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(54) **Lock arrangement**

(57) A lock arrangement including a lock element having a locked position at which it locks an associated latch and an unlocked position at which it unlocks an associated latch, the lock arrangement further including a powered actuator having an output element, the output element being actuatable between a first position at which it is capable of moving the lock element to its locked position and a second position at which it is capable of moving the lock element to its unlocked position in which there is a lost motion connection between the lock element and the output element in which the lock arrangement further includes a block element having a blocking position at which it prevents the lock lever being moved from the locked to unlocked position and an unlocked position at which it allows the lock lever to move from the locked to the unlocked condition.

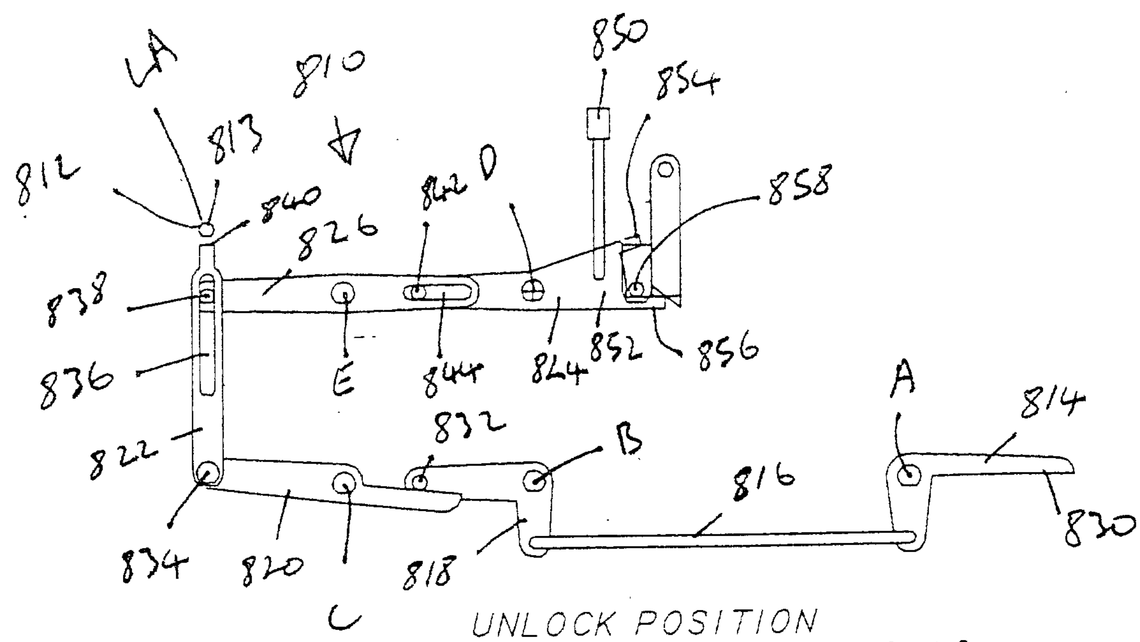

FIG 9

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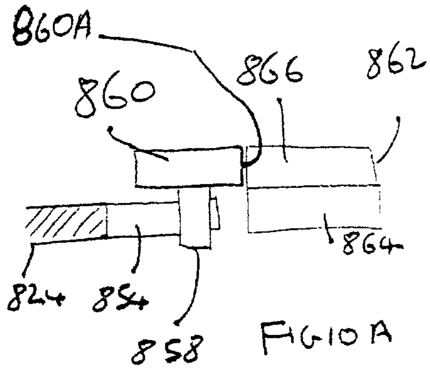


FIG10A

Description

[0001] The invention relates to lock arrangements, and in particular lock arrangements for use on vehicles such as cars (automobiles).

[0002] Known car lock have actuators connected directly to the lock arrangement which allow the lock to be powered into a locked and unlocked condition.

[0003] An object of the present invention is to provide an improved form of lock arrangement.

[0004] Thus according to the present invention there is provided a lock arrangement including a lock element having a locked position at which it locks an associated latch and an unlocked position at which it unlocks an associated latch, the lock arrangement further including a powered actuator having an output element, the output element being actuatable between a first position at which it is capable of moving the lock element to its locked position and a second position at which it is capable of moving the lock element to its unlocked position in which there is a lost motion connection between the lock element and the output element in which the lock arrangement further includes a block element having a blocking position at which it prevents the lock lever being moved from the locked to unlocked position and an unlocked position at which it allows the lock lever to move from the locked to the unlocked condition.

[0005] The invention will now be described, by way of example of only, with reference to the accompanying drawings in which:-

FIGURE 1 is a schematic view of a lock arrangement according to the present invention show in an unlocked condition,

FIGURE 1A shows a cross section of the lock arrangement of figure 1,

FIGURES 2 to 6 show the lock arrangement of figure 1 in differing positions,

FIGURES 7 and 8 show the lock arrangement of figure 1 in differing positions, together with a sill button,

FIGURES 9 to 12 a second embodiment of the present invention in various positions,

FIGURES 13 to 16 show a third embodiment of the present invention in various positions,

FIGURE 17 shows figures 13 to 16 overlaid for comparison purposes, and

FIGURE 18 shows a specific component of the third embodiment in isolation.

[0006] With reference to figures 1 to 6 there is a shown a lock arrangement 710 including a lock element in the form of a lock lever 712, a superlock element in the form of a superlock lever 714, a blocking arrangement in the form of a blocking lever 716 and a powered actuator output element in the form of an output lever 718.

[0007] Lock lever 712 is pivotably mounted about axis H and is forked at end 720 to provide prongs 722 and 724.

[0008] It can be seen from figure 1A lock lever 712 has two regions 726 and 728 which lie parallel to each other, with region 728 being higher than region 726 when viewing figure 1A. Region 728 includes a hole 730.

[0009] Superlock lever 714 is generally planar and also pivots about axis H. Superlock lever 714 also includes a forked end 732 having forks 734 and 736. At end 738 remote from forked end 732 there is provided an arcuate abutment 740, the centre of the arc being at axis H, and an angled cam surface 742.

[0010] Block lever 716 is pivotally mounted about axis J and includes a pin 744 (see especially figure 1A).

[0011] Output lever 718 is pivotally mounted about axis K and also includes a pin 746 (see especially figure 1A).

[0012] It can be seen from the figures that pin 746 sits between prongs 722 and 724 of lock lever 712, and also sits between prongs 734 and 736 of superlock lever 714.

[0013] Note that the circumferential gap L between prongs 734 and 736 of the superlock lever (see figure 4) is less than the circumferential gap M between prongs 722 and 724 of lock lever.

[0014] Hole 730 is connected via a lever 748 (only shown in figures 5, 7 and 8) pivotable about axis N, to sill button 750.

[0015] Block lever 716 is biased in a clockwise direction about axis J by a spring 752 (shown schematically in figure 3 only).

[0016] The output lever 718 can be powered operated to various positions as will be further described below.

[0017] Hole 730 is also connected to locking features of a latch such that when the lock lever 712 is in the position as shown in figure 1 the latch is unlocked and when the lock lever is in the position shown in figures 3 and 5 the latch is locked and superlocked respectively.

[0018] Thus when the lock arrangement in a position as shown in figure 1 the components are at rest and in particular the electric motor P (shown schematically in figure 3) which drives the output lever 718 is at rest.

[0019] By powering the motor P, the output lever 718 is caused to move to the clockwise position as shown in figure 2 whereupon the lock lever 712 has been rotated clockwise by the pin 746 when compared with figure 1. However, the superlock lever 714 has not been moved and hence the block lever 716 also has not been moved since pin 744 is biased against arcuate abutment 740 of the superlock lever.

[0020] When power to the motor P is cut, the output lever 718 returns to its at rest position as shown in figure 3 but the lock lever, superlock lever and block lever do not move. Thus the lock arrangement achieves the locked condition as shown in figure 3.

[0021] A further pulse of energy to the motor P causes the output lever 718 to move to the position as shown in figure 4 which results in pin 746 contacting prongs 724 and 736 and moving both the lock lever and superlock lever to the position as shown in figure 4. Note that in this position the block lever 716 has rotated clockwise since pin 744 has now moved off the arcuate abutment 740 and is in abutment with angled cam surface 742.

[0022] When the pulse of energy to motor P ceases, the output lever 718 returns to its rest position as shown in figure 5 and the block lever returns to its locked position as shown in figure 5. However, it should be noted that both the superlock lever 714 and block lever 716 are in the same position when viewing figures 4 and 5.

[0023] Consideration of figure 5 shows that there is a small gap G between the edge 754 of region 726 of the lock lever and the adjacent portion of pin 744.

[0024] If an attempt is made to unlock the lock arrangement by lifting sill button 750, this gap G closes resulting in edge 754 contacting pin 744 and thus preventing the lock lever from rotating further anticlockwise. It should be noted that by the time gap G has closed a line joining axis J and the centre of pin 744 is at greater than 90 degrees to the edge 754 thus continued lifting of the sill button 750 causes a clockwise moment on pin 744 about axis J, ensuring that the block lever remains in this position.

[0025] By powering the motor P the output lever 718 is moved to the position as shown in figure 6. In particular pin 746 abuts both prongs 722 and 734 rotating both the lock lever and superlock lever anticlockwise. During an initial part of this anticlockwise motion, whilst gap G is being closed, the angle cam surface 742 of the superlock lever acts on pin 744 and causes the block lever to rotate anticlockwise. By the time gap G has closed, a line joining axis J and the centre of pin 744 is now at less than 90 degrees to edge 754 thus continued powered movement of the output lever in an anticlockwise direction causes the edge 754 to assist in caming the block lever 716 in an anticlockwise direction until such time as pin 744 passes shoulder 756 (see figure 1A) and rests upon arcuate abutment 740.

[0026] When power to the motor is cut the output lever 718 returns to the at rest position as shown in figure 1.

[0027] Consideration of figures 7 and 8 show the operation of the lock arrangement when the sill button is lowered (see figure 8) to lock the door and raised (see figure 7) to unlock the door. It should be noted that in both figure 7 and figure 8 the output lever 718 remains in the same position and also that the pin 744 of the block lever 716 always abuts the arcuate abutment 740 of the superlock lever. Thus when considering figures 7 and 8, at no time does the block lever provide for superlocking.

[0028] Note that in further embodiments the output lever 718 could rotate about a different axis, in particular it could rotate about axis H. Furthermore by extending the prongs the pin 743 of the output element could be moved in a linear fashion e.g. vertically up and down when viewing figure 1.

[0029] With reference to figures 9 to 12 there is shown a lock arrangement 810 which incorporates a latch 812, only part of which is shown. Lock arrangement 810 includes an inside handle 814, a link 816, and inside release lever 818, and outside release lever 820, a common release lever 822, an inside lock lever 824, and an outside lock lever 826.

[0030] Inside handle 814 is pivotally mounted about axis A on the inside of a door and includes a manually actuatable portion 830. Inside handle 814 is connected to inside release lever 818 by link 816. Inside release lever 818 is pivotally mounted about axis B and includes a pin 832 for engagement with outside release lever 820.

[0031] Outside release lever 820 is pivotally mounted about axis C and is connected via a connection (not shown) to an outside door handle (not shown).

[0032] A pivot pin 834 operably connects outside release lever 820 to common release lever 822, allowing the common release lever 822 to pivot relative to the outside release lever 820.

[0033] Common release lever 822 includes an elongate slot 836 within which moves pin 838 of outside lock lever 826. Common release lever 822 further includes a release abutment 840 for engagement with the pin 813 of latch 812.

[0034] Inside lock lever 824 is pivotally mounted about axis D and includes a pin 842 which moves within slot 844 of outside lock lever 826.

[0035] Outside lock lever 826 is pivotally mounted about axis E.

[0036] Latch 812 is of known construction and typically might include a rotating claw (latch bolt which releaseably engages a striker mounted on fixed structure of the vehicle such as a B post or a C post. The claw is retained in a closed position in a pawl operably connected to pin 813. Movement of pin 813 from the latched position LA (see figure 9) to the released position R (see figure 12) causes the pawl to disengage the claw, thus allowing the striker to be released and hence allowing the door to open.

[0037] Inside lock lever 824 is connected to sill button 850 and has a forked end 852 with short prong 854 and long prong 856. A pin 858 of a linear actuator output element 860 sits between prong 854 and 856 and is engageable there with has will be further described below.

[0038] A blocking lever 862 is pivotally mounted about axis Q and includes a prong abutment 864 which lies in the general plain of prongs 854 and 856. Blocking lever 862 also includes an angled cam surface 866 which lies in the general plain of the output element 860 (see especially figure 10A).

[0039] Consideration of figure 9 shows prong 856 in abutment with prong abutment 864, and sill button 850 in the raised position such that the lock arrangement is unlocked. Operation of an inside door handle causes the inside door handle to move to a position as shown in figure 12 which results in the link 816 causing the inside release lever to rotate anticlockwise following which pin 832 engages one end of outside release lever 820 causing common release lever 822 to move substantially vertically as shown in figure 12 whereupon release abutment 840 engages with and moves pin 813 to the released position thus allowing the associated door to open. Upon release of the inside handle 814 the components return to the position as shown in figure 9.

[0040] The lock arrangement can be moved to the locked position as shown in figure 10 either by depressing the sill button or by powering the linear actuator motor such that the pin 856 of the output element momentarily moves to the position 860 as shown in figure 10.

[0041] Under these circumstances operation of the inside handle 814 will cause the common release lever to move substantially vertically when viewing figure 10 whereupon release abutment 840 will bypass pin 13 and door will not open. Similarly operation of the outside door handle will cause release abutment 840 to bypass pin 813 and again the door will not open.

[0042] The lock arrangement 810 can be put into a superlock position as shown in figure 11 by powering the linear actuator motor such that the pin 856 of the output element moves to the position as shown in figure 11. It should be noted that edge 860A of the linear actuator output element 860 has moved down to a position which allows the blocking lever 862 to pivot clockwise when viewing figure 11 under the influence of spring 870 (shown schematically). Under these circumstances the upper edge of prong 854 abuts the prong abutment 864 of the blocking lever 862. This prevents lifting of the sill button and hence the lock arrangement 810 cannot be unlocked by operation of the sill button.

[0043] The only way to unlock the lock arrangement is to power the linear actuator motor such that it moves vertically when viewing figure 11 such that edge 872 engages with angle cam surface 866 and causes the locking lever to rotate anticlockwise to the vertical position whereupon the prong abutment surface 864 disengages prong 854. Continued vertical movement of the output element causes pin 858 to engage with prong 854 and to rotate the inside lock lever 824 in an anticlockwise direction to either the locked position or the unlocked position.

[0044] Consideration of figures 13 to 18 show a further lock arrangement 910 with components which performs substantially the same function as those of lock arrangement 810 labelled 100 greater. In this case the inside lock lever 924 is similar to lock lever 824 but includes a freewheel slot 980 in a reverse L shape having a freewheel portion 980A and a non freewheeling portion 980B.

[0045] In this case the rod 950A of sill button 950 includes a lower pin 950B which engages in the freewheel slot 980.

[0046] The lever 990 includes an arm 986 which guides the rod 950A.

[0047] Lever 990 includes an angle cam surface 966 equivalent to cam surface 866, but does not include a prong abutment equivalent to prong abutment 864. Thus lever 990 is incapable as acting as a locking lever. Operation of lock arrangement 910 is similar to the operation of lock arrangement 810 except when the lock arrangement 910 is moved to the superlocked position as shown in figure 15 the rotation of the lever 990 causes the sill button 950 to also rotate which in turn moves the pin 950B to the confluence of the freewheeling and non freewheeling portions 980A and 980B (see figure 15).

[0048] The lock arrangement 910 is a 'freewheel' type of arrangement since it is possible to lift the sill button 950 when in the position as shown in figure 15, though such lifting does not change the state of the lock since all that happens is that pin 950B moves up the freewheeling part 980A of the freewheeling slot. Whilst the inside lock lever 924 is not blocked from rotating by lever 990, it nevertheless does not rotate since there are no forces acting on it to cause it to rotate as the sill button 950 is raised and lowered.

[0049] The embodiments above show lock arrangements having a locked position and also a superlocked position. However, the invention is also applicable to lock arrangements which do not have a superlocked position.

[0050] There now follows examples of actuators suitable for use with the present invention.

