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DRAWINGS ATTACHED

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(54) ELECTRIC TIMEPIECE

(71) We, EBAUCHES S.A., a Swiss Body Corporate, of 1, Faubourg de l'Hôpital, Neuchâtel, Switzerland, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement: The present invention relates to an electric time-piece. According to the invention, there is provided an electric timepiece comprising a flexing resonator having at least one vibrating flexible blade, a ratchet wheel driven step by step by the flexible blade through a driving pawl, an elastically loaded retaining pawl acting on the ratchet wheel and a circular gauge, of a diameter smaller than that of the ratchet wheel which can be substituted for the ratchet wheel for adjusting the elastic loading of the retaining pawl, the arrangement being such that, when the retaining pawl is just in contact with the said gauge, without exerting any radial pressure thereon, the elastic loading of the retaining pawl, when the ratchet wheel is again put into place, corresponds to the value necessary for a satisfactory operation of the ratchet and pawl mechanism. The invention will now be further described, by way of example, with reference to the accompanying drawings, in which:— Figure 1 is a plan view, from above, of the movement of an electric wrist-watch. Figure 2 is a sectional view along line II-II of Figure 1 on an enlarged scale. Figure 3 is a plan view, from below, of a portion of the movement separated from the rest thereof providing a broken plan the shape of which is indicated by the line rn-rn of Figure 2. Figure 4 is a sectional view of a detail, along line IV-IV of Figure 1, on an enlarged scale, and Figure 5 is a sectional view of a detail, also on an enlarged scale. The watch movement is carried by a frame comprising a first base plate 4 and a second base plate 1. The base plate 1 (Figs. 1 and 2) carries the conventional mechanical elements of the movement especially the gearing which is carried at one side by the base plate 1 and at the other side by a gearing bridge 2, visible in Figure 2 only. The bridge 2 is secured to the base plate 1 by screws 3 provided with conical bearing surfaces. The second base plate 4 is removably secured to the base plate 1, on the upper face thereof, above the gearing bridge 2, and is held in place by means of securing screws 5 (Fig. 1).

The base plate 4, the shape of which has been represented by a reinforced line in Figure 1, to help increase the clarity of the drawing, is represented as viewed from below in Figure 3. It carries all the driving and drive controlling means. The driving and drive controlling means comprise a symmetrical flexing resonator 6,

secured to the base plate 4 by means of screws 7, the flexible arms 6a of which carry, at their free ends the movable elements 8 of a transducer the fixed elements of which are constituted by two driving windings 9. The flexible arms 6a of the resonator 6 carry moreover, in the neighborhood of their free ends and secured by pins 10, rigid arms 11 ending in enlarged portions 1 la, as balance weights, and which themselves carry balancing masses 12. These latter, which have the shape of three-armed stars, are asymmetric since one of their arms is provided with a notch 13. Thus, by rotating these masses, one modifies the position of the center of gravity of each of these two symmetrical portions 11, 12 of the resonator, thus permitting adjustment of its frequency. The two enlarged portions I la of the rigid arms 11 are each provided with a graduated scale 14 (Figure 1), thus permitting control of the position of the masses 12 and facilitating regulating operations.

