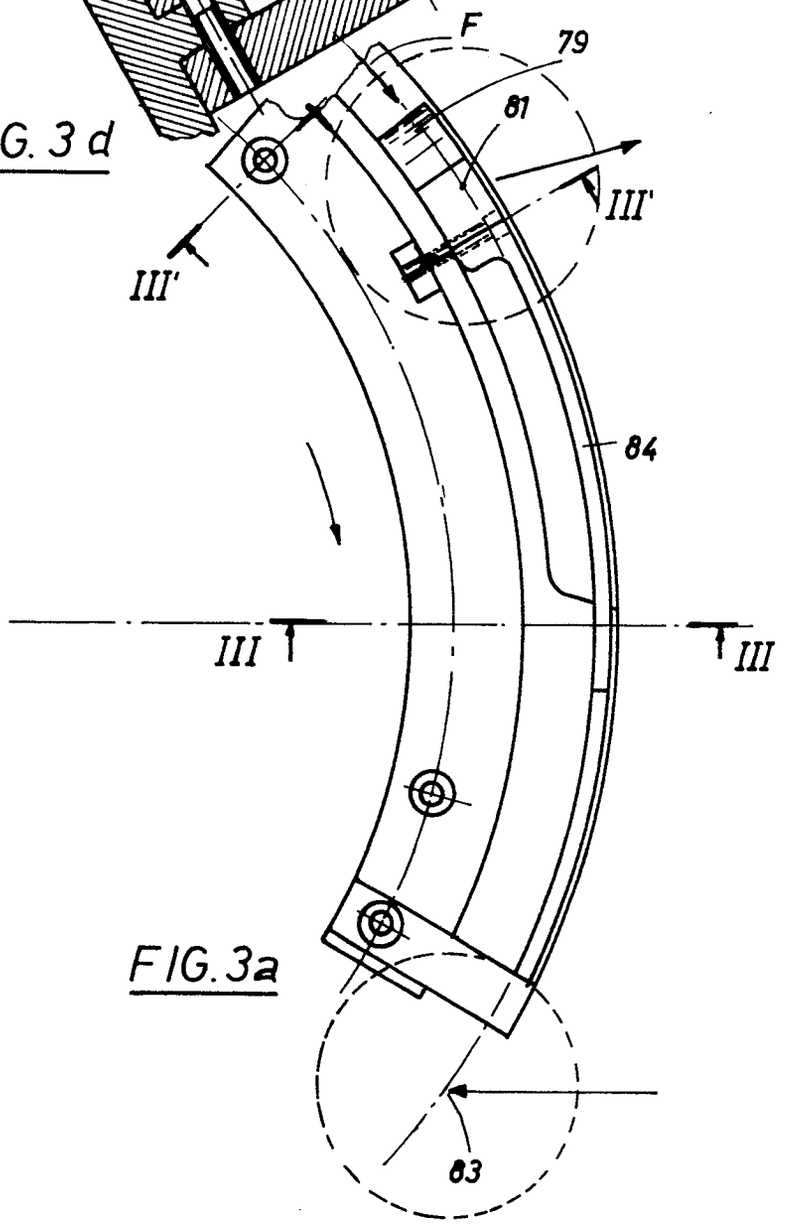

FIG. 3a

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