Figure 1.1 is an exploded view of an actuator for use with the present invention;

Figure 1.2 is an exploded view of an alternative cam arrangement for use in the embodiment shown in figure 1.1;

Figures 1.3 and 1.4 are developed views of the cam arrangements of figures 1.1 and-1.2 respectively;

Figure 1.5 is a exploded view of a further embodiment of an actuator for use with the present invention;

Figures 1.6 and 1.7 are developed views of the cam arrangement of figure 1.5;

Figure 1.8 is an exploded view of an alternative form of cam arrangement for use in the actuator of figure 1.5;

Figures 1.9 and 1.10 are developed views of the cam arrangement of figure 1.8, and

Figure 1.11 is a partial schematic view of a further embodiment of an actuator for use with the present invention.

[0051] With reference to figure 1.1 there is shown a actuator 10 having a right and left hand casing 12 and 14 respectively.

[0052] A motor 16 is capable of driving pinion 18 via centrifugal clutch 20. The motor, pinion and centrifugal clutch are secured in the casings 12 and 14 in recess 22 (only shown for left hand casing 14).

[0053] In this case the motor is a DC motor, though other motors would be suitable including a electric stepper motor.

[0054] A worm screw 24 is rotationally fast with gear 26. Ends 28 and 30 of the worm screw sit in bearing housing 28A and 30A respectively (only shown on left hand casing 14).

[0055] Worm screw 24 is thus rotatable within the right and left hand casings but axially fast therein.

[0056] The actuator further includes an output member in the form of a plunger 32 having a first end 34 having pin 34A (shown schematically) for connection to components to be actuated. The plunger includes a body portion 36 having an elongate slot 38. At a second end 40 is a spigot 42 having an internal thread (not shown) for engagement with the worm screw 24.

[0057] A shuttle in the form of cam follower 44 has an annular body 46 and two diametrically opposed cam follower pins 48.

[0058] Cam follower 44 is rotatably mounted on spigot 42 and is retained axially in position by cam follower retainer ring 50 also being mounted on spigot 42 and being axially secured thereto.

[0059] A caming arrangement 52 is provided by first cam ring 54 and second cam ring 56.

[0060] Each cam ring is generally cylindrical and has an array of teeth around the circumference of one end.

[0061] In this case cam ring 54 has eight teeth T1 (see fig 1.3), all identical with each tooth having a tooth edge T2. Between adjacent teeth edges T2 there is provided a cam follower stop S1. In this case the axial height of all teeth edges T2 is the same and the axial height of all cam followers stops S1 is the same.

[0062] Cam ring 56 also has an array of eight teeth, four of which (T3) are of one profile and the remaining four of which (T4) are of a different profile. It should be noted that the teeth edges T5 of all teeth T3 and T4 are at the same axial position. Cam follower stops S2 and S3 are alternately positioned between teeth T4 and T3 with cam follower stops S2 all being at the same axial position which is different from the axial position of cam follower stops S3.

[0063] With the actuator 10 in an assembled condition, pinion 18 engages with gear 26 and worm screw 24 engages with the internally threaded hole (not shown) of spigot 42. As mentioned above, worm screw 24 is axially fast within the right and left hand casings thus rotation of worm screw via the motor 16, centrifugal clutch 20, pinion 18 and gear 26 will cause the plunger 32 to move in an axial direction.

[0064] Cam ring 54 and 56 are secured rotationally and axially fast in recesses 54A and 56A of the casings.

[0065] The outer diameter of annular body 46 is a clearance fit within the bore of cam rings 54 and 56. However, cam follower pins 48 are positioned at a radius that allows them to engage the teeth and cam follower stops of the cam rings 54 and 56.

[0066] The plunger 32 is assembled into the casings 12 and 14 such that bosses 12A and 14A of the casing sit within elongate slot 38 thus preventing the plunger 32 from rotating in use.

[0067] A spring 58 abuts rim 60 of plunger 32 and also abuts boss 12B and 14B of the right and left hand casings to bias the plunger in a upward direction when viewing figure 1.1.

[0068] Upward movement of plunger 32 is limited by contact between cam follower pins 48 and either cam follower stops S2 (where the plunger is in a raised position when viewing figure 1.1) or by contact with cam follower stops S3 (where the plunger is in a mid position when viewing figure 1.1).

[0069] Operation of the actuator is as follows:-

It is assumed the start position of one of the cam follower pins 48 is in position 1 of figure 1.3 in abutment with cam follower stop S3.

[0070] Therefore the other cam follower pin 48 is in position 1A in abutment with a corresponding cam follower S3.

[0071] The motor is energised causing the centrifugal clutch 20 to spin and engage whereupon pinion 18 rotates causing gear 26 to rotate and hence worm screw 24 to rotate. Engagement of worm 24 with the internally threaded hole of spigot 42 causes the plunger to move downwards when viewing figure 1.1. This downward movement of the plunger causes the cam following pin 48 to move from position 1 as shown in figure 1.3 progressively to position 2 whereupon continued downward movement of the plunger causes the cam follower pin 48 to move downward and leftward when viewing figure 1.3 such that it achieves the position 3 wherein it is in abutment with cam follower stop S1. At this point the motor is stalled and shortly afterwards the power to the motor is cut.

[0072] The spring 58 is under sufficient compression such that it can now lift the plunger and hence the cam follower pin 48 moves progressively from the position 3 through position 4 to position 5 as shown in figure 1.3. At position 5 the cam follower pin is in engagement with cam follower stop S2 and this then limits the upward movement of the plunger.

[0073] When the motor is subsequently energised again the cam, follower pin 48 moves progressively from position 5 through position 6 to position 7 as shown in figure 1.3, and when the power to the motor is cut the cam follower pin 48 moves progressively from position

7 through position 8 to position 9 as shown in figure 1.3. It can be seen that with the cam follower pin 48 in either position 1 or position 9 the plunger is at the same axial position since the cam follower pin is at the same axial position.

[0074] It can be seen that with each powering of the motor the plunger moves downwards compressing spring 48, and as the power is cut to the motor the plunger moves upwards to one of two heights as spring 58 partially relaxes. Furthermore as the motor is energised the cam follower is caused to rotate through 45 degrees and as the power is cut to the motor the cam follower again rotates in the same direction through a further 45 degrees. Thus four energising/de-energising cycles of the motor will cause the cam follower to rotates through 360 degrees.

[0075] It can be seen that when the motor 16 is powered, the plunger 32 always achieves a particular axial position but when the motor is deactivated then the plunger can achieve one of two different axial positions.

[0076] Consideration of figure 1.2 shows a cam arrangement 152 having a cam ring 154, similar to cam ring 54 but with only six teeth and a cam ring 156 similar to cam ring 56. However, in this case cam ring 156 has six teeth with three different tooth forms T5, T6 and T7 (see figure 1.4) which provide for three different cam follower stop positions S4, S5 and S6. Cam ring 154 only has six teeth, all of identical form.

[0077] Operation of actuator 10 when incorporating cam arrangement 152 provides for one plunger position when the motor is energised (as with cam arrangement 52) but three plunger positions when the motor is de-energised i.e. when the cam follower pins 48 abut cam follower stops S4, S5 and S6 respectively.

[0078] Consideration of figure 1.5 shows a second embodiment of an actuator 210 in which components which fulfil the same function as those in actuator 10 are labelled 200 greater.

[0079] In this case it should be noted that motor 216 drives pinion 218 directly, there being no centrifugal clutch on this arrangement.

[0080] Furthermore the cam follower 244 is held axially fast relative to plunger 232 by a resilient lip 270 of spigot 242.

[0081] In this case pins 272 and 273 ensure that cam rings 256 and 254 remain both axially and rotationally fast within the right and left hand casing 212 and 214.

[0082] Consideration of figure 1.6 shows cam ring 254 has cam follower stops S7, S8 and S9 and cam ring 256 has cam follower stops S10, S11 and S12. In this case cam follower stops S8 and S9 are at the same axial position which is different from the axial position of cam follower stop S7. Furthermore cam follower stops S11 and S12 are also at the same axial position which is different from the axial position of cam follower stop S10.

[0083] Assuming a start position of a cam follower pin 248 abutting cam follower stop S11 (see figure 1.7) then a complete cycle of the plunger would be as follows:-

S11 to S7 to S12 to S8 to S10 to S9 to S11.

[0084] Note that whilst the plunger has gone through a complete cycle as described above, the cam follower has only turned through 180 degrees.

[0085] Consideration of figure 1.8 shows an alternative form of cam arrangement 352 for use in the actuator of figure 1.5.

[0086] Consideration of figure 1.9 shows that cam ring 356 has cam follower stop S13 positioned at a different axial position to cam follower stops 17. Furthermore cam follower stops S15 and S19 are both positioned at the same axial position which is different to both cam follower stops S13 and S17.

[0087] Cam ring 354 has cam follower stops S16, S18 and S20 all positioned at the same axial position which is different from the axial position of cam follower stop S14. Sequential energisation and de-energisation of the motor 216 when the cam arrangement 352 is substituted for the cam arrangement 252 progressively moves a cam follower pin 248 as follows:-

S13 to S14 to S15 to S16 to S17 to S18 to S19 to S20 to S13 (see figure 1.10). Note in this example the cam follower is caused to rotate in an opposite direction when compared with figure 1.7.

[0088] The above embodiments demonstrate a way of providing an actuator having differing output positions. Any particular output position can correspond to a powered output position i.e. when the motor is being energised or an at rest position i.e. when the motor has being de-energised. It can be seen it is possible to provide an actuator with differing powered output positions and also differing at rest positions.

[0089] Further embodiments may provide for different combinations of powered output position and/or different combinations of rest positions. Furthermore it is clear that each cam arrangement is not limited to only having opposing teeth and it is also clear that the cam follower is not limited to only having two diametrically opposed cam follower.

[0090] Figures 1.1 to 1.10 show an arrangement with an axially and rotationally fixed caming arrangement which co-operates with a rotatable shuttle in the form of a cam follower. In this case the cam arrangement is in the form of two arrays of teeth on the cam rings which face each other. In an alternative arrangement it is possible to provide a shuttle arrangement rotatably on the plunger with two arrays of teeth which face away from each other and to provide two sets of cam followers, one set for each array of teeth, which are rotatably and axially fixed on the casings.

[0091] Figure 1.11 shows a schematic view of a further embodiment of the present invention in which a shuttle 444 is provided with an array of teeth 445 and a cam follower 446. A caming arrangement is provided by an array of teeth 447 and a cam follower 448, both of which are fixed axially and rotatably fast. The shuttle moves between the teeth 447 and cam follower 448 and is caused to rotate by engagement between teeth 447 and cam follower 445 and by engagement between teeth 445 and cam follower 448.

[0092] It can be seen that the cam follower pins of figures 1.1 to 1.11 provide the two functions, namely that of indexing the cam follower rotationally and also of providing stop abutment with the plunger. In alternative embodiments these two functions need not be provided by the same component, thus cam follower pin could solely provide the means for indexing the cam follower rotationally and the axial position of the plunger could be defined an alternative stop arrangement.

[0093] Furthermore the preceding description has described how by energising and deactivating a motor, the various output positions can be achieved. It should be noted that it is also possible to achieve any particular output position by applying a force to the plunger, in particular a manual force. Thus sequential pressing and release of for example the plunger 32 of figure 1.1 in a downwards direction will cause the cam follower retaining ring to index around allowing the plunger to achieve, in particular, the two at rest output conditions.

[0094] There now follows further examples of actuators suitable for use with the present invention.

FIGURE 2.1 is a view of an actuator for use with the present invention,

FIGURE 2.2 is an exploded view of figure 2.1,

FIGURES 2.3 to 2.6 show an axial view of some of the components of the actuator of figure 2.1 in various positions,

FIGURE 2.7 shows an axial view of the cam arrangement of figure 2.1 in isolation,

FIGURE 2.8 shows a partial view of figure 2.7,

FIGURE 2.9 is a view of a further actuator for use with the present invention,

FIGURE 2.10 is an exploded view of figure 2.9,

FIGURES 2.11 to 2.16 show an axial view of some of the components of the actuator of figure 2.9 in various positions,

FIGURES 2.17 shows an axial view of the cam arrangement of figure 2.9,

FIGURE 2.18 shows an isometric view of an alternative cam arrangement for use in the actuator of figure 2.9.

[0095] With reference to figures 2.1 to 2.7 there is shown an actuator 10 including a housing 12, a motor 14, a pivot pin 16, a cam wheel 18 and an output member 20, a housing cover 22 and a spring 24.

[0096] Housing 12 includes a motor recess 26 and a cam wheel recess 28.

[0097] Motor assembly 14 includes a motor 30 driveably connectable to an output pinion 32 via a centrifugal clutch 34.

[0098] Cam wheel 18 includes an array of teeth 36 for engagement with output pinion 32, and a central hole 38 to allow the cam wheel to be pivotably mounted on pivot pin 16. Cam wheel 18 further includes a recess 40 which will be described further below.

[0099] Housing cover 22 is generally planar in form and includes a recess (not shown) within boss 42 to receive shaft 31 of motor assembly 14, a recess (not shown) corresponding to cam wheel recess 28, and a lever recess (not shown) within boss 44 to allow the output lever to rotate as will be described further below.

[0100] Output member 20 includes levers 46 and 48 and pivot pin 50. Lever 46 includes a cam follower 52 at one end thereof for engagement with recess 40 and a hole 54 at the other end thereof, profiled in such a manner as to engage end 50A of pin 50 in a press fit and rotationally fast manner.

[0101] Lever 48 includes a hole 56 at one end thereof having a pin 56A connectable in use to a component to be actuated. A hole 58 is positioned at the other end of lever 48, profiled to engage in a press fit manner and rotationally fast with end 50B of pivot pin 50.

[0102] Lever 48 further includes a spring hole 60 through which ends 24A of spring 24 passes. The other end 24B of spring 24 is inserted into spring hole 62 of boss 44.

[0103] When assembled:-

Motor assembly 14 sits in motor recess 26 with shaft 21 engaging and being supported by the hole within boss 42.

[0104] Cam wheel 18 sits in recess 28 and the corresponding recess (not shown) of cover 22 with the array of gear teeth 36 in engagement with pinion 32, and central hole 38 being mounted on pivot pin 16 which in turn is mounted in hole 29 of housing 12 and a corresponding hole (not shown) beneath boss 44.

[0105] The output member is assembled such that a part of mid portion 51 of pivot pin 50 is pivotally mounted within hole 45 of boss 44, and spring 24 is mounted around an adjacent part of mid portion 51.

[0106] In particular spring 24 is arranged such that the output member 20 is biased in a clockwise direction when viewed in the direction of arrow A i.e. cam follower 52 is biased in a radially outward direction relative to the axis 16A of pivot pin 16.

[0107] When motor 30 is energised the centrifugal clutch 34 will engage, hence driving pinion 32 in an anticlockwise direction when viewed in the direction of arrow A causing the cam wheel to rotate in a clockwise direction when viewed in the direction of arrow A. This rotation of the cam wheel will cause the cam follower 52 to follow the profile of recess 40 and cause the output member to pivotally reciprocate as will be described further below.

[0108] Furthermore external reciprocation of the output member 20 (e.g. by manual reciprocation) will cause the cam follower 52 to drive the cam wheel 18 in a clockwise direction. Such rotation causes output pinion 32 to also rotate, though motor 30 is not rotated since the centrifugal clutch 34 is not engaged.

[0109] Consideration of figure 2.7 shows the cam wheel 18 in more detail.

[0110] In particular recess 40 includes an outer wall 70 and an inner wall 80 which together form a cam.

[0111] Outer wall 70 includes two first stops 71A and 71B both located at radius R1 from axis A.

[0112] Outer wall 70 further includes stops 72A and 72B, both located at radius R2 from axis A. Note that radius R2 is smaller than radius R1.

[0113] Stops 71A, 71B, 72A and 72B act to limit the outward movement of the cam follower.

[0114] The profile of the outer wall 70 between stop 71A and 72A is split into three distinct portions 73, 74 and 75.

[0115] Spirally curved portion 73 starts at stop 71A at circumferential position C1 and spirals inwards to edge 76A at radius R3 and circumferential position C2. It should be noted that radius R3 is less than radius R1.