The oscillations of the resonator 6 are sustained electrically by means of a transistorized electronic circuit fed by an electric battery 15 (Figure 1) located in an arc shaped recess 16 provided in the base plate 4 and in a circular recess 17 provided in the base plate 1. These two recesses are coaxial when the two base plates are assembled together, thus providing a circular compartment intended to receive the battery 15 which occupies, substantially, the whole height of the movement. The battery is maintained in place by two straps which also ensure the electrical connection of the battery to the electronic circuit; these two straps are constituted by elastic blades one of which, designated by 18, is secured to the base plate 1 by a screw 19 and the other of which, designated by 20, is secured to the base plate 4 by means hereafter disclosed. The strap 18 ensures connection of the positive terminal of the battery 15 to the mass of the movement and the strap 20 ensures connection of the negative terminal of the battery to one of the terminals of the electronic Circuits. The electronic circuit for sustaining the oscillations of the resonator comprises two different electronic blocks each comprising a small plate 21 or 22. secured to the base plate 4, under the latter, by means of screws 23. These small plates have been reinforced in Figure 3 to help increase the clarity of the drawing. Each of the electronic blocks comprises one of the two driving windings 9 and a portion of the electronic components of the circuit; one of the blocks comprises moreover a pick-up winding combined with one of the two windings 9. The two electronic blocks, the small plates 21 and 22 of which are made of insulating material, are constituted by printed circuits which are made according to a technique known per se, by cutting a conductive metallic sheet so as to constitute a grid, by embedding this grid into the insulating material of the small plates, as a moulding operation, then by cutting the edges of the grid so as to separate the elements of the circuit from one another; the electronic components are welded to the grid after the moulding and the cutting of the edges thereof. Figure 3 shows, by way of example, three metallic tongues 24 which constitute the terminals of three elements of the circuit, protruding laterally on the edge of the small plate 21, and a metallic tongue 25 constituting also a connecting terminal of the circuit. protruding laterally on the edge of the small plate 22. The strap 20 maintaining in place the battery 15 and ensuring the electrical connection of the negative terminal of the battery, is riveted at 26 (Figures 1 and 3) to the small plate 21 and is welded to one of the elements of the grid constituting the circuit. The connection of the circuit to the positive terminal of the battery, which positive terminal, as has been stated hereabove. is connected to the mass of the movement, is ensured by a. pin 27 (Figures 1 and 3) carried by the above mentioned metallic tongue 25, which is normally in contact with an elastic blade 28 carried by the base plate 4. This blade passes through a notch provided in a bent portion 29a of a displaceable member 29 mounted on the base plate 4 and guided for displacements, as indicated by the arrows 30 of Figures 1 and 3, by two pins 31 carried by the base plate 4 and which pass through elongated openings 32 of this member 29. The member 29 is provided with a fork shaped portion, between the arms 29b of which is engaged a pin 33 (Figure 1) carried by a setting-lever (not shown) of the movement. When the stem 34 of the setting lever is moved longitudinally, the pin 33 moves along the direction of arrow 35, thus producing the displacement of the member 29 in the direction of the arrow 30. the return of the member 29 in the reverse direction being ensured by the elastic blade 28, sewing as a return spring. The arrangement is such that, when the setting stem occupies its rest position, in which it is fully pushed in. (the position represented in the drawing) the blade 28 is in contact with the pin 27, closing the electric circuit sustaining the oscillations of the resonator; it is the same when the setting stem 34 occupies an intermediate position for date setting of a date indicating element (not shown), owing to the play of the pin 33 between the arms 29b of the fork of the member 29, while, when the stem 34 is entirely pulled out, in a hand setting position, the member 29 is displaced towards the centre of the movement, against the resilient action of the blade 28. That action separates the blade 28 from the pin 27 and thus interrupts the supply to the sustaining circuit. The counting of the oscillations of the resonator 6 is effected by means of a ratchet wheel 36 provided with a very fine toothing, and rotating between the base plate 4 and a small plate or bridge 37 (Figure 3) secured under the base plate 4 by two screws 38; the shape of this small plate has been reinforced in Figure 3 to help increase the clarity of the drawing A pawl 39, secured to a pin 40 on one of the portions I Ia of the resonator 6, acts on the wheel 36 for rotating it by one tooth at each oscillation of the resonator.

