(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number : **0 572 362 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number : **93830223.9**

(51) Int. Cl.[5] : **E01F 13/00**

(22) Date of filing : **25.05.93**

(30) Priority : **28.05.92 IT FI920116**

(43) Date of publication of application :
01.12.93 Bulletin 93/48

(84) Designated Contracting States :
AT BE CH DE DK ES FR GB GR IE LI LU MC NL PT SE

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(54) Hydraulic apparatus for controlling the raising and lowering of the barrier of a level crossing.

(57) The apparatus comprises : a hydraulic power unit for a hydraulic cylinder-and-piston actuator (46, 42) for the raising and lowering of the barrier (A) by means of a sector gear and rack (54A, 50) ; a hydraulic circuit with distributors, pressure regulators, valves and the like ; mechanical locking means (56, 52) at least for the lowered position of the barrier (A) ; and auxiliary units (7, 10 ; 9, 14) for overcoming initial inertia on opening.

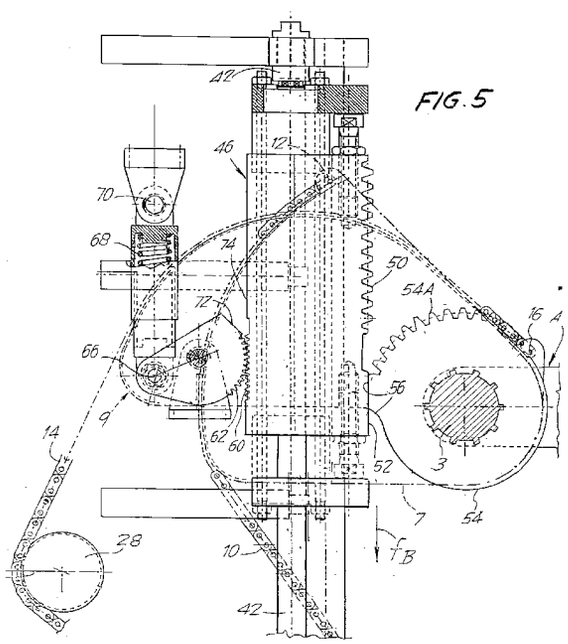


FIG.5

EP 0 572 362 A1

The invention relates to improved apparatus for the control of the barriers or bars of level crossings, suitable for providing improved performance, greater safety and improved functioning by comparison with apparatuses which exist at present and are for the most part electro-mechanical. The objects and advantages of the invention will become apparent from the text which follows.

The apparatus substantially comprises: a hydraulic power unit capable of actuating a hydraulic cylinder-and-piston actuator for the raising and lowering of the barrier; a hydraulic circuit with distributors, pressure regulators, valves and the like; mechanical locking means at least for the lowered position of the barrier; and auxiliary units for overcoming initial inertia on opening.

The hydraulic circuit may comprise, as an actuator, a double-acting cylinder-and-piston system, a valve connected in parallel with the cylinder-and-piston system between the circuit branches which feed it; a non-return valve opened by the working pressure of the pump motor group; a directional control valve of the open-and-closed type in the two branches of the supply circuit; and a linkage between the mobile member of the actuator and the angularly mobile equipment of the barrier to be moved.

The linkage may comprise a sector gear on the mobile equipment of the barrier and a rack on the sliding cylinder forming the mobile member of the actuator. The said gear and the said rack may furthermore have flat surfaces which interact with each other in sliding contact to lock the barrier in the lowered position at the end of the corresponding stroke of the actuator.

Other features are defined in the sub-claims following the description. In particular, counter-weights may be provided to balance the equipment of the barrier, which counter-weights are recessed in a housing for linear sliding and are connected to the said equipment of the barrier by a chain or similar flexible drive, settling gradually on a cam profile. A particularly safe arrangement is thus achieved, in that the counter-weights do not project externally and hence cannot constitute a potential risk to persons as occurs in the apparatuses which are currently known.

The invention will be better understood by studying the description and the attached drawing which shows a practical, non-limiting embodiment of the said invention. In the drawing:

Fig. 1 shows an external view of a method of embodiment;

Fig. 2 shows a view along the line II-II in Fig. 1;

Fig. 3 shows a horizontal section substantially along the line III-III in Fig. 2;

Fig. 4 shows a diagram of the hydraulic plant; and

Fig. 5 shows an enlarged detail of Fig. 1.