[0116] For the avoidance of doubt term inward spiral refers to a curved traced by a point which rotates about a fixed position towards which it continually approaches, and the term outward spiral should be construed accordingly. In particular a straight line is a special form of curve and the term spiral curve includes for example and embodiment wherein stop 71A is connected to edge 76A by a straight line.

[0117] It should be noted that the exact form of spirally curved portion 73 can be varied, for example it could be part of an archimedian spiral, part of a circle, part of an ellipse, or other forms. The significant point is that point 76A is circumferentially displaced from stop 71A and is radially closer to axis A than stop 71A.

[0118] Portion 74 is substantially radially orientated.

[0119] Portion 75 comprises an outward spirally curved portion.

[0120] The portion of outer wall between stop 72A and 71B has equivalent inwardly spirally curved portion 77, substantially radially orientated portions 78 and outwardly spirally curved portion 79.

[0121] In particular it should be noted that portion 78 should be regarded as a substantially radially orientated portion even though in fact it is part of an arc, the centre of which is the axis of pivot pin 70 when the cam follower is situated adjacent this portion of the outer wall. The form of portion 78 thus allows the cam follower to move substantially radially relative to axis A without causing the cam wheel to rotate.

[0122] Three corresponding portions (not marked for clarity) can be identified between stop 71B and stop 72B and three corresponding portions (not marked for clarity) can be identified between stop 72B and stop 71A.

[0123] With reference to figure 2.8 it can be seen that inner wall 80 includes third stops 81A, 81B, 81C and 81D, all positioned at radius R3 from axis A.

[0124] Consideration of the outer wall profiled between stop 81A and 81B shows a substantially radially orientated portion 82 and an inwardly spirally curved portion 83.

[0125] The profile of the inner wall between stops 81B and 81C includes a substantially radially orientated portion 84 and an inwardly spirally curved portion 85. Equivalent portions (not marked for clarity) can be identified between stops 81C and 81D and also between stops 81D and 81A.

[0126] It should be noted that the circumferential position C4 of inner stop 81B is circumferentially between the circumferential positions C1 and C3 of outer stops 71A and 72A respectively.

[0127] Furthermore it can be seen that the circumferential position C4 of stop 81b is circumferentially offset (mis-aligned) from edge 86 (positioned at circumferential position C5) edge 86 is also circumferentially offset from stop 72a (compare positions C5 and C3).

[0128] Powered operation of the actuator is as follows:-

> Consideration of figure 2.3 shows the actuator in a stationary position with the cam follower 52 being biased in a radially outward direction by spring 24. Cam 52 is limited in its outward movement by engagement with stop 72A.

[0129] The motor is energised such that the cam wheel is caused to rotate in a clockwise direction whereupon portions 77, 78 and 79 progressively move past cam follower 52. As portion 77 moves pass cam follower 52 the cam follower progressively moves radially inwardly relative to axis A causing the output member 20 to rotate in an anticlockwise direction about axis B.

[0130] As the end of portion 77 adjacent portion 78 moves pass cam follower 52, the output member snaps' clockwise under the influence of spring 24 until such time as the cam follower 52 abuts the end of portion 79 adjacent portion 78. Continued rotation of the cam wheel 18 in a clockwise direction causes the portion 79 to move pass cam follower 52 until such time as the actuator achieves the position as shown in figure 2.4 whereupon cam follower 52 engages stop 71B.

[0131] It should be noted that due to the radial difference between stop 72A and 71B the output member 20 is in a different position when comparing figures 2.3 and 2.4. It should be noted that motor 30 is energised with a pulse of predetermined duration and provided that edge 76A has passed under cam follower 52 and provided that edge 76B has not passed under cam follower 52 then whenever the pulse of energy ceases with the cam follower between these two edges, the spring 24 will cause the cam wheel to return or advance to the position as shown in figure 2.4 since this is the radially outer most position achievable by the cam follower between edges 76A and 76B.

[0132] A further pulse of energy to motor 30 will cause stop 72B to move beneath the cam follower. Note that at this position the output member 20 will be in the position as shown at figure 2.3 but the cam wheel will be rotated 180 degrees from the position as shown in figure 2.3. A further pulse of energy to the motor will move stop 71A beneath cam follower 52 and a yet further pulse of energy will move stop 72A beneath cam follower 52 returning the actuator to the position as shown in figure 2.3.

[0133] Note that during powered operation cam follower 52 only need engage the outer wall 70 and no contact is required between cam follower 52 and inner wall 80. It is possible to externally actuate the output member 20 to rotate the cam wheel 18 under these circumstances the sequence of movements are shown sequentially in figure 2.3, figure 2.5, figure 2.4 and figure 2.6.

[0134] Thus manual actuation of the output member 20 in an anticlockwise direction about axis B causes cam follower 52 to disengage the outer wall and engage the inner wall at portion 85, since edge 86 is circumferentially offset from stop 72A. Continued anticlockwise movement of output member 20 results in cam follower 52 moving substantially radially inwardly relative to axis A causes a camming action between cam follower 52 and portion 85 resulting in clockwise rotation of cam wheel to the position as shown in figure 2.5, whereupon cam follower 52 engages stop 81C.

[0135] Release of output member 20 results in output member snapping clockwise under the influence of spring 24 until such time as cam follower 52 engages an end of portion 79 of the outer wall. Spring 24 continues to basis cam follower 52 in a radially outward direction resulting in the camming action between cam follower 52 and portion 79 until such time as the actuator achieves the position as shown in figure 2.4.

[0136] A further manual actuation of the output member in an anticlockwise direction about axis B causes cam follower 52 to disengage the outer wall and engage the inner wall at portion 80 causing the actuator to move to the position as shown in figure 2.6. Subsequent release of the output member will cause this component to move to the position as shown in figure 2.3 under the influence of spring 24 (though it should be noted that the cam wheel will be positioned 180 degrees from the position as shown in figure 2.3).

[0137] Thus it can be seen that progressive pulses of energy to the motor can cause the output member to move between the position as shown in figures 2.3 and 2.4. Furthermore the output member can be caused to move between these two positions by successive manual or other external actuation of the output member 20.

[0138] As mentioned above, the spring 24 acts to bias the cam follower radially outwardly relative to the cam wheel axis. A person skilled in the art would readily appreciate that it is also possible to arrange the spring to bias the cam follower radially inwardly and to provide an appropriate cam formation.

[0139] With reference to figures 2.9 to 2.16 there is shown a second embodiment of an actuator 110 in which components which fulfil substantially the same function as those in actuator 10 are labelled 100 greater.

[0140] Note that recess 140 is of a different profile to recess 40.

[0141] Furthermore housing pivot 122 does not include a hole equivalent to spring hole 62 and lever 148 does not include a hole equivalent to spring hole 60. However, housing cover 122 does include a projection 90 having sides 90A and 90B separated by distance W and lever 148 includes a tab 91 having sides 91A and 91B also separated by width W.

[0142] Spring 124 has ends 124A and 124B which are generally tangentially orientated relative to the body of spring 124 with end 124A lying adjacent side 90A and 91A and end 124B lying adjacent side 90B and 91B when assembled (see figure 2.9). The combination of projection 90, tab 91 and spring 124 act to bias tab 91 in line with projection 90. Thus if lever 148 where to be biased clockwise when viewing figure 2.10 in the direction of arrow D, edge 91B would engage and move end 124B clockwise whilst end 124A of spring 124 would engage stationary edge 90A. This results in winding up of spring 124 which in turn biases lever 148 to a position such that projection 90 aligns with tab 91. Clearly rotation of lever 148 anticlockwise when viewing figure 2.10 in the direction of arrow D causes edge 91A to engage and move end 124A whilst end 124B engages stationary edge 90B of projection 90. This again causes spring 124 to be wound up and hence the spring biases lever 148 to a position such that projection 90 aligns with tab 91.

[0143] Figures 2.11, 2.13 and 2.15 show the position of the output member 120 when tab 91 is aligned with projection 90.

[0144] Consideration of figure 2.17 shows that recess 140 includes outer wall 170 and inner wall 180.

[0145] Outer wall 170 includes stops 92A, 92B and 92C, substantially radially orientated portions 93A, 93B and 93C and spirally curved portions 94A, 94B and 94C. It should be noted that spirally curved portions 94A and 94C spiral outwards whilst spirally curved portion 94B spirals inwardly.

[0146] Inner wall 180 includes stops 95A, 95B and 95C substantially radially orientated portions 96A, 96B and 96C and spirally curved portions 97A, 97B and 97C. It should be noted that spirally curved portions 97A and 97C spiral outwards whilst spirally curved portion 97B spirals inwards.

[0147] Powered operation of the actuator is as follows:-

With the actuator in the position as shown in figure 2.11 the cam 152 abuts stop 92C. Powering of the motor causes the cam wheel 118 to rotate anticlockwise such that spirally curved portion 97C engages and cams out cam follower 152.

[0148] Output member 120 will momentarily achieve the position as shown in figure 2.12 following which it will snap back to the position as shown in figure 2.13.

[0149] A subsequent energisation of the motor will again rotate the cam 180 anticlockwise when viewing figure 2.13 whereupon cam follower 152 will engage with and be cammed out by spirally curved portion 97A. The output member 120 will momentarily achieve the position as shown in figure 2.14 following which it will snap back to the position as shown in figure 2.15 under the influence of spring 124.

[0150] A further energisation of the motor will again cause the cam wheel 118 to rotate anticlockwise following which the cam follower 152 will engage and be cammed inwardly by spirally curved portion 94B of the outer wall 170. The output member 120 will momentarily achieve the position as shown in figure 2.16, following which it will snap back to the position as shown in figure 2.11.

[0151] Note that in moving between the positions as shown in figures 2.11, 2.12 and 2.13 the output member moves clockwise and anticlockwise, in moving between the position as shown in figures 2.13, 2.14 and 2.15 the output member moves clockwise then anticlockwise, but in moving between the position as shown in figures 2.15, 2.16 and 2.11 the output member initially moves anticlockwise and then moves clockwise. Furthermore the output member 120 has moved further clockwise in figure 2.12 than in figure 2.14.

[0152] It is also possible to externally actuate the output member 120 e.g. by manual operation. Thus starting at figure 2.11 manually moving the output member 120 clockwise about axis E of pivot pin 150 causes the actuator to move to the position as shown in figure 2.12 subsequent release of the output member 120 causes the actuator to move (snap) to the position as shown in figure 2.13. Subsequent clockwise rotation of output member 120 causes the cam follower 152 to engage spirally curved position 94A resulting in the actuator moving to the position as shown in figure 2.14. Subsequent release of the output member 120 causes the actuator to move (snap) to the position as shown in figure 2.15. Subsequent manual rotation of the output lever 120 in an anticlockwise direction causes the cam follower to engage spirally curved portion 97B and move to the position as shown in figure 2.16. Subsequent release of the output member 120 causes the actuator to move (snap) to the position as shown in figure 2.11.

[0153] Consideration of figure 2.18 shows an alternative cam wheel 218 suitable for use in the actuator 110. In this case recess 240 is of a differing profile and in particular is rotationally symmetrical through 180 degrees, i.e. the view shown in figure 2.18 is identical the same view when the cam wheel has been rotated through 180 degrees.

[0154] Outer wall 270 includes an diametrically opposed stops 1A and 1B and diametrically opposed stops 2A and 2B. The outer wall 279 further includes substantially radially orientated portions 3A, 3B, 4A and 4B the outer wall further includes inwardly spirally curved portions 5A and 5B and outwardly spirally curved portions 6A and 6B. Corresponding stops, substantially radially orientated portions and spirally curved portions can be found on inner wall 280.

[0155] When cam wheel 280 is used in the actuator 110 in place of cam wheel of cam wheel 118 it provides for two 'momentary' output positions of the output member 120 (rather than the three 'momentary' positions as shown in figures 2.16, 2.12 and 2.14 when using cam wheel 118). This is because of the 180 degree rotational symmetry of cam 218. Thus for example the stops 1A and 1B are positioned at the same radius and stops 2A and 2B are also positioned at the same radius (though different from the radius of stops and 1A and 1B). The two 'momentarily' output positions associated with cam wheel 218 are positioned one on either side of the rest position of the output member 120, i.e. the position to which it is biased towards bias spring 124.

[0156] Any form of motor can be used but in particular DC electric motors are particularly suitable as are electric stepper motors.

[0157] The embodiments thus far described show a cam follower in the form of a pin which is positioned in a groove which provides for the cam profile. In further embodiments different cam profile and cam follower arrangements could be used in particular a twin pronged fork cam follower could be used with a fork being provided on either side of a rail, the rail being shaped to provide the cam profile

Claims

1. A lock arrangement including a lock element having a locked position at which it locks an associated latch and an unlocked position at which it unlocks an associated latch, the lock arrangement further including a powered actuator having an output element, the output element being actuatable between a first position at which it is capable of moving the lock element to its locked position and a second position at which it is capable of moving the lock element to its unlocked position in which there is a lost motion connection between the lock element and the output element in which the lock arrangement further includes a block element having a blocking position at which it prevents the lock lever being moved from the locked to unlocked position and an unlocked position at which it allows the lock lever to move from the locked to the unlocked condition.

2. A lock arrangement as defined in claim 1 in which the lock element can be independently moved between the locked and unlocked positions.

3. A lock arrangement as defined in claim 2 in which the lock element can be independently moved by a sill button.

4. A lock arrangement as defined in claim 2 or 3 in which the lost motion connection acts to allow the lock element to be independently moved between its locked and unlocked position.

5. A lock arrangement as defined in any preceding claim in which the first and/or second positions of the actuator as transient positions.

6. A lock arrangement as defined in any preceding claim in which the actuator has a third rest position on the path between the first and second positions.

7. A lock arrangement as defined in claim 6 in which the third rest position allows the lock element to be independently moved between its locked and unlocked positions.

8. A lock arrangement further including a superlock element having a superlocked position at which the associated latch is in a superlocked condition and having an unlocked position at which the associated latch is in an unlocked condition.

9. A lock arrangement as defined in claim 8 in which the actuator output element is movable to a fourth position to move the superlock element between the superlocked or unlocked position.

10. A lock arrangement as defined in claim 9 in which one of the first and second positions is on the path between the other of the first and second positions and the fourth position.

11. A lock arrangement as defined in any preceding claim in which the lock element adopts a transient position when the superlock element is moved to the superlocked position.

12. A lock arrangement as defined in claims 8 to 11 in which there is a second lost motion connection between the actuator output element and the superlocked element.

13. A lock arrangement as defined in claim 12 in which the second lost motion connection is capable of acting to allow the actuator to move between its first and third positions or its second and third positions.

14. A lock arrangement as defined in any preceding claim in which the block lever adopts the blocking position when the superlock element is moved to the superlocked position.

15. A lock arrangement as defined in any preceding claim in which the block element is biased towards the blocking position.

16. A lock arrangement as defined in any preceding claim in which the block element is moved to the unblocked position when the superlock element moves from the superlocked to the unlocked position.

17. A lock arrangement as defined in claim 16 in which the superlock element cams the block element away from its blocking position.

18. A lock arrangement as defined in any preceding claim in which a block abutment on the block element engages an abutment on the lock lever to prevent the lock lever being moved.

19. A lock arrangement as defined in claim 18 in which there is a lost motion gap between the block abutment and abutment when the locking arrangement is in the superlocked condition.

20. A lock arrangement as defined in claim 19 in which the lost motion gap allows the superlock lever to move the block element to a position at which it no longer prevents the lock lever being moved.

21. A lock arrangement as defined in claim 20 in which when the lost motion gap closes the locking element assists in caming the block element to the unblocked position.

22. A lock arrangement as defined in any preceding claim in which the lock element is a lever having a pivot point.

23. A lock arrangement as defined in claim 22 in which attempts to unlock the lock arrangement when it is in the superlock condition cause a moment about the pivot point which maintains the block lever in the block position.

24. A lock arrangement as defined in claim 22 when dependent upon claim 21 in which when the lost motion gap closes the lock element causes a moment about the pivot point to move the block lever towards to the unblocked condition.

25. A lock arrangement as defined in any preceding claim in which at least one of the lock element and superlock element are levers.

26. A lock arrangement as defined in any preceding claim in which the powered actuator includes a shuttle and a camming arrangement axially moveable relative to each other to provide rotational indexing of the shuttle and the camming arrangement relative to each other, so that different output positions of the output member are provided for.