The other portion 1 ho of the resonator carries a 41 for balancing the pin 40. A second pawl, i.e. a retaining paw!, designated by 42, acts on the wheel 36. This second pawl is carried by a small plate which is submitted to the action of a screw 44 constituting a positioning device, screwed in a stud carried by the base plate this screw acting laterally on the small plate for maintaining it in position, by means of a part-circular notch thereof which bears against a pin 45, constituting a pivot carried by the base plate 4, and for maintaining an elastic arm 43a of the small plate against a pin 46 carried by the base plate 4. The small plate 43 is prevented from being lifted on the one hand by a head 45a provided on the pin 45 and on the other hand a head 47a provided on a holding pin, designated by 47, which is of smaller section than the pin 45 and is positioned with play in an opening 48 having the shape of key-hole, provided in the small plate. The portion of greater diameter of the keyhole 48 permits the head 4Th of pin 47 to pass through for mounting and dismounting the small plate. The orientation of the key-hole 48 is such as to obviate, when the small plate 43 is being put in place, any risk of damage to the toothing of the wheel 36, since the positioning, in height and in plane, of the small plate is effected before the pawl 42 enters into contact with the wheel.

The arrangement as disclosed permits the position of the retaining pawl 42 to be modified by means of the screw 44 and, thereby, the relative position of the two pawls, the driving pawl 39 and the retaining pawl 42 to be adjusted with high precision, that is to say their relative phasing. Owing to the type of mounting of the small plate 43, it has no play, the small plate permanently bearing against pin 45 under the effect of its elastic arm 43a and of the screw 44. The pawl arrangement of the ratchet wheel is claimed in Patent Application No. 8616/70 (Serial No. 1287644). The radial pressure exerted by the two pawls 39 and 42 on the ratchet wheel 36 has also to be adjusted very precisely. To this effect, the movement is provided with a gauge 49 (Figures 4 and 5) located, when it is not used, in a circular compartment 50 provided in the base plate 4, and closed by the base plate I when the movement is assembled. The adjustment of the pressure of the pawls on the wheel 36 is effected when the base plate 4 is separated from the base plate 1. The gauge 49 is then accessible and can be withdrawn from the compartment 50 for engagement in the bore, designated by 51, of the base plate 4, containing the upper bearing, designated by 52, of the wheel 36, after this wheel has been removed (Figure 5). The height of the bore 51 is sufficient to permit the engagement of an extension 49a of the gauge into this bore, below the bearing 52. The extension 49cz is annular, having the shape of a collar, so as to be slightly resilient and thereby to be able to engage frictionally the bore 51. The diameter of the gauge is very slightly less than that of the wheel 36, the difference being chosen in such a way that, when the pawls 39 and 42 are just in contact with the gauge, without exerting thereon any pressure, the elastic loading of the pawls, when the ratchet wheel 36 is substituted for the gauge, has the desired value. The gauge 49, stored in the compartment 50, is thus always at the disposal of repairers. This gauge is provided, besides the collar 49a by means of which it is engaged either into the bore 51 of the base plate 4 or into a circular recess 53, of the same diameter as the bore 51, provided centrally in the bottom of the compartment 50, with a central button 49b, situated on the opposite face to the one provided with the collar 49a, which permits it to be held by means of tweezers, for manipulating it. The transmission of the intermittent rotary movements, step by step, of the ratchet wheel 36 to the indicating elements of the watch, i.e. to the hands 54, 55 and 56, indicating respectively hours, minutes and seconds, is ensured by a pinion 57 rigid with the wheel 36 (Figure 2) and meshing with a wheel 58 rigid with a pinion 59 engaged, with a very slight play, in an annular bearing element 60 carried by the small plate 37; the lower spindle of the element 58-59 is carried, when the movement is assembled, by a bearing 61 itself mounted in the base plate 1. The wheel 58 and pinion 59 constitute an intermediate element connecting the points carried by the first base plate 4 and the second base plate 1. The pinion 59 meshes with a wheel 62 which is axially urged, by an arched elastic washer 63, against a pinion 64 mounted on a seconds shaft, at the control of the movement, and designated by 65. The friction coupling constituted by the elastic washer 63 and the elements which are associated therewith ensures the protection of the ratchet mechanism 39-36 which could be damaged if a reverse direction force were applied to the wheel 36, for example when the seconds hand was being put into place. A wire spring 66 acts on a pulley 67 mounted on the shaft 65 and acts as brake for the seconds hand. The pinion 64 drives a wheel 68 axially urged by an arched elastic washer 69 against a disk 70 rigid with a pinion 71 rotatably