In accordance with what is shown in the attached drawing, 1 generally indicates a supporting frame which can be enclosed in a protective hood 2 from which limited parts project and in which access ports are provided for inspections and maintenance. On the frame 1 are provided supports 1a for a horizontal shaft 3 which rotates with the barrier complex generally designated A. Provided on the shaft 3 and coupled thereto is a hub 5 to which two sector gears 7 and 9 are solidly fixed; the gear 7 is a sector of a circle on which a chain 10, anchored at 12 on the upper end of the said gear 7, can settle; the gear 9, by contrast, is shaped in the form of a variable-radius cam, and a chain 14 anchored at 16 on the end of the cam profile of the said gear 9 can settle thereon. The chain 10 is deflected by a deflection pulley 18 towards a hollow cylinder 20 into which it penetrates, reaching and anchoring itself on a lower plug 22 which is able to slide in-the said cylinder 20; a large helical spring 24 acts upon the plug 22, which surrounds the chain 10 and acts against the upper closed end 20A of the cylinder 20. The chain 14 is in turn deflected by a pulley 28 and by a second pulley 30 in order to reach and anchor itself on the end 32A of a rod 32 which passes through a plurality of counter-weights 34 - which are, for example, discoidal or equivalent - which are stacked and supported by the rod and can be adjusted in number, and hence in total weight, in order to balance the mobile equipment around and with the shaft 3, and which comprises the barrier A and the gears 7 and 9. In order to achieve an amplified effect, the chain 14, instead of being continuous in order to reach the counter-weights 34, may be interrupted by a speed change means replacing the deflection pulley 28 or the deflection pulley 30, in order to reduce the bulk and load of the weights 34. The objects of the two balancing systems will now be specified in more detail.

40 designates an assembly with a hydraulic pump and motor for a power unit which serves to supply a double-acting hydraulic actuator. This actuator comprises a cylinder-and-piston system with a rod 42 to which is solidly fixed a piston 44 which remains stationary while the cylinder 46 is slidable; in the drawing, the said actuator 42, 44, 46 is arranged in the vertical attitude. Solidly fixed to the cylinder 46, which represents the mobile member of the cylinder-and-piston system, is a rack 50 which is followed by a flattened zone 52; see in particular Fig. 5. On the shaft 3 and solidly fixed thereto is provided a discoidal body 54 having a sector gear 54A followed by a flattened zone 56. The function of this arrangement of the rack 50 and of the toothing 54A is, with the hydraulic actuator 42, 44, 46, to cause angular displacements of the sector 54A and hence of the mobile equipment about the axis of the shaft 3 and with the shaft 3 and which comprises the sector gears 7 and 9, and the entire complex of the barrier A which is supported on and solidly fixed to the shaft 3 and is mobile angularly therewith. At the end of the upward stroke of the cylinder 46, the two flat surfaces 52 and 56 interact mu-

tually by sliding.

The mobile equipment 46 of the cylinder of the hydraulic actuator also forms a pair of racks 60, opposite to the rack 50 and capable of engaging with corresponding sector gears 62, which are articulated at 64 and on which there acts - via a crosspiece 66 - a large compression spring 78, expediently sheathed, to oscillate about the axis of the crosspiece and via a fixed articulation 70. The sector gear 62, like the sector gear 54A, also has a flattened part 72, with which there can interact a flattened part 74 which is formed in the mobile part 46 of the cylinder of the actuator 42, 44, 46 in alignment with the rack 60, similarly to the flattened part 52 which is aligned with the rack 50 of the mobile cylinder 46.