27. A lock arrangement as defined in any one of claims 1 to 25 in which the actuator includes a motor in driving connection with a cam rotatable about a cam axis, the actuator further including a cam follower connected to the output element, in which powered rotation of the cam causes the cam follower to be radially displaced relative to the cam axis to provide differing output positions of the output element.

28. A lock arrangement as defined in any preceding claim in which the actuator is powered in a single direction to provide for the differing output positions of the output element.

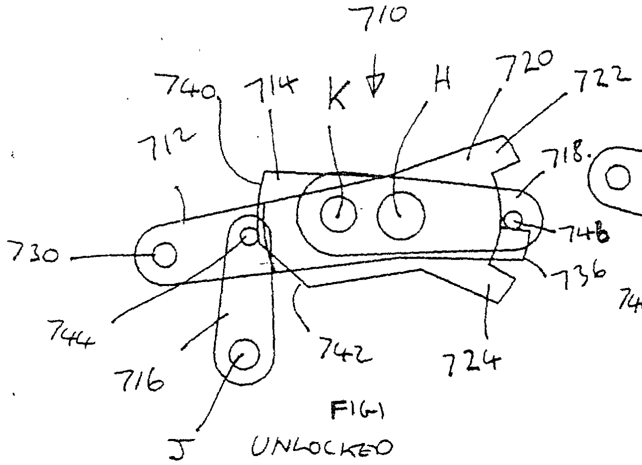


FIG1 UNLOCKED

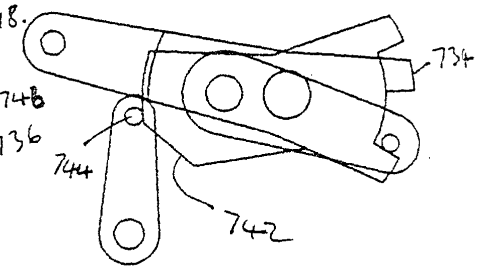


FIG2

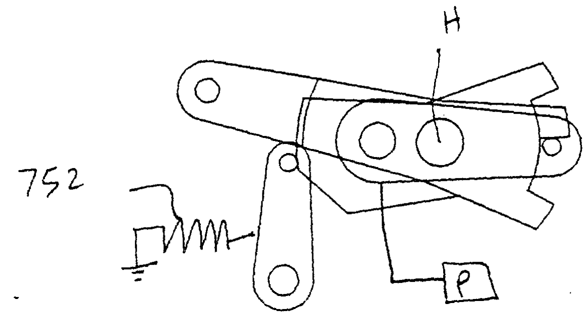


FIG3 LOCKED

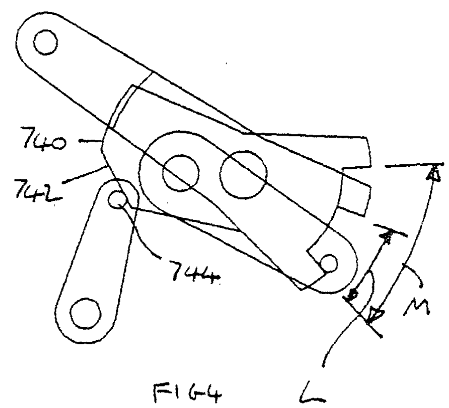