mounted between the base plate 1 and the gearing bridge 2. The friction coupling constituted by the elastic washer 69 and the elements which are associated therewith operates in the same manner as a conventional watch and permits the setting of the watch without exerting any action on the drive controlling elements. The pinion 71 meshes with the minutes wheel, designated by 72, rotatably mounted on a sleeve 73 carried by the base plate 1 and which controls, through a conventional diai-train, not represented, the hour wheel designated by 74. The general arrangement of the movement in "modules ", one of which, that of the base plate 1, comprises the conventional mechanical elements of the watch, and the other of which, that of the base plate 4, comprises the driving and drive controlling means, including the electric portion, is very advantageous from the point of view of repair of the several elements, of their mounting, of their setting and of their assembling. This arrangement, which is especially flexible, permits each module to be mounted separately and to be tested before assembly. This is especially useful where the two modules belong to two different technical fields, one belonging to conventional watchmaking, and the other one to electronics. For instance, any alteration of the ratchet device is thereby prevented, which could occur, in spite of the friction coupling of the spring 63, when the hands of the watch are set or through accidental contact during the mounting operations. The conventional portion i.e. the base plate 1, provided with the gearing bridge 2 and all the mechanical elements carried thereby can even be put into the casing of the watch, before the base plate 4 with the driving and drive controlling means is assembled therewith. This arrangement moreover permits the repairer to open the watch, to withdraw the battery therefrom, to withdraw the module of the base plate 4 and to handle it per se, for instance for chaning one or the other of the electronic blocks, without touching the resonator 6 and without having to reset the ratchet device 39-36. It is to be noted that the tests of the driving and drive controlling means can be effected when this portion is not assembled with the module of the base plate 1: this is made possible by the fact that the bearing 60, traversed by the pinion 49. provisionally holds this latter in place when the module of the base plate 4 is separated from the module of the base plate 1. This further permits, on connecting the two terminals of the electronic circuit to a source of current, the operation of the driving and drive controlling means, that is to say the resonator 6 and the ratchet mechanism, independently of the rest of the movement. This modular arrangement is claimed in Patent Application No. 86 14/70 (Serial No. 1287642).

WHAT WE CLAIM IS:—

1. An electric timepiece comprising a flexing resonator having at least one vibrating flexible blade, a ratchet wheel driven step by step by the flexible blade through a driving pawl, an elastically loaded retaining pawl acting on the ratchet wheel and a circular gauge, of a diameter smaller than that of the ratchet wheel, which can be substituted for the ratchet wheel for adjusting the elastic loading of the retaining pawl, the arrangement being such that, when the retaining pawl is just in contact with the said gauge, without exerting any radial pressure thereon, the elastic loading of the retaining pawl. when the ratchet wheel is again put into place. corresponds to the value necessary for a satisfactory operation of the ratchet and pawl mechanism. 2. An electric timepiece as claimed in claim 1, wherein one of the bearings of the ratchet wheel is located in a bore of an element of the frame of the movement, the height of which bore is greater than the height of the bearing such that an annular extension of the circular gauge can be frictionally engaged in the bore, adjacent the said bearing, the gauge being then in the position normally occupied by the ratchet wheel. 3. An electric timepiece as claimed in claim 1 or 2, wherein an element of the frame of the movement is provided with a circular compartment in which the circular gauge is located when it is not in use. 4. An electric timepiece as claimed in claims 2 and 3, wherein the bottom of the compartment is provided with a central circular recess of the same diameter as the said bore, such that the annular extension of the gauge can be frictionally engaged in the recess and thus maintained in place in the compartment.