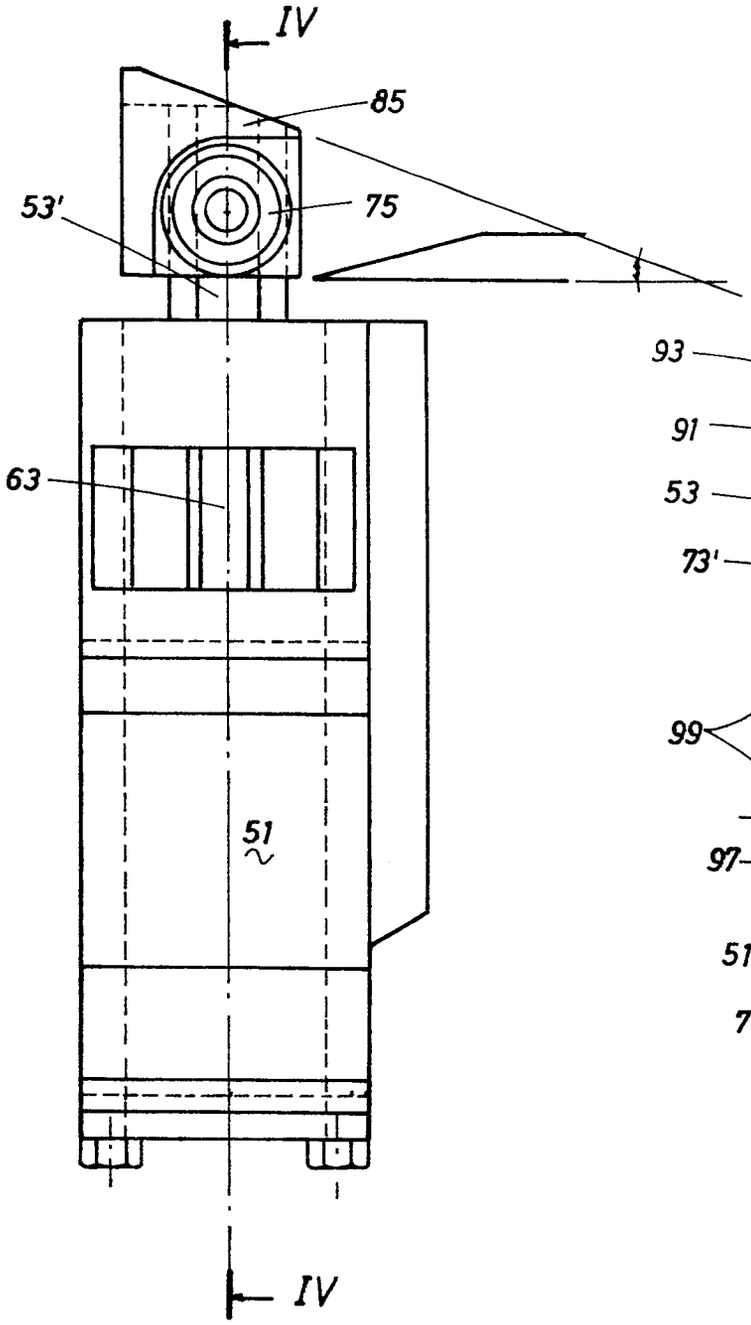

FIG. 4a

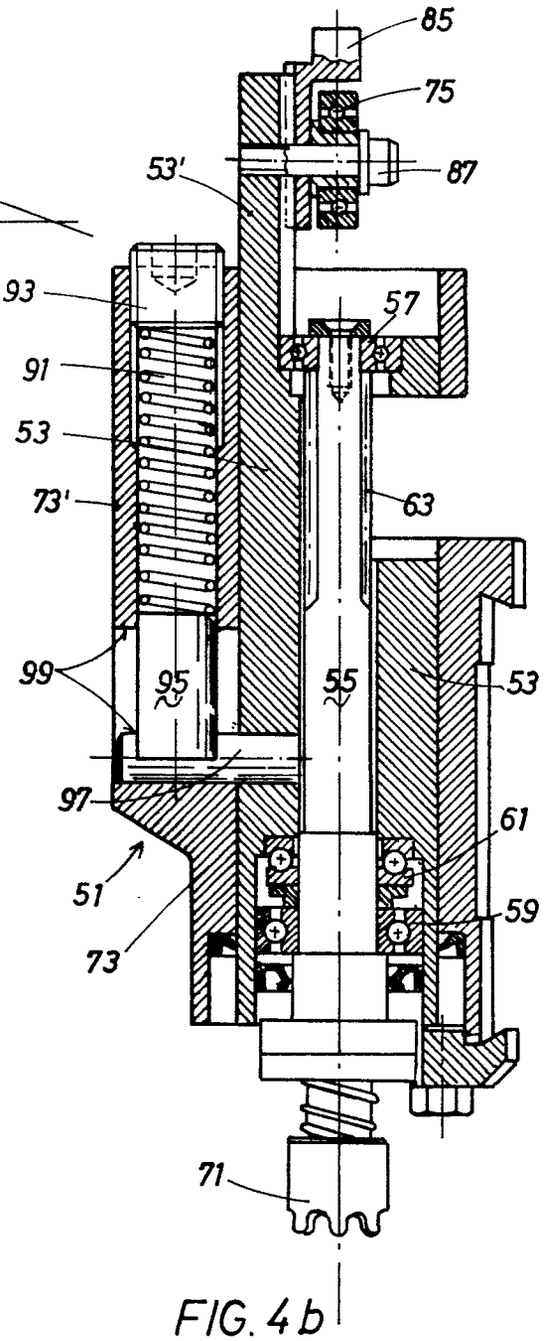

FIG. 4b