FIG4

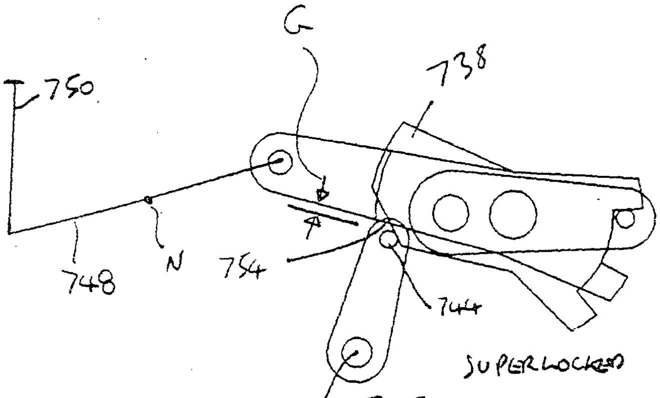


FIG5

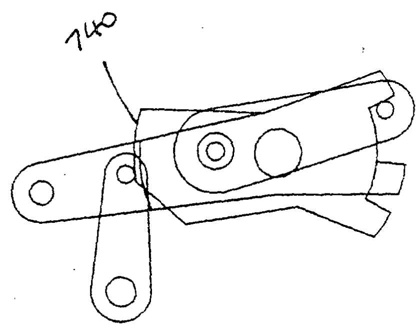


FIG6

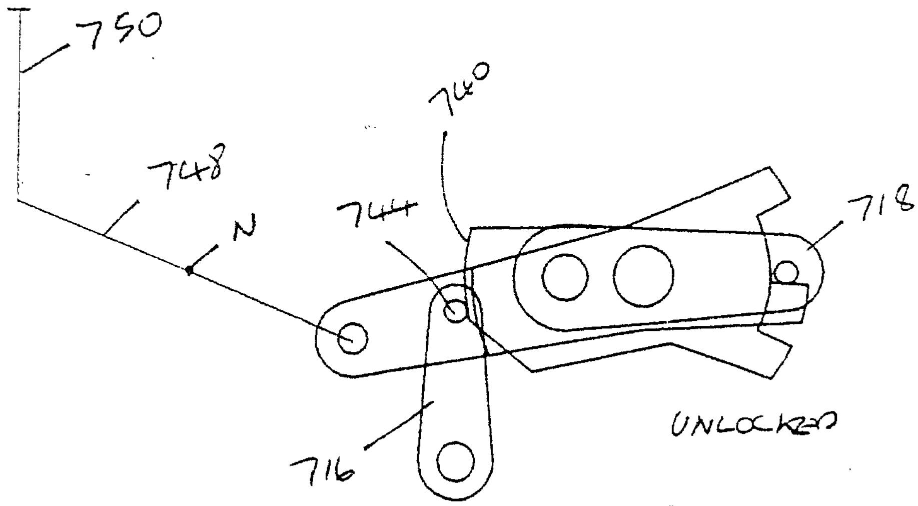


FIG7

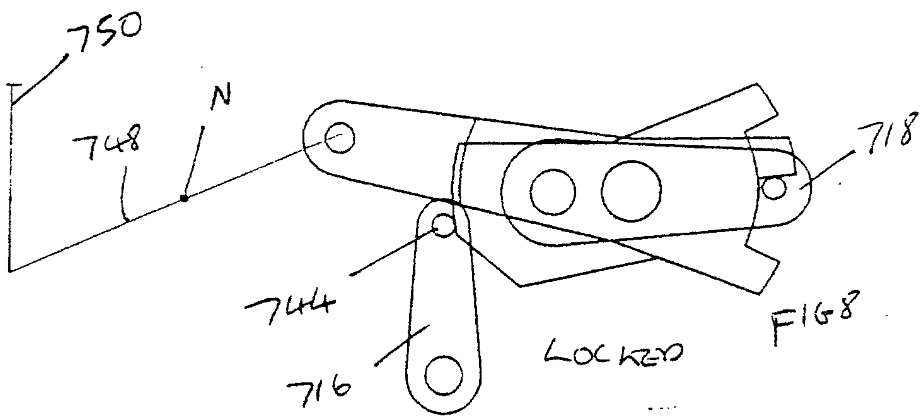


FIG8

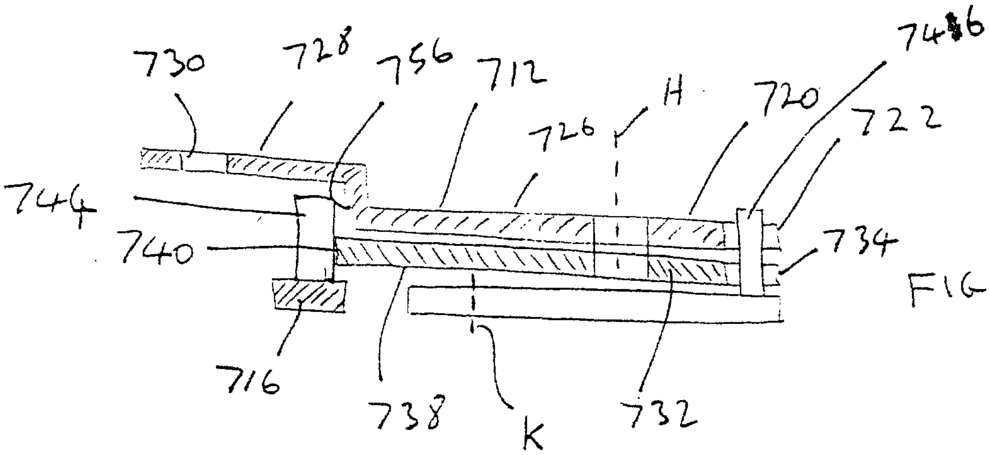


FIG1A

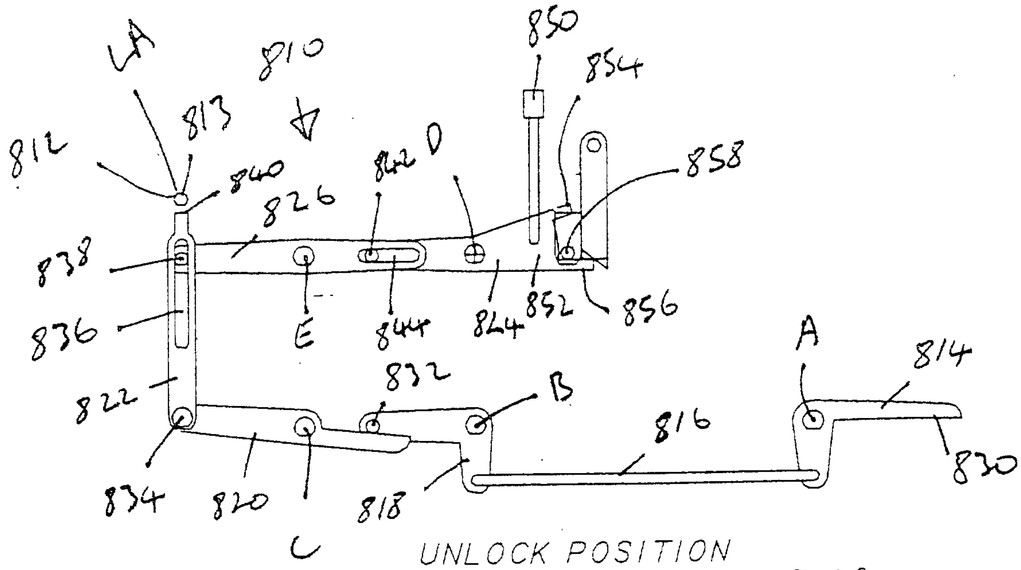


FIG 9

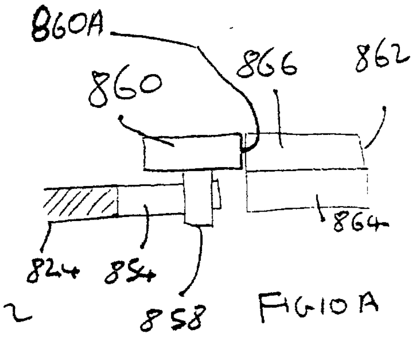


FIG 10A

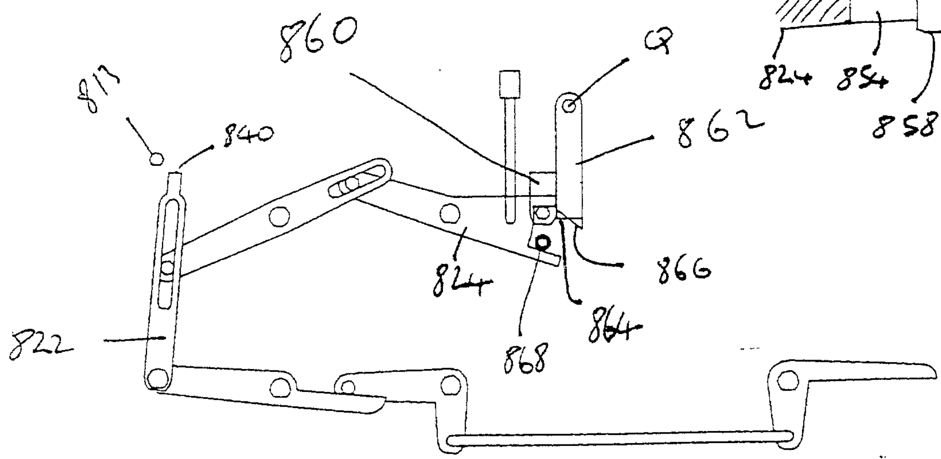


FIG 10

LOCK POSITION

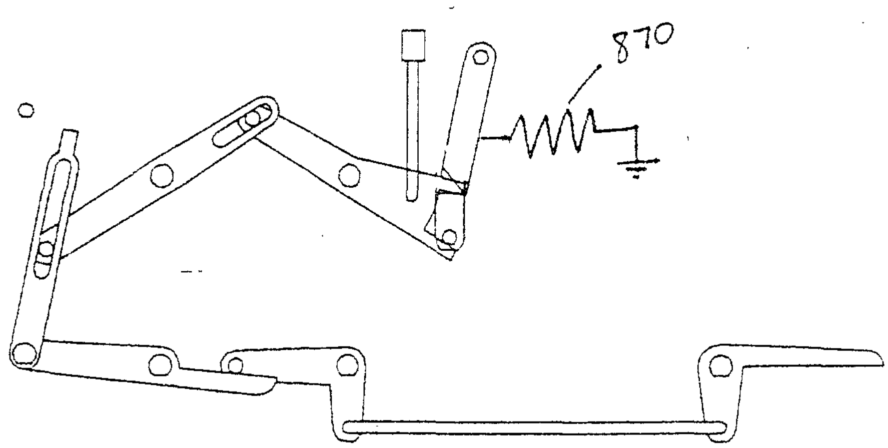


FIG11

SUPERLOCK POSTION

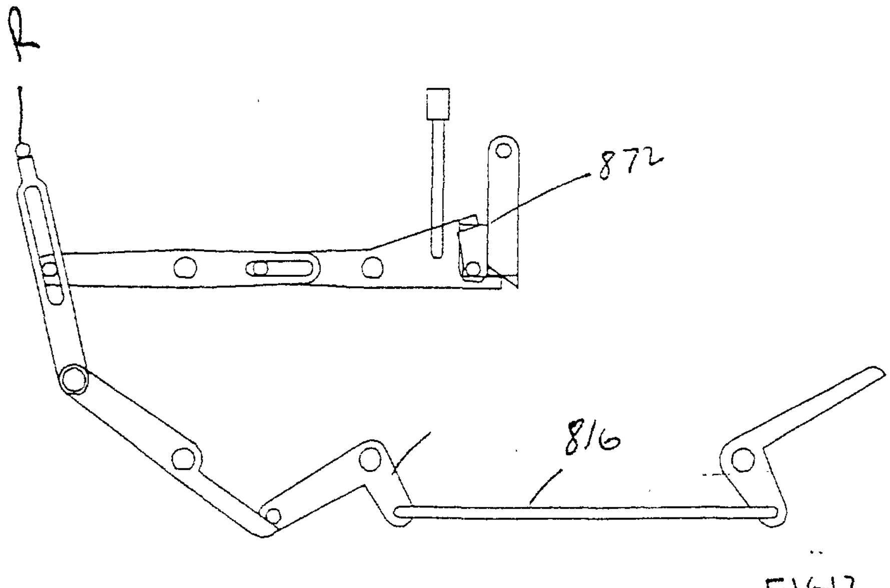


FIG12

RELEASE POSITION

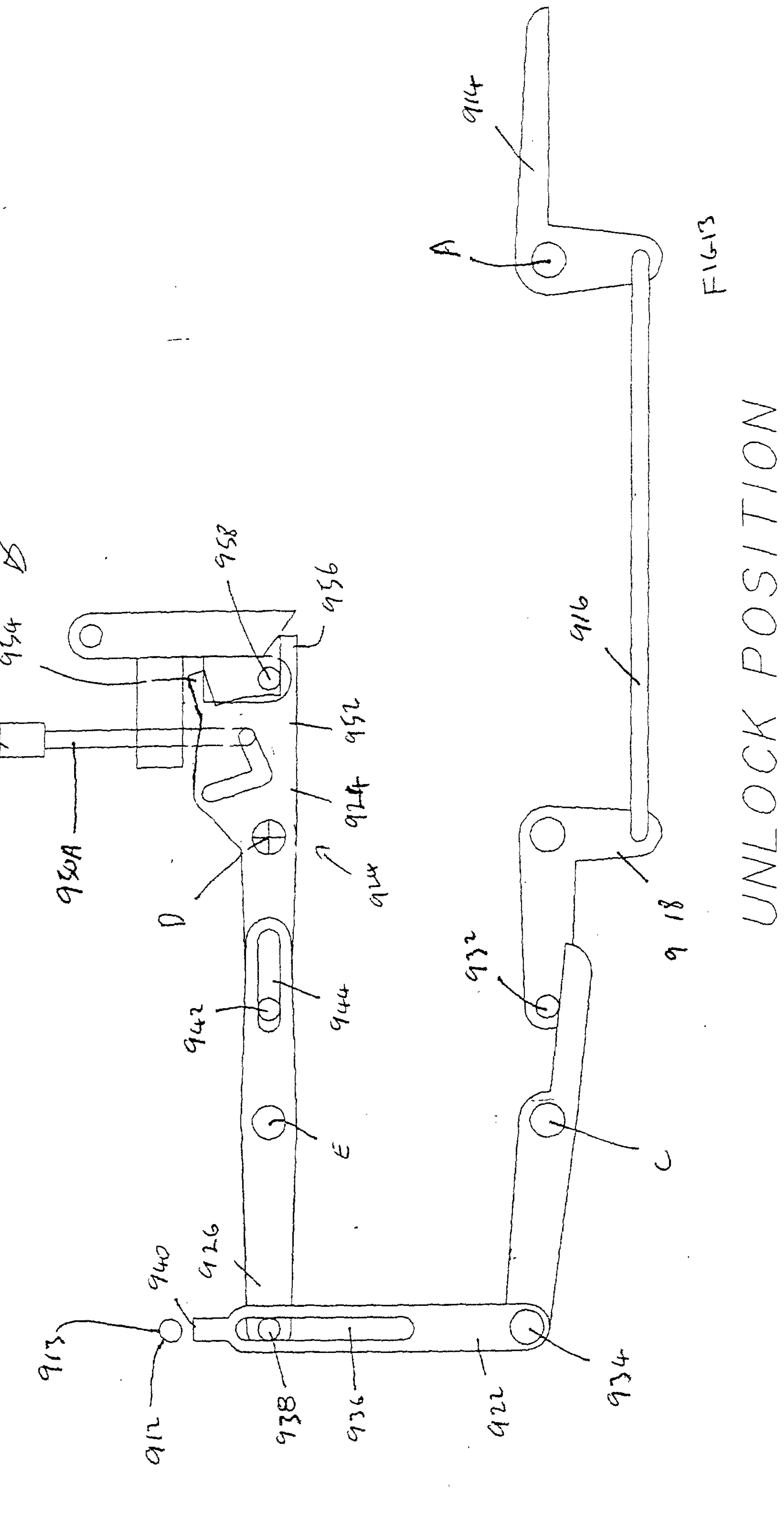

UNLOCK POSITION
910
914
A
916
918
932
C
934
922
936
938
912
913
940
926
E
942
944
D
924
950A
950
954
958
956
952

FIG 13

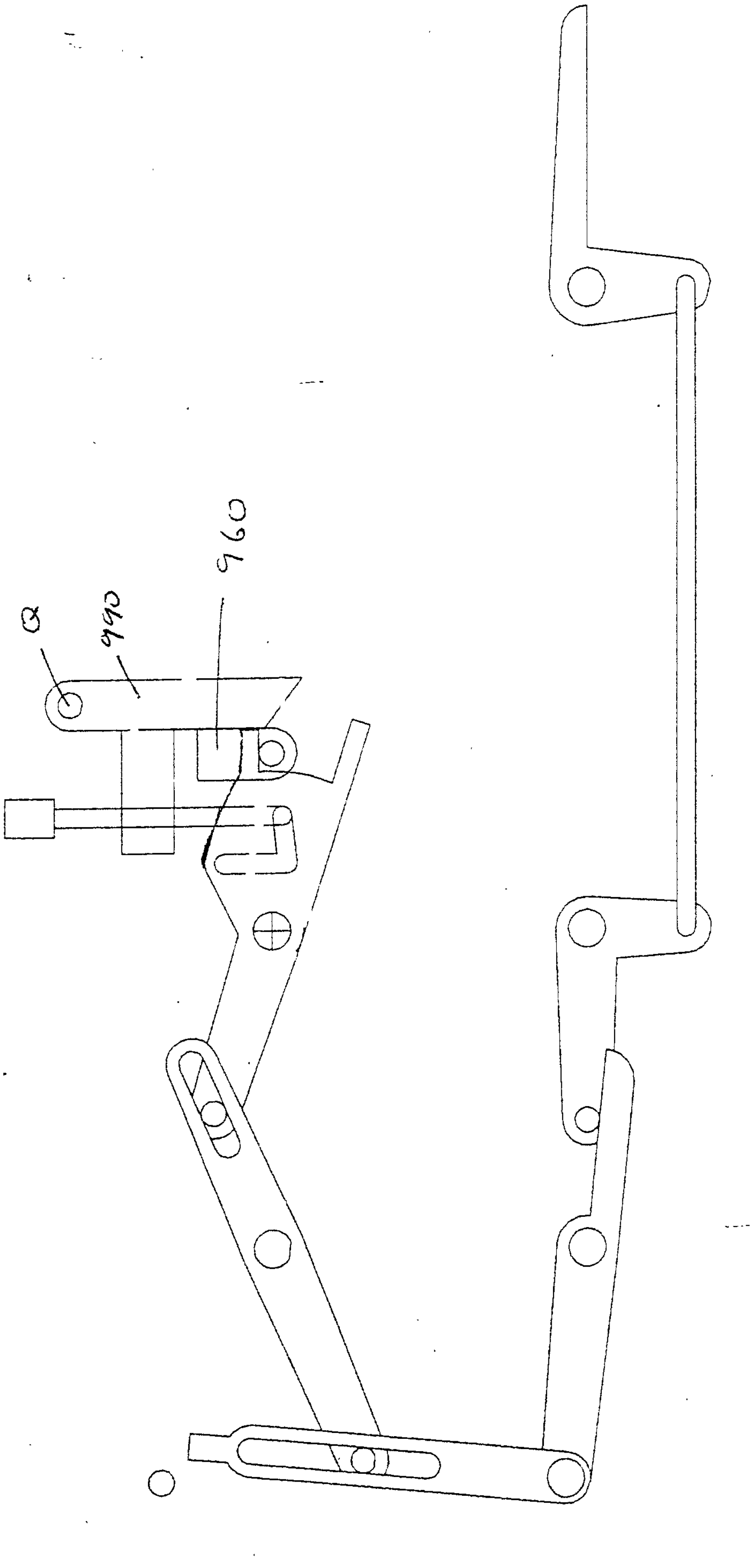
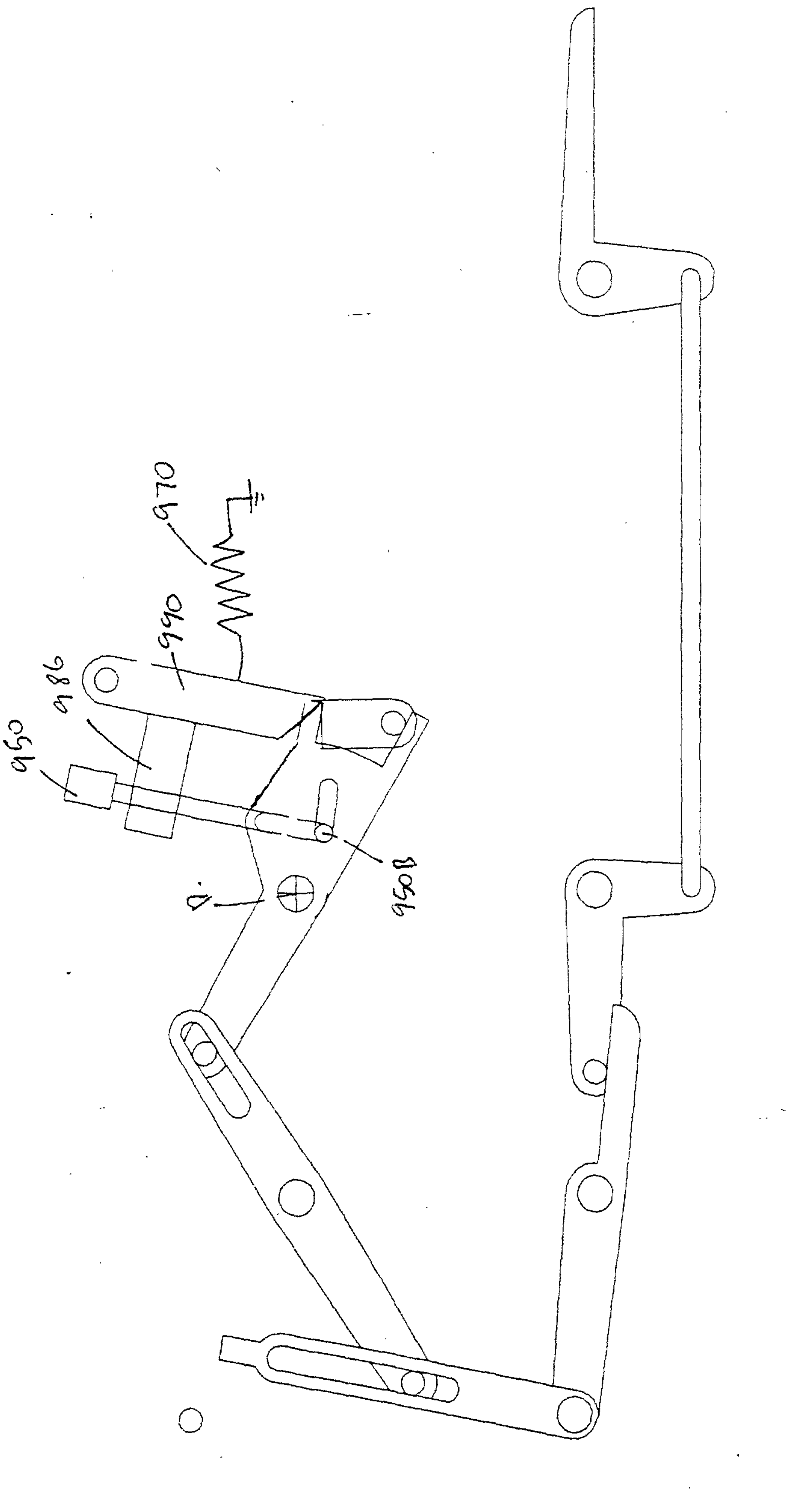