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COMPLETE SPECIFICATION
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SHEET 1

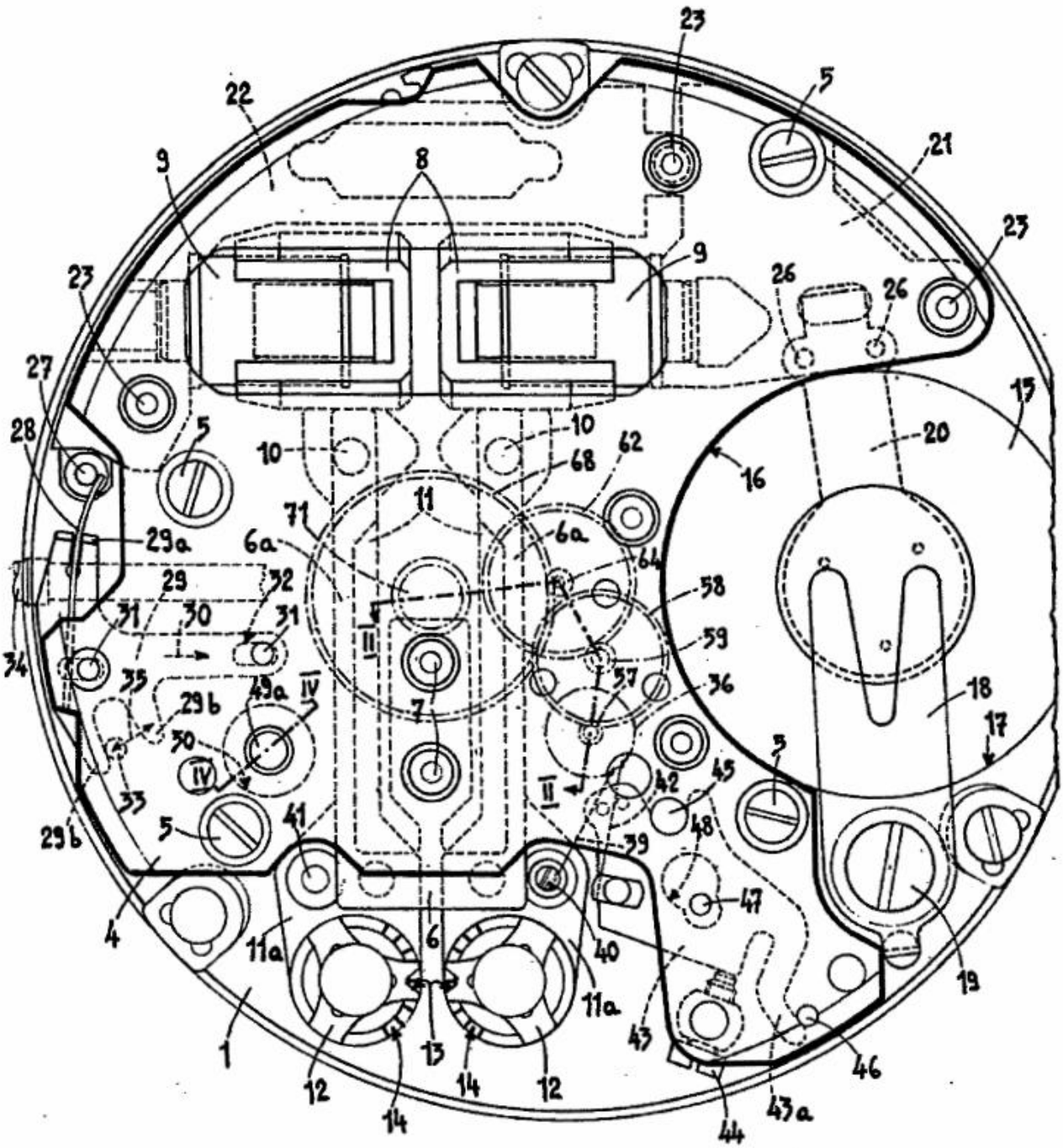

FIG. 1

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SHEET 2

FIG. 4