The displacement of the mobile cylinder 46 brought about by the cylinder-and-piston system 42, 44, 46 causes rotation of the mobile equipment of the barrier A comprising the shaft 3, the gear 54A and the gears 7 and 9, until mutual engagement takes place between the rack 50 and the gear 54A; beyond a certain limit of the lifting of the cylinder 46, the flattened part 56 of the body 54 enters into sliding contact with the flattened part 52 of the mobile cylinder 46, fixing the position reached by the said mobile equipment and hence by the barrier A in the horizontal position. Similarly, the sector gear 62, engaging with the rack 60, causes a rotation of the gear 62 when the toothings of the gear 62 and of the rack 60 are engaged, while it frees the gear 62 when the flattened part 72 thereof enters into sliding contact with the flattened part 74 of the cylinder 46. In the position shown in Fig. 5, the cylinder 46 is in the position of maximum elevation and the bar A is lowered, that is to say horizontal; when it is caused to move downwards, that is to say in the direction of the arrow fB, the cylinder 46 initially causes merely the rotation, in a clockwise direction as shown in Figs. 1 and 5, of the gear 62 and hence causes a loading of the spring 68 until, after the first part of the downward stroke of the cylinder 46, the flattened surfaces 62 and 64 enter into sliding coupling and fix the position of the assembly 62, 68 in a condition of maximum compression, that is to say maximum loading of the spring 68. During the first initial part of the downward stroke of the cylinder 46, there also take place a sliding of the surface 52 on the surface 56 and an unchanged retention of the angular position of the equipment leading to the shaft 3 and comprising the barrier A; immediately afterwards, engagement commences between the rack 50 and the sector gear 54A, and this initiates the rotation - in the anticlockwise direction, as shown in Figs. 1 and 5 - of the equipment of the shaft 3, of the gears 7 and 9 and of the barrier A. The lifting movement of the barrier thus takes place about the axis of the shaft 3. At the start of the angular lifting movement of the barrier A, in the anticlockwise direction as seen in Fig. 1 and Fig. 5, the chain 10 is in the position of maximum upward pressure caused by the gear 7 and hence the spring 24 is in a state of maximum loading by compression; as the barrier A rises, that is to say as the equipment of the barrier and of the shaft 3 rotates in the anticlockwise direction as seen in Figs. 1 and 5, the spring 24 tends to re-expand, having cooperated in the initial lifting displacement of the barrier A, when the force resisting the lifting is maximum for the horizontal position of the said barrier A; the effect of the spring 24 is attenuated as the lifting progresses; at this time, however, the force resisting the lifting of the barrier is reduced by the gradually increased inclination of the barrier relative to the horizontal. At the start of the lifting of the barrier A and of its equipment the system of counter-weights 34 also cooperates in overcoming the initial load, these acting with a constant load on the chain 14 and hence on the gear 9 with the cam profile, producing, as regards the mobile equipment, an initial assistance which is relatively very powerful as a result of the high leverage created between the profile of the gear 9 and the axis of the shaft 3; this effect is gradually attenuated as the barrier A rises and hence as the equipment thereof rotates about the axis of the shafts 3, as a result of the gradual reduction of the radius of action of the chain 14 at its tangent point relative to the profile of the gear 9.

At the start of the lowering of the cylinder 46, the engagement between the rack 60 and the sector gear 72 produces a rotation of the gear 72 and hence a compressive loading of the spring 68, which constitutes an energy accumulation- system which is stabilised, as the lowering of the cylinder 46 continues, by the effect of the locking of the gear 62 brought about by the flattened surfaces 72 and 74 which are coupled and which slide relative to each other, keeping the loading of the spring 78 stabilised; only at the end of the lowering of the barrier A to the horizontal, and hence only towards the end of the lifting of the cylinder 46 by the actuator 42, 44, 46, does the overloaded spring 68 intervene, completing the lifting of the cylinder 46 by means of the toothings 62 and 60 and coupling the surfaces 52 and 56 in order to bring about the locking of the lowered barrier A; the spring 68 has the purpose of moving the cylinder 46 to the end of its stroke once the barrier A is lowered into the horizontal position to achieve the blocking of any exchange.