FIG 14

LOCK POSITION



SUPERLOCK POSITION FIG 15

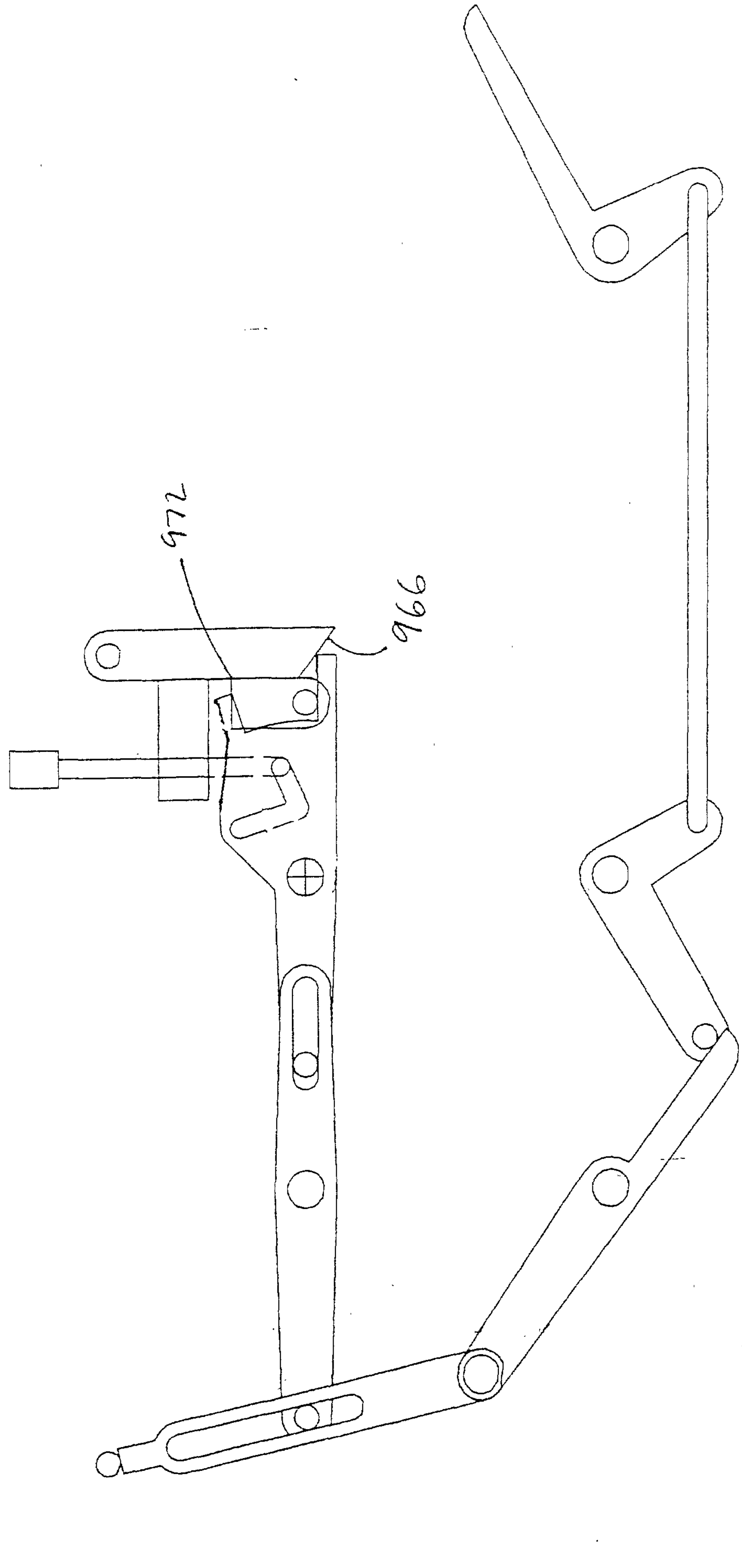


FIG16

RELEASE POSITION

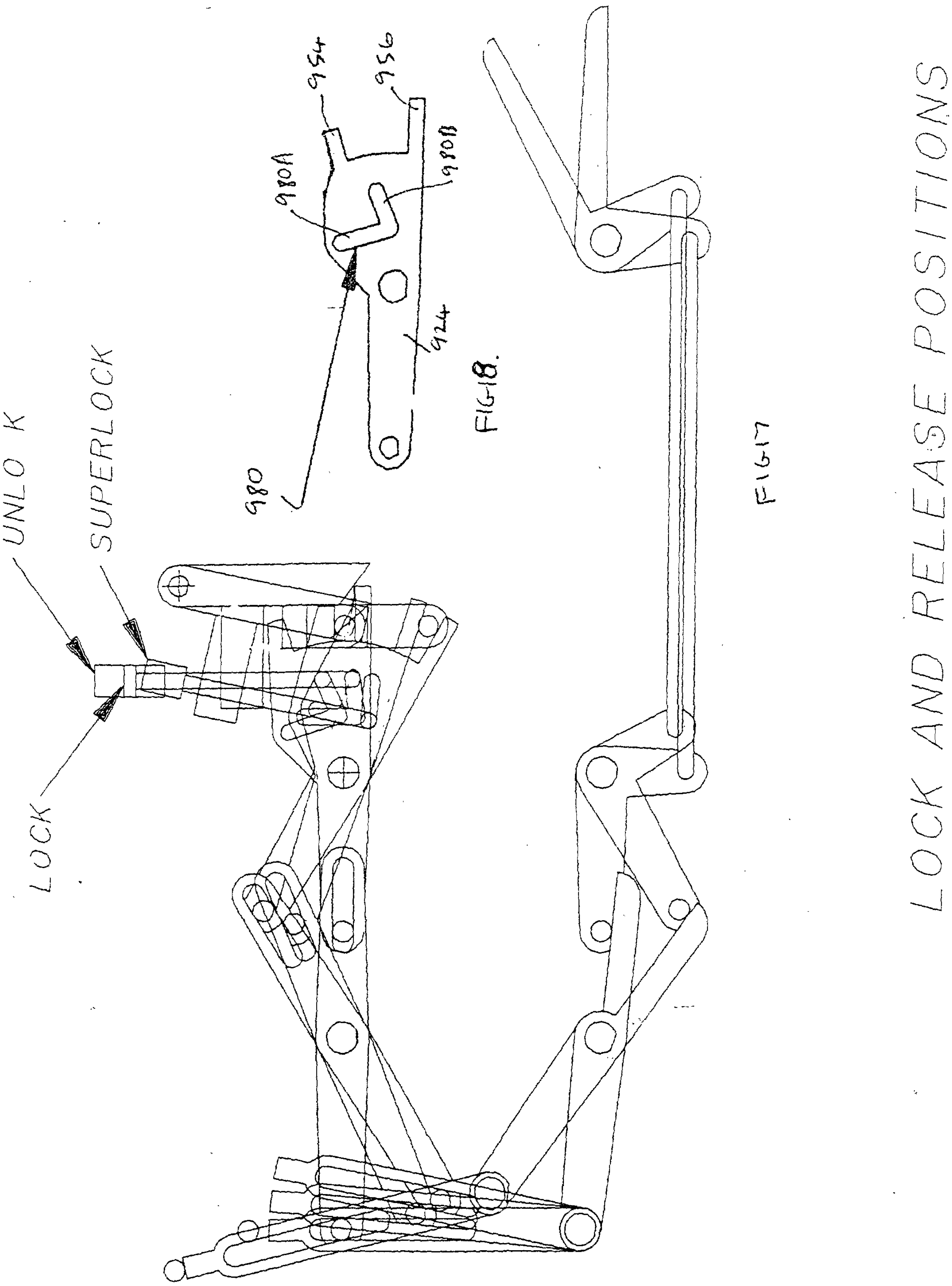
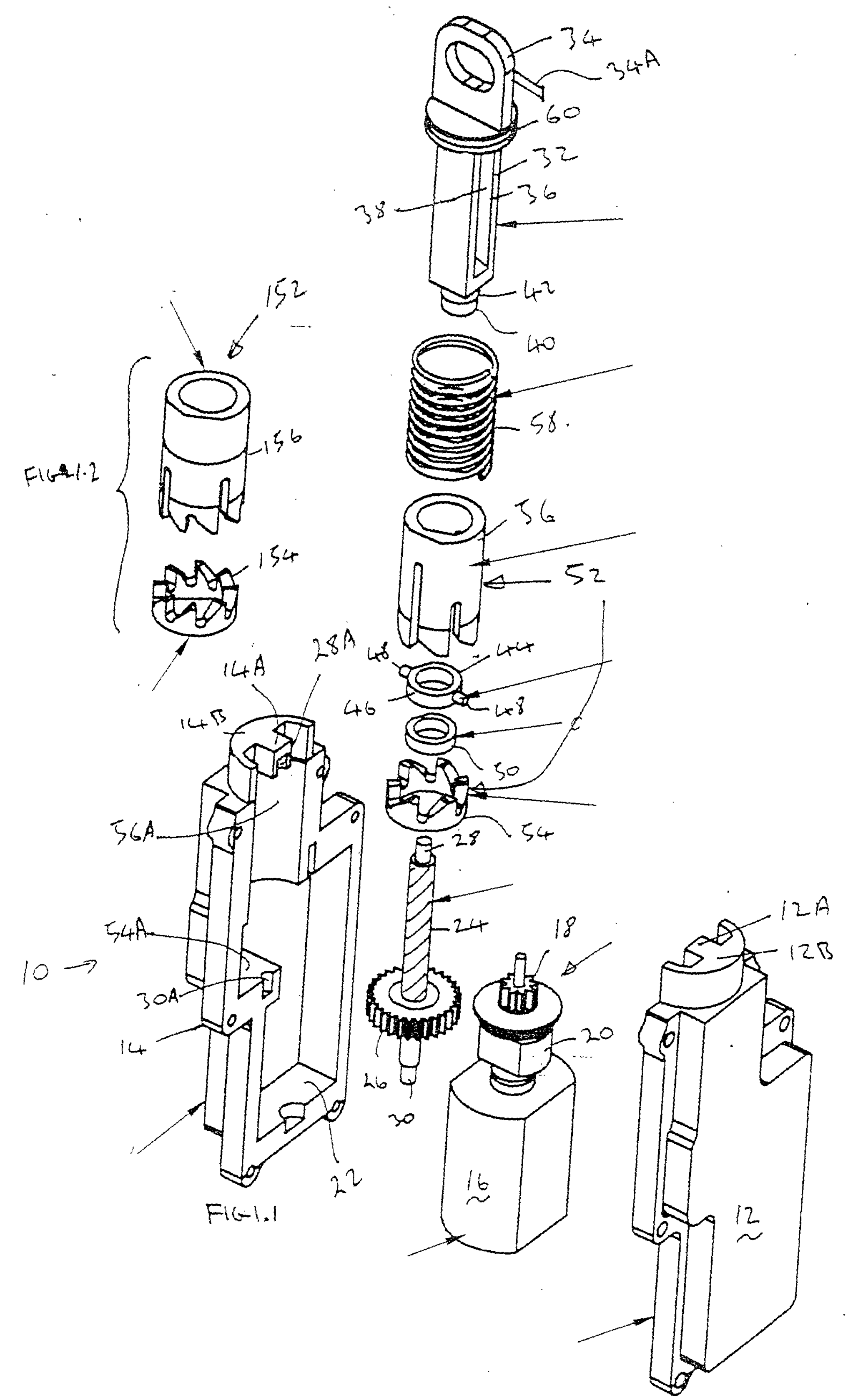

UNLO K
SUPERLOCK
LOCK
980
980A
980B
954
956
924
LOCK AND RELEASE POSITIONS

FIG 18.

FIG 17


34
34A
60
32
36
38
42
40
152
58
156
FIG 1.2
56
154
52
28A
14A
48
44
46
48
14B
C
50
56A
54
28
24
12A
18
12B
54A
10
30A
20
14
26
30
22
16
12
FIG 1.1

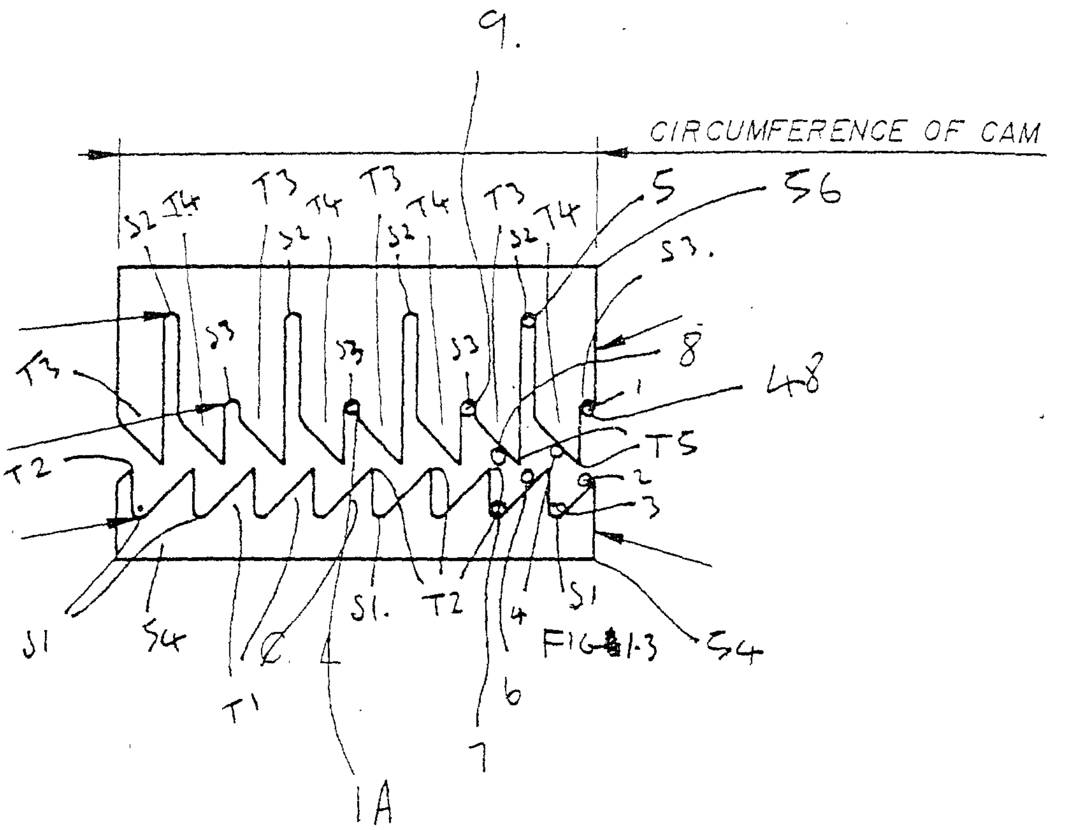

9.
CIRCUMFERENCE OF CAM
S2
T4
T3
S2
T4
T3
S2
T4
T3
S2
T4
5
56
S3.
8
48
T3
S3
S3
S3
1
T5
T2
2
3
J1
S4
T1
C
L
S1.
T2
4
S1
S4
6
7
1A

FIG 1·3

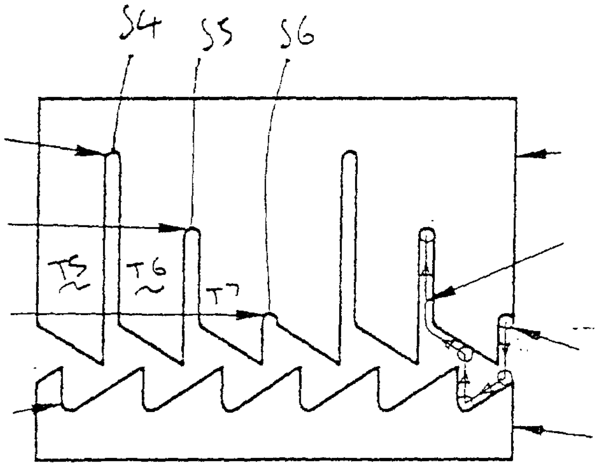

S4
S5
S6
T5
T6
T7

FIG 1·4

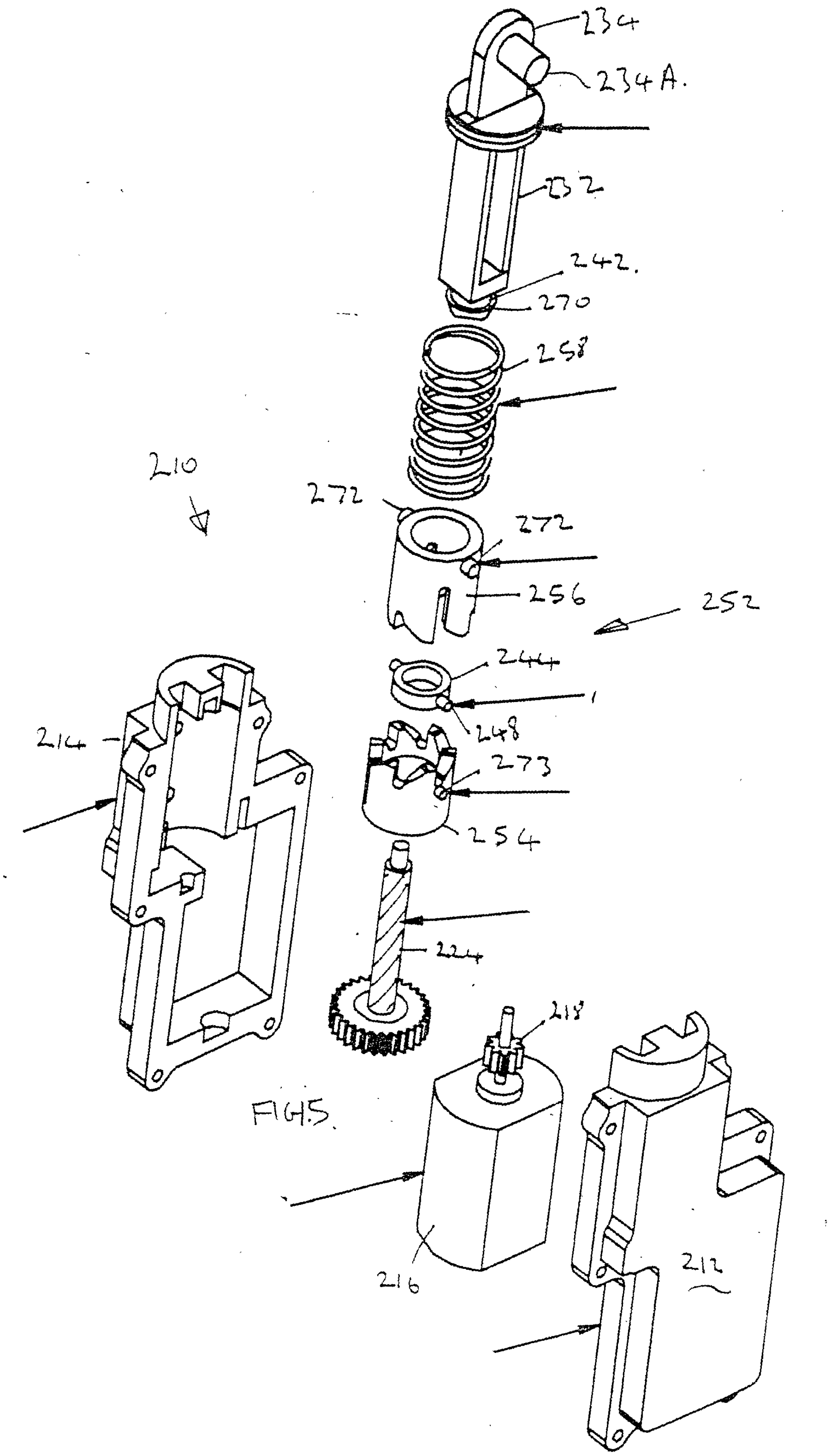

234
234A.
232
242.
270
258
210
272
272
256
252
244
248
214
273
254
224
218
216
212

FIG.5.