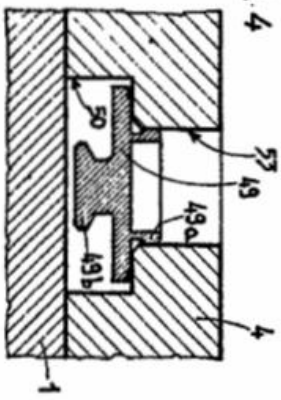


FIG. 5

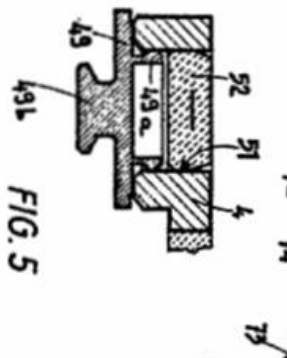
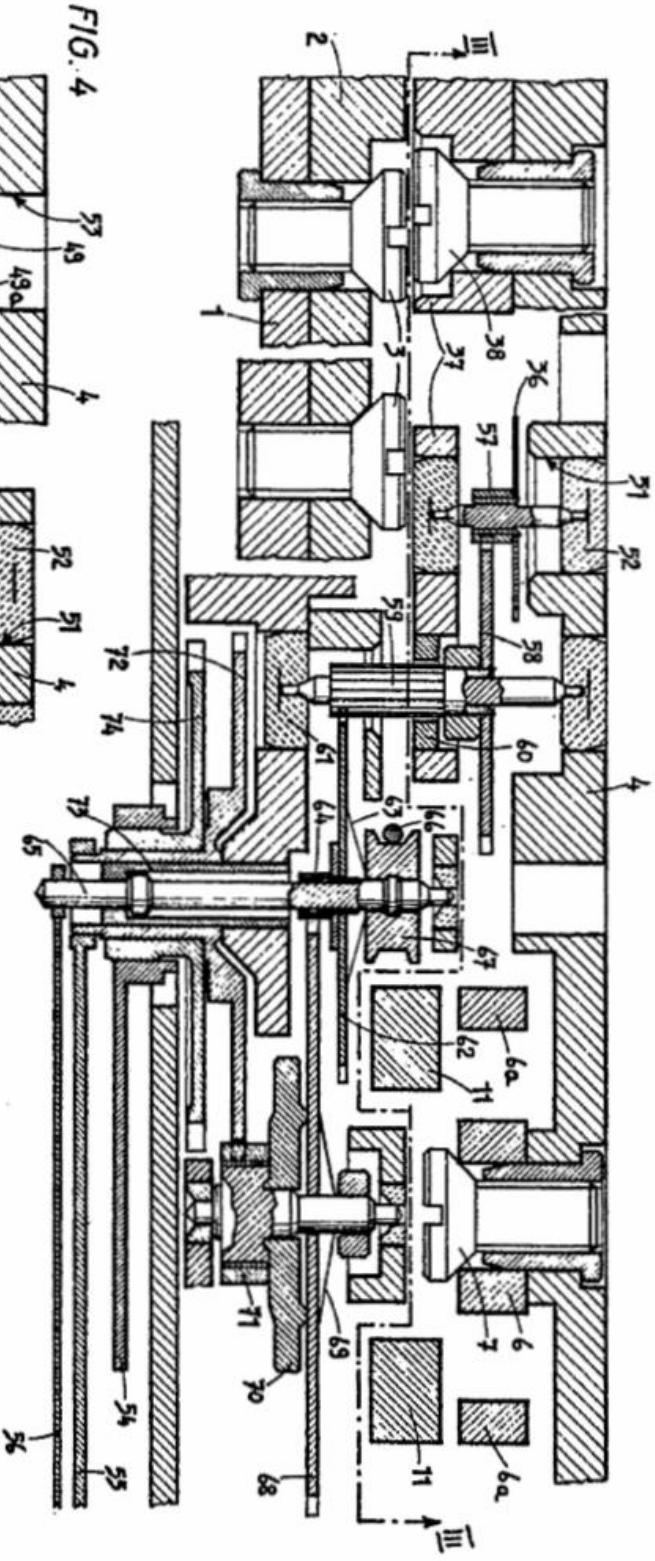


FIG. 2



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COMPLETE SPECIFICATION
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SHEET 3