The hydraulic circuit for controlling the actuator 42, 44, 46 responsible for the movement of the barrier A, is illustrated in Fig. 4, in which the motor/pump unit 40 and the actuator 42, 44, 46 are illustrated diagrammatically. In the diagram, 82 designates a non-return valve and 84 and 86 designate pressure regulating valves, the valve 86 being capable of being excluded, if desired, by means a tap 88 which, when opened, bypasses the valve 86 causing the valve 84 to work alone, whereas closure of the tap 88 causes the ad-

ditional activation of the regulator valve 86, which then operates in series with the valve 84. 90 designates a regulator of flow, and hence of the speed of the displacements of the actuator and of the equipment of the barrier. 92 designates a directional control valve for switching the displacements, in one direction or the other, of the mobile equipment, that is to say of the cylinder 46 of the actuator 42, 44, 46: the valve 92 switches the delivery from the pump through the regulator 90 and the outflow 94, towards the reservoir 96. The valve 98, which is closed during normal operation, opens in the absence of current, enabling the counter-weights to move the bar into the position required by the project, without passive resistance caused by hydraulic loading. The valve 100 retains the oil in the line and hence locks the barrier: it opens only in the presence of a hydraulic command of opposite sign.

The reason for this selection is that mechanical locking of the lowered barrier is required while, depending on the type of level crossing, it may be desirable to keep the barrier raised or to lower it by gravity in the event of absence of current.

In any event, when the barrier is raised, a locking is desired, which cannot be mechanical, given that the barrier must be released if the electrical supply fails.

It is understood that the drawing shows only an example of embodiment, given solely by way of a practical demonstration of the invention, it being possible for the said invention to vary in forms and arrangements without thereby departing from the scope of the idea which underlies the said invention. The presence of any reference numbers in the appended claims has the purpose of facilitating reading of the claims with reference to the description and to the drawing, and does not restrict the scope of the protection represented by the claims.

Claims

1. Apparatus for controlling the raising and lowering of the barrier of a level crossing, characterised in that it comprises: a hydraulic power unit (40) capable of actuating a hydraulic cylinder-and-piston actuator (46, 42) for the raising and lowering of the barrier (A); a hydraulic circuit with distributors, pressure regulators, valves and the like; mechanical locking means (52, 56) at least for the lowered position of the barrier (A); and auxiliary units (7, 10; 9, 14) for overcoming initial inertia on opening.

2. Apparatus according to Claim 1, characterised in that the hydraulic circuit comprises, as an actuator, a double-acting cylinder-and-piston system (46, 44, 42); a valve (92) connected in parallel on the two branches of the supply circuit leaving to the cylinder-and-piston system; and a linkage (50, 54A) between the mobile member (46) of the actuator and the angularly mobile equipment of the barrier (A) to be moved.

3. Apparatus according to at least Claim 2, characterised in that it comprises a valve (98) which establishes communication between the two volumes of the cylinder (46) of the cylinder-and-piston system (46, 44, 42), the said valve being closed in normal operating conditions and opening in the event of lack of electrical supply, in order to lock the barrier (A) and to permit the latter to reach a predetermined design position under the effect of its own weight and the counterweight.

4. Apparatus according to Claim 3, characterised in that a valve (100) is arranged in one branch of the supply circuit of the cylinder-and-piston system (46, 44, 42) and closes the said line, keeping the barrier locked, the said valve opening only as a result of a hydraulic pressure of sign such as to cause lifting of the barrier (A).

5. Apparatus according to Claim 2, 3, or 4, characterised in that the said linkage comprises a sector gear (54A) on the mobile equipment of the barrier (A) and a rack (50) on the slidable cylinder (46) constituting the mobile member of the actuator.