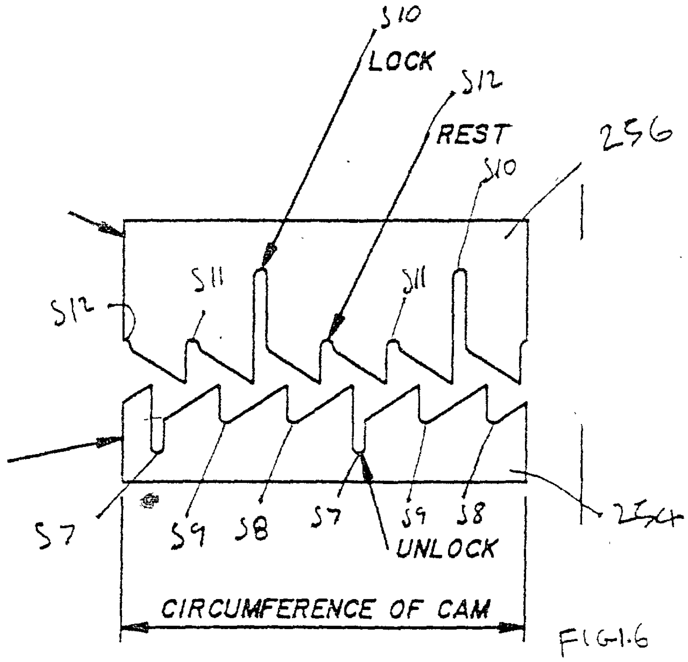


FIG.6

CAM PROFILES

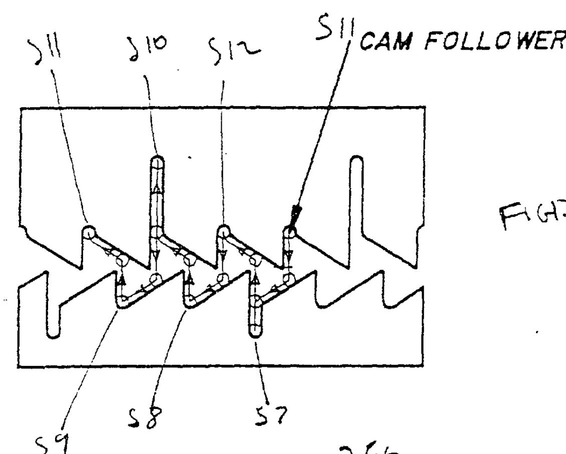


FIG.7

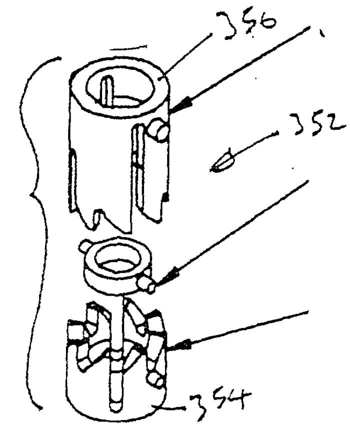


FIG.8

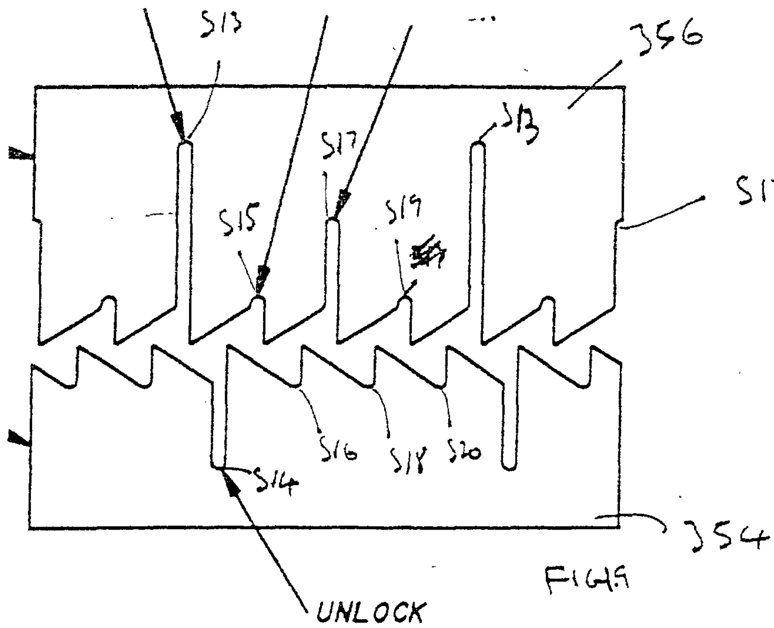


FIG.9

CAM PROFILES

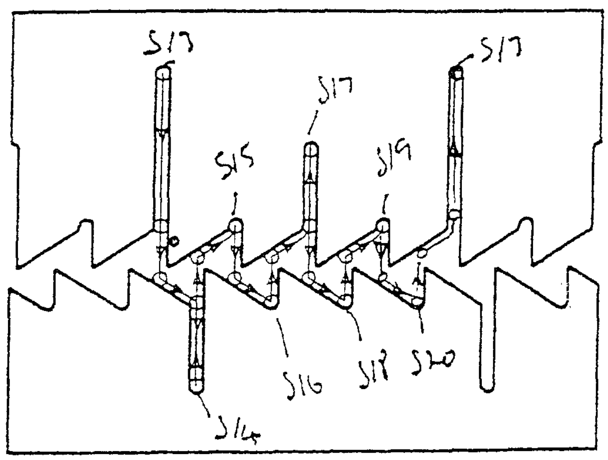


FIG. 1.10

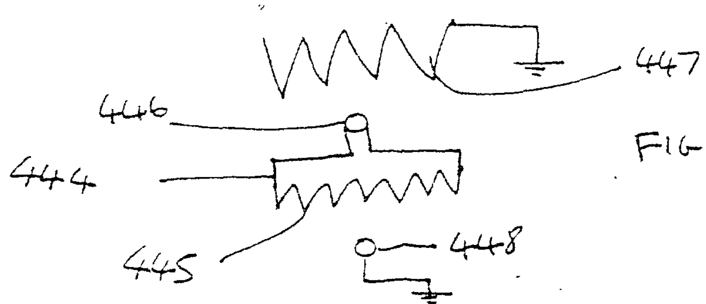


FIG.11

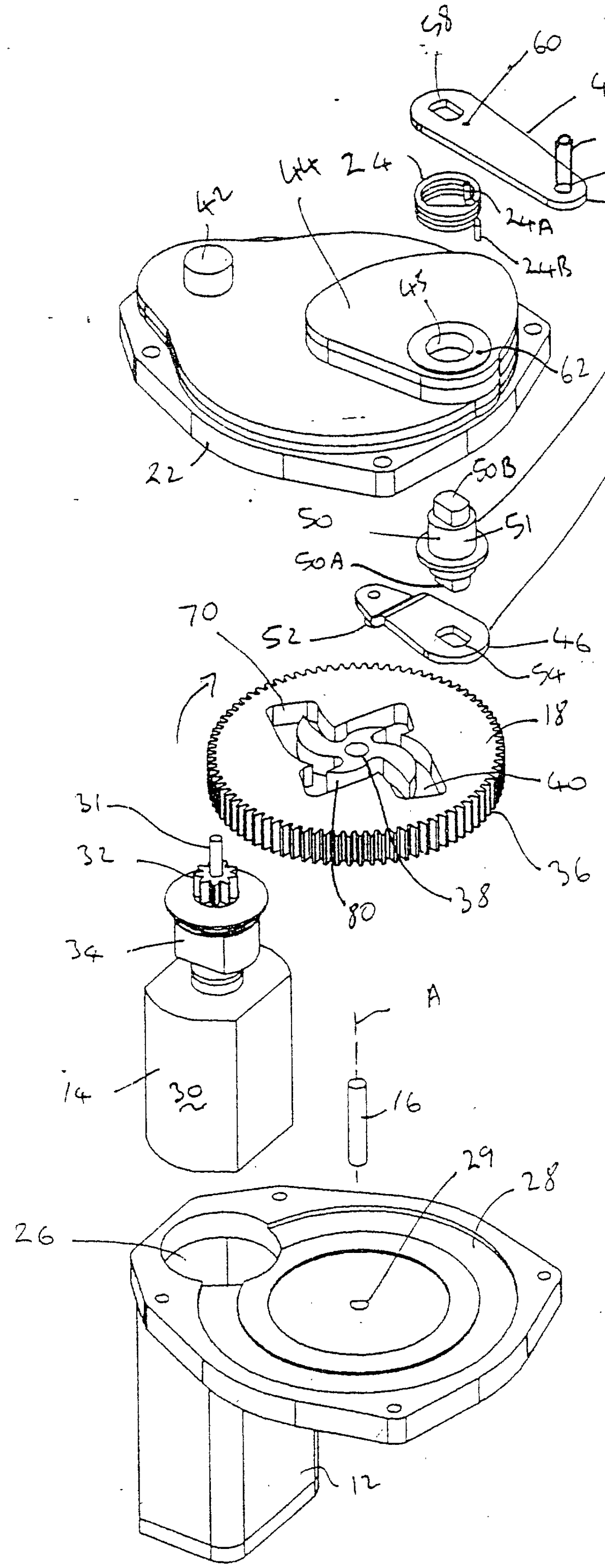

58
60
48
56A
56
44
24
24A
24B
20
42
43
62
22
50B
50
51
50A
70
52
46
54
18
40
31
32
36
38
80
34
A
14
30
16
29
28
26
12

FIG 2.2

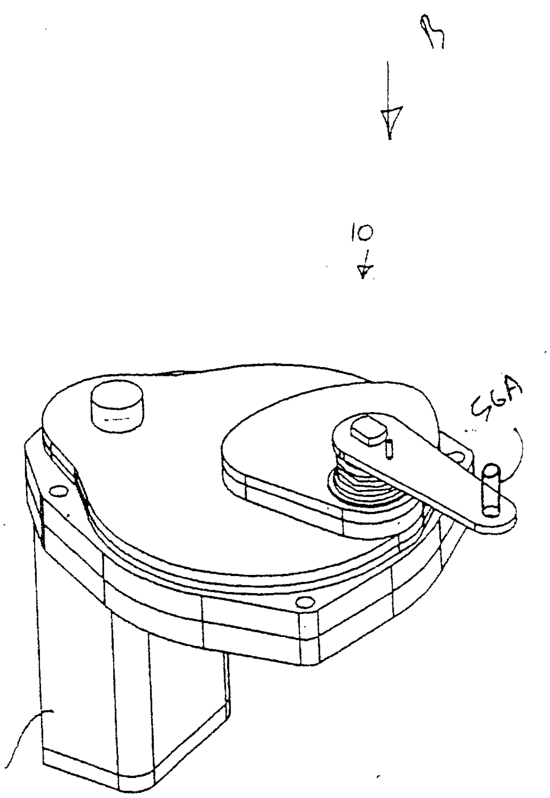

B
10
56A
12

FIG 2.1

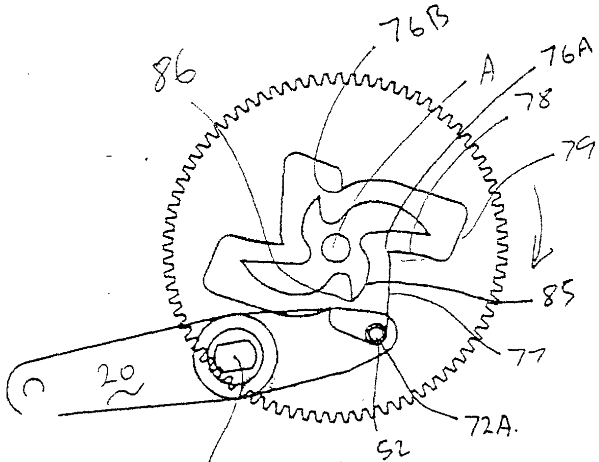


FIG 23

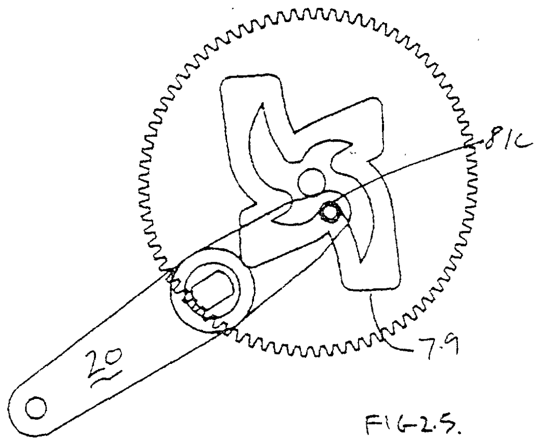


FIG 25.