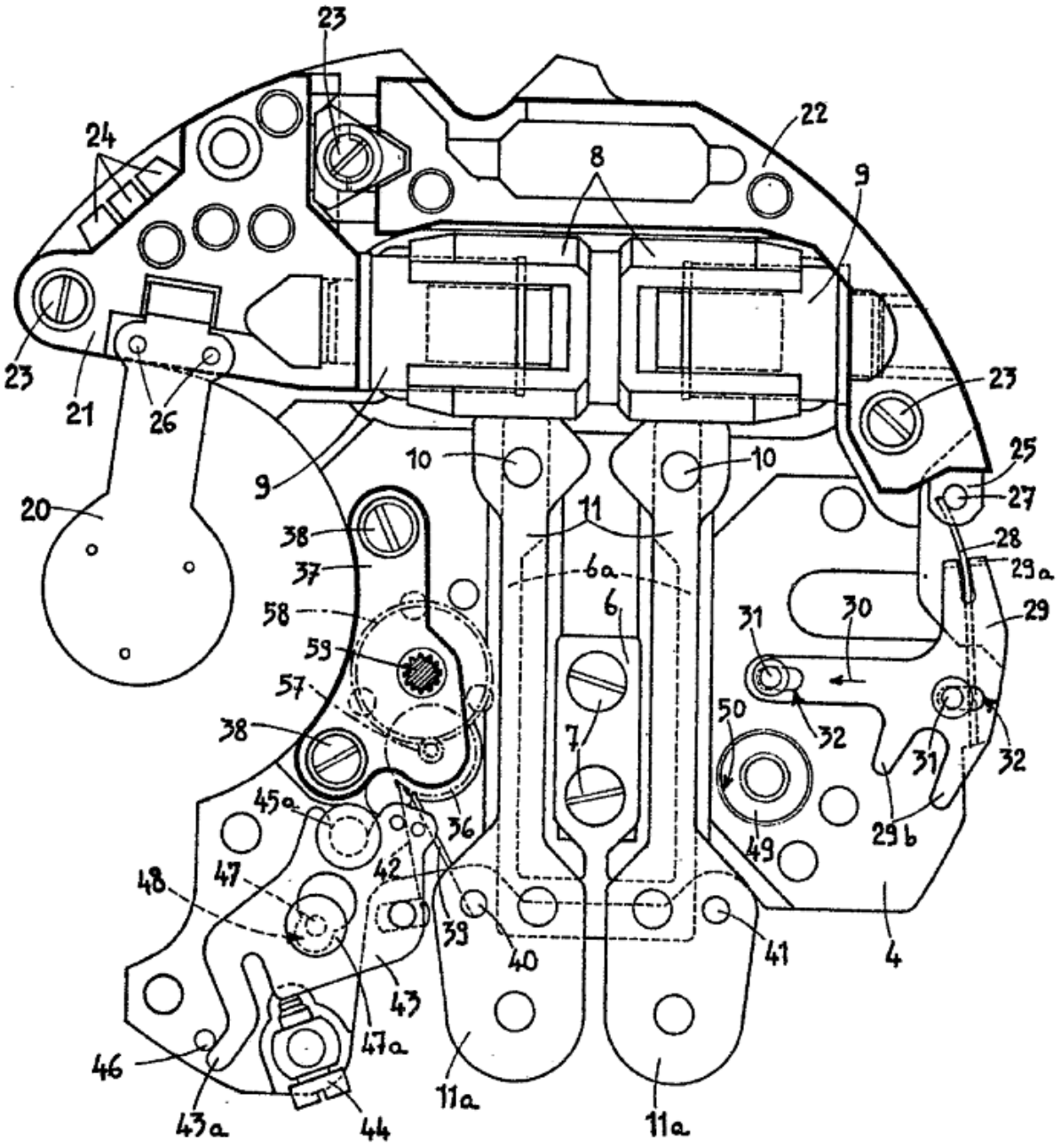

FIG. 3