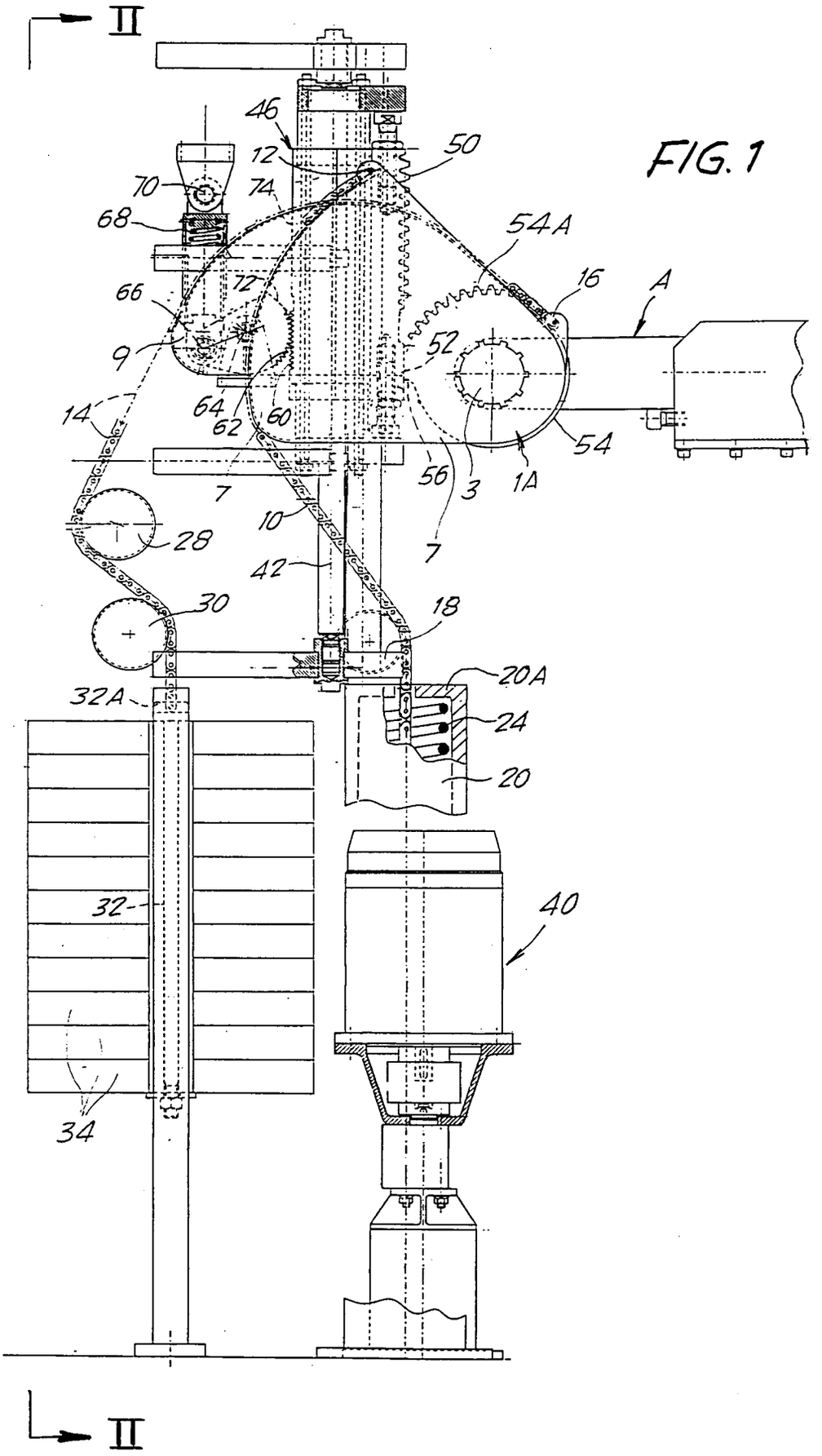
6. Apparatus according to Claim 5, characterised in that the said gear (54A) and the said rack (50) have flat surfaces (56, 52) which interact mutually with sliding contact in order to lock the barrier (A) in the lowered position at the end of the corresponding stroke of the actuator.

7. Apparatus according to one or more of the proceeding claims, characterised in that it comprises a spring (68) which is loaded at the start of opening by a sector gear (62), is kept loaded - by means of interacting flat surfaces (72, 74) - during the opening and closing strokes, and is capable of completing the closure stroke.

8. Apparatus according to one or more of the preceding claims, characterised in that the equipment of the barrier (A) also comprises a gear (7) for a chain or other flexible connector (10) interacting with an auxiliary compression spring (24) which acts on the equipment of the barrier at the start of the lifting stroke for the purpose of opening, the said auxiliary spring (24) being reloaded during the lowering of the barrier (A), having a balancing function.

9. Apparatus according to one or more of the preceding claims, characterised in that it comprises counter-weights (34) to balance the equipment of the barrier, which counterweights are recessed in a housing for linear sliding and are connected to the said equipment of the barrier (A) by a chain or similar flexible drive (14), settling gradually on a cam profile (9) of variable radius, solidly fixed to the said equipment.