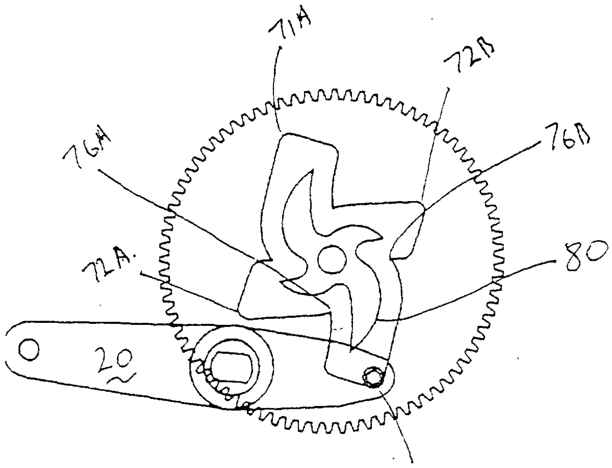


FIG 24

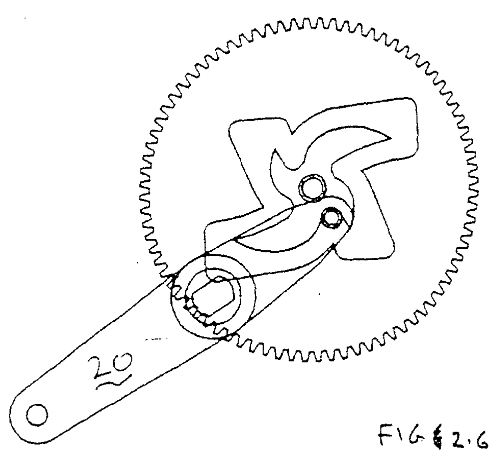


FIG 26

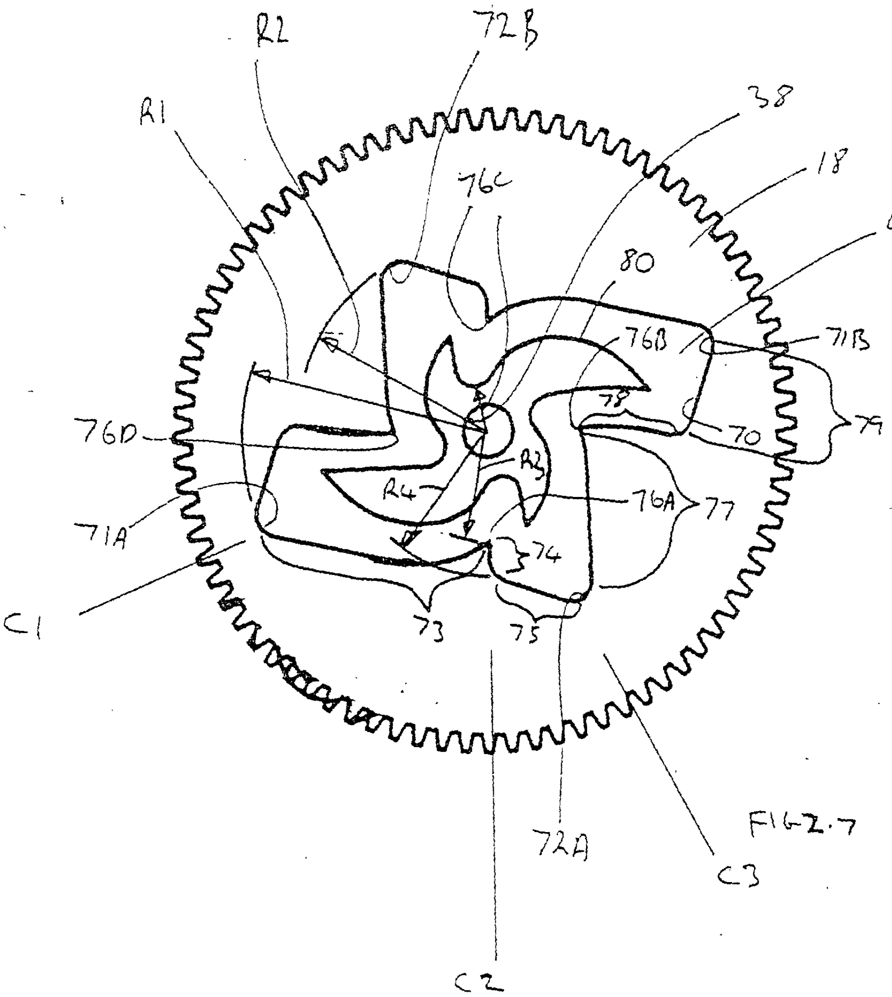

R2
72B
38
R1
18
76C
40
80
76B
71B
78
79
76D
70
R3
R4
76A
77
71A
74
C1
73
75
72A
C3
C2

FIG 2.7

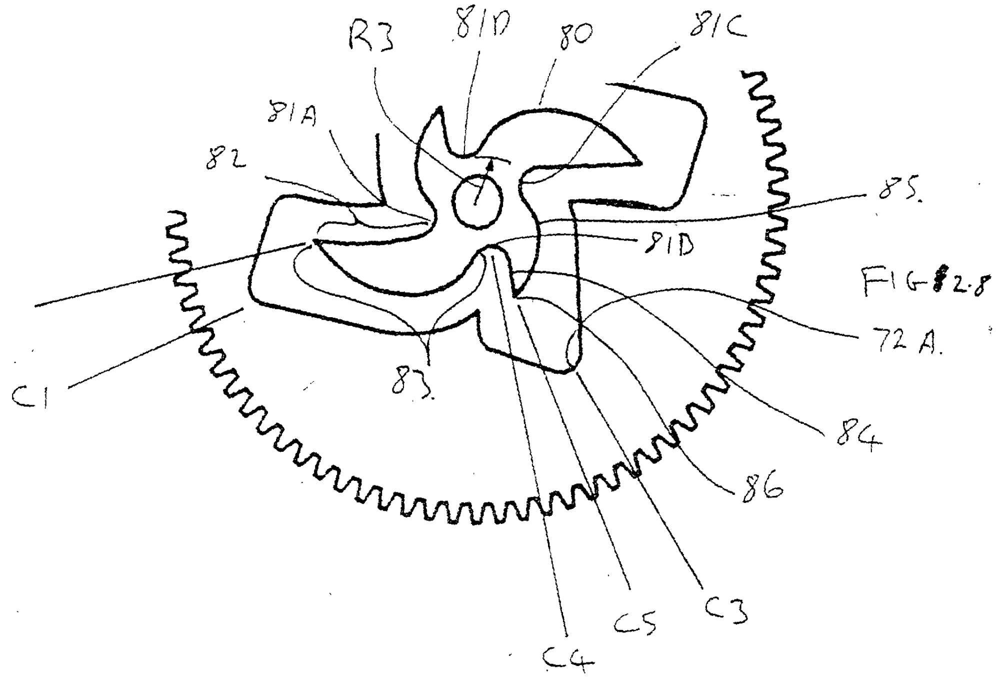

R3
81D
80
81C
81A
82
85
81D
72 A
C1
83
84
86
C5
C3
C4

FIG 2.8

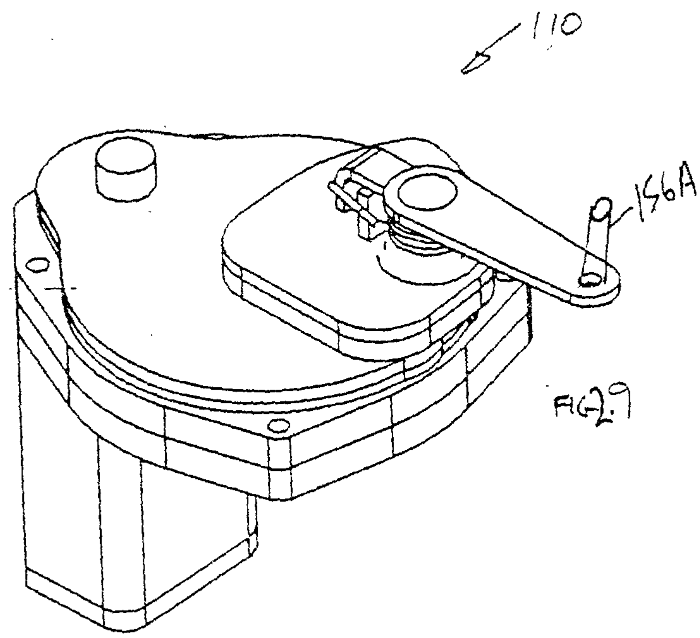


FIG 29

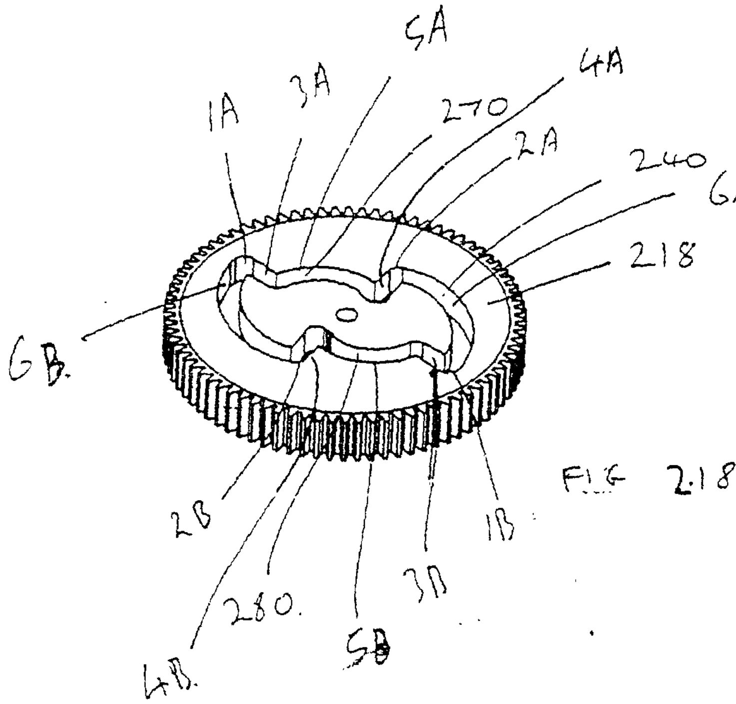


FIG 218

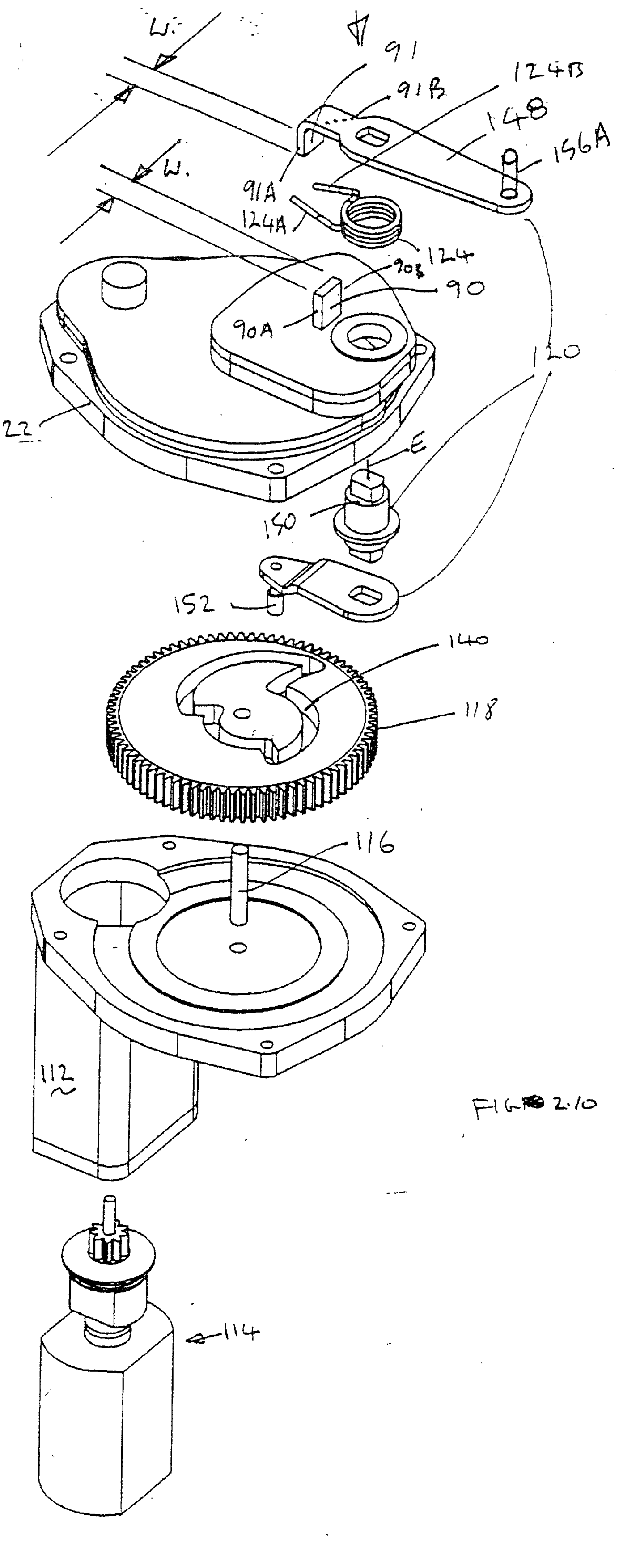

W.
91
91B
124B
148
156A
91A
W.
124A
124
90B
90
90A
120
122
E
150
152
140
118
116
112
114

FIG 2.10

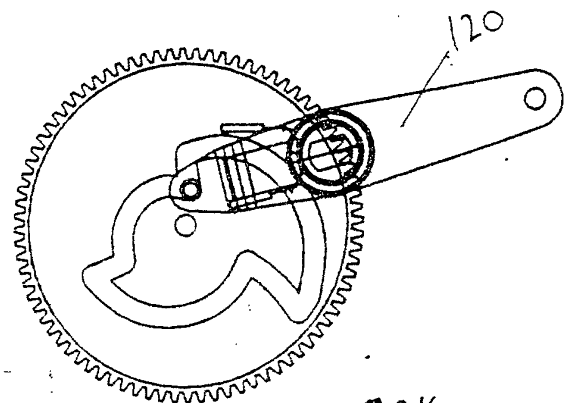


FIG 2.16

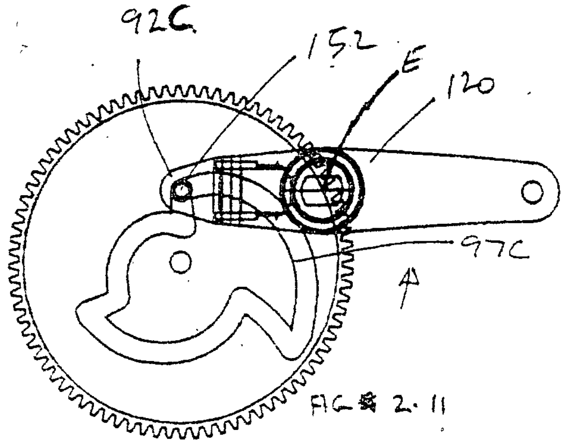


FIG 2.11

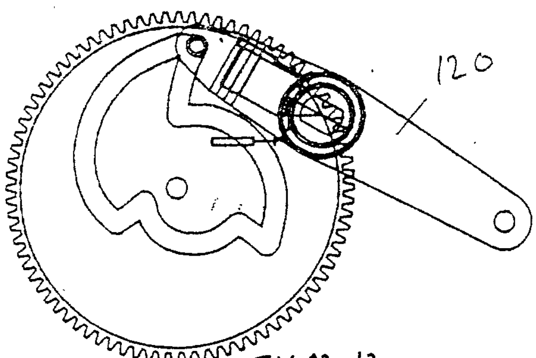


FIG 2.12

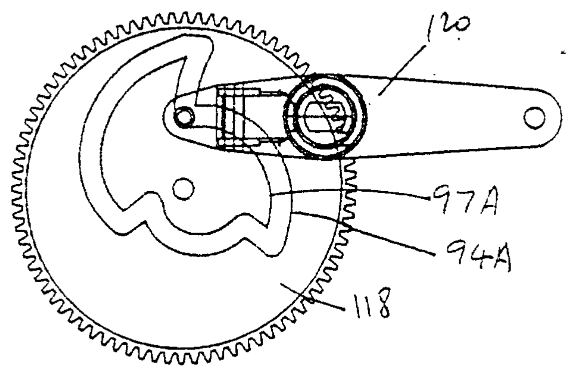


FIG 2.13

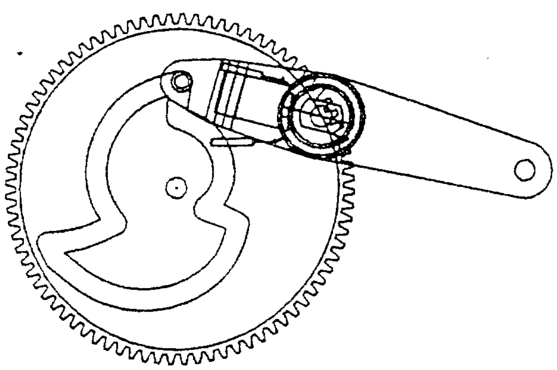


FIG 2.14

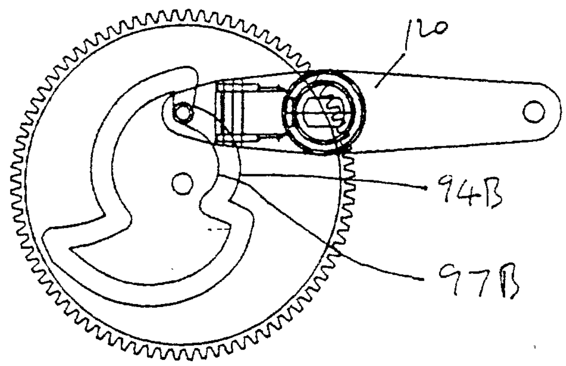


FIG 2.15

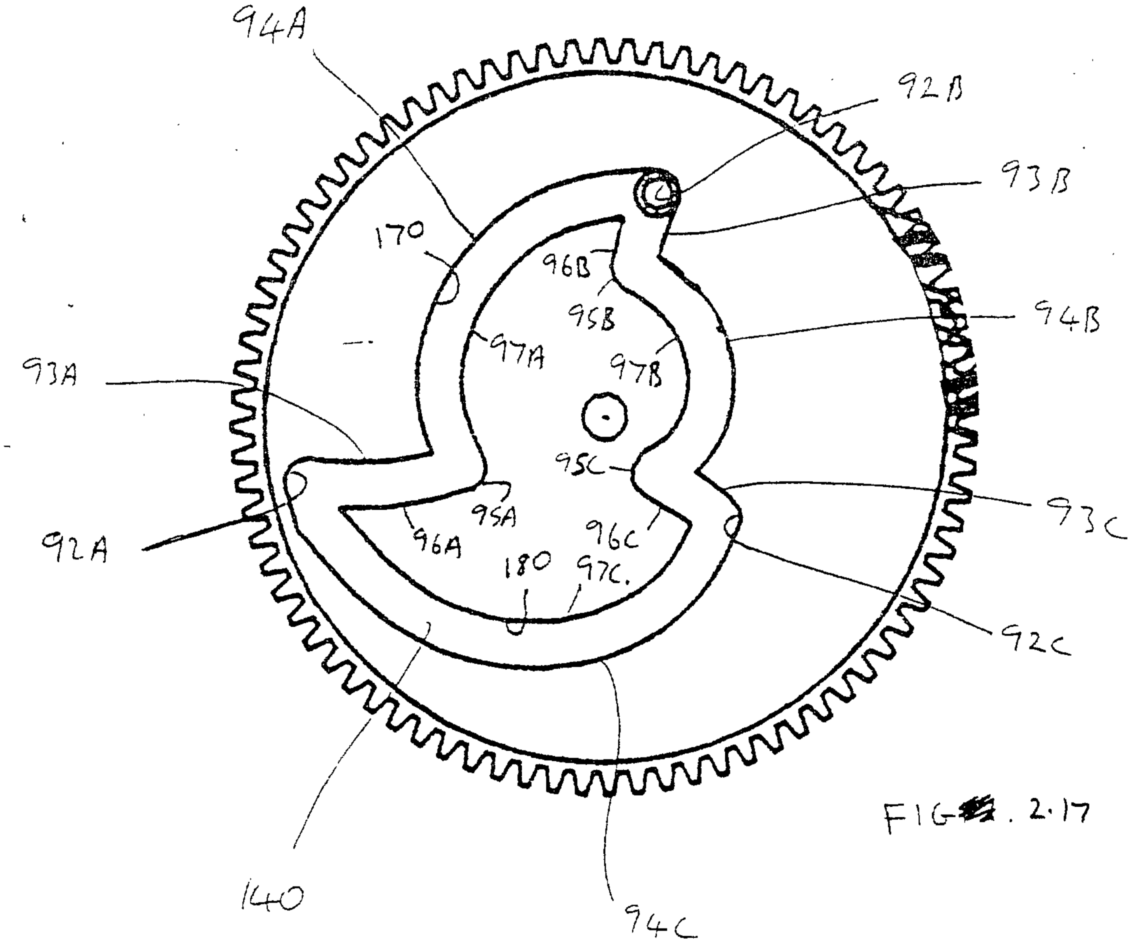

94A
92B
93B
170
96B
95B
94B
97A
97B
93A
95C
93C
92A
95A
96A
96C
180
97C.
92C
140
94C

FIG. 2.17