10. Hydraulic apparatus for controlling the raising and lowering of the barrier of a level crossing; all as described and illustrated by way of example in the attached drawing.


II
46
12
50
70
74
68
54A
16
A
66
12
52
9
64
62
60
14
54
56
3
1A
7
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42
7
30
18
20A
32A
24
20
32
40
34
II

FIG. 1

FIG.2

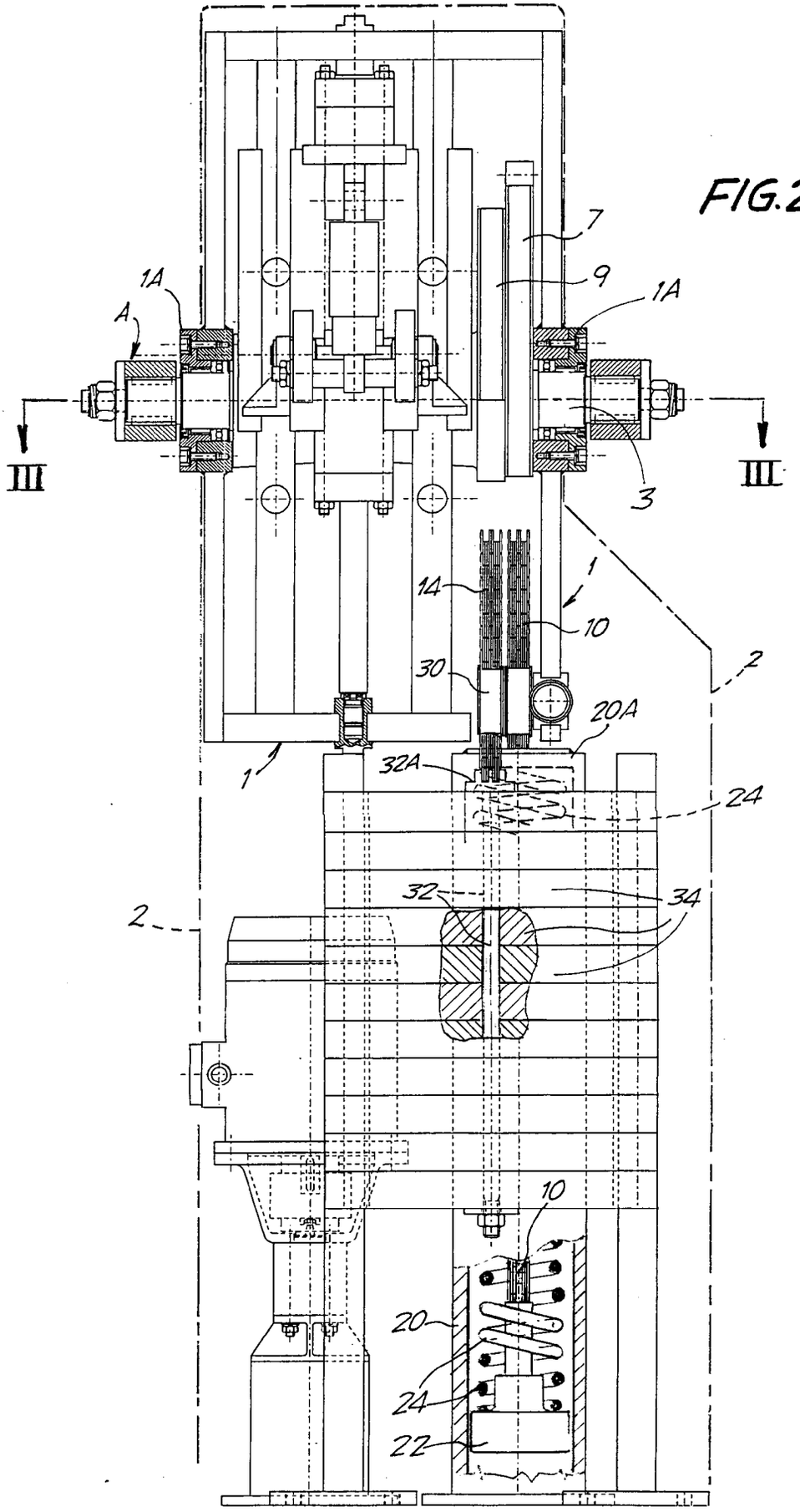
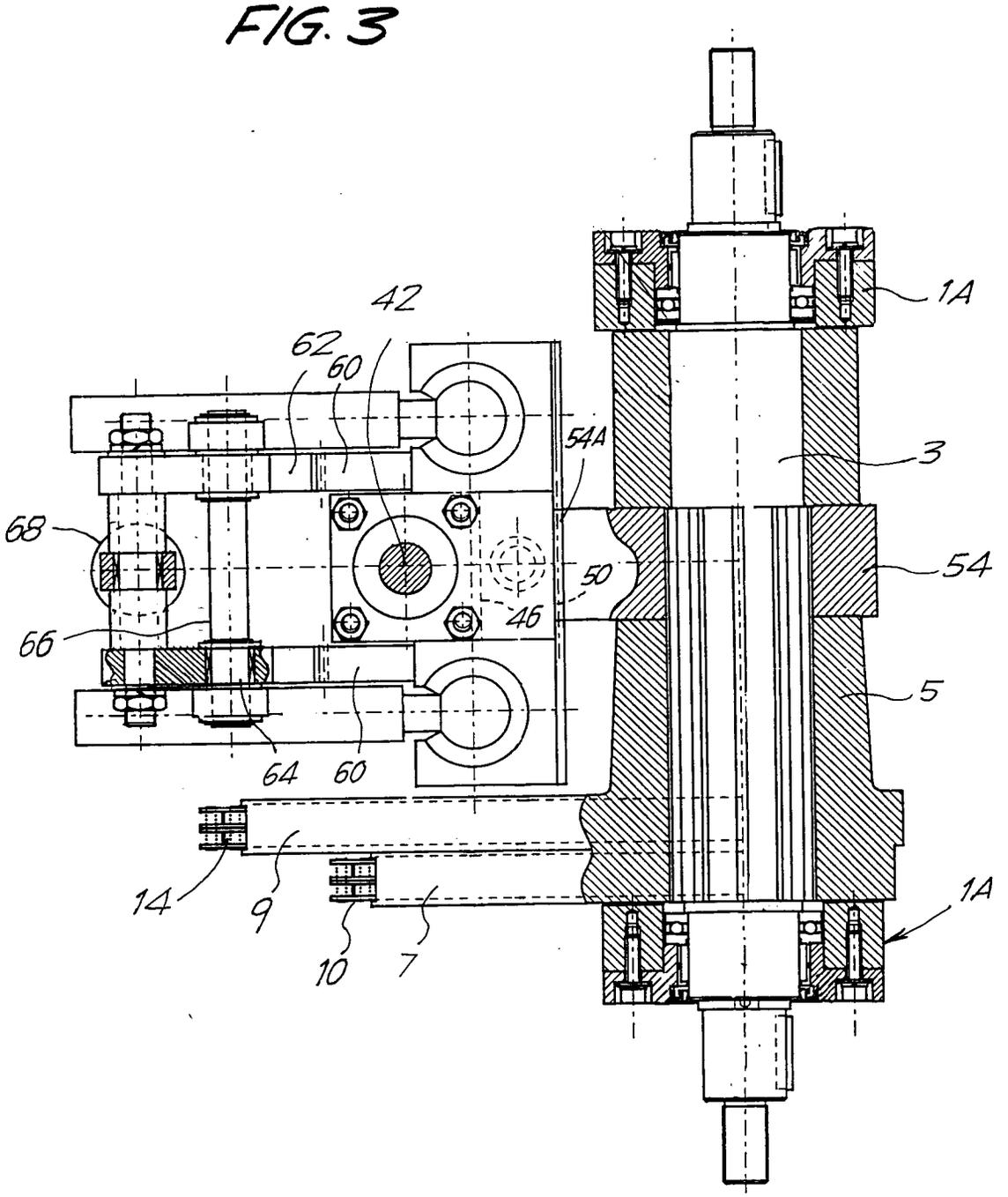


FIG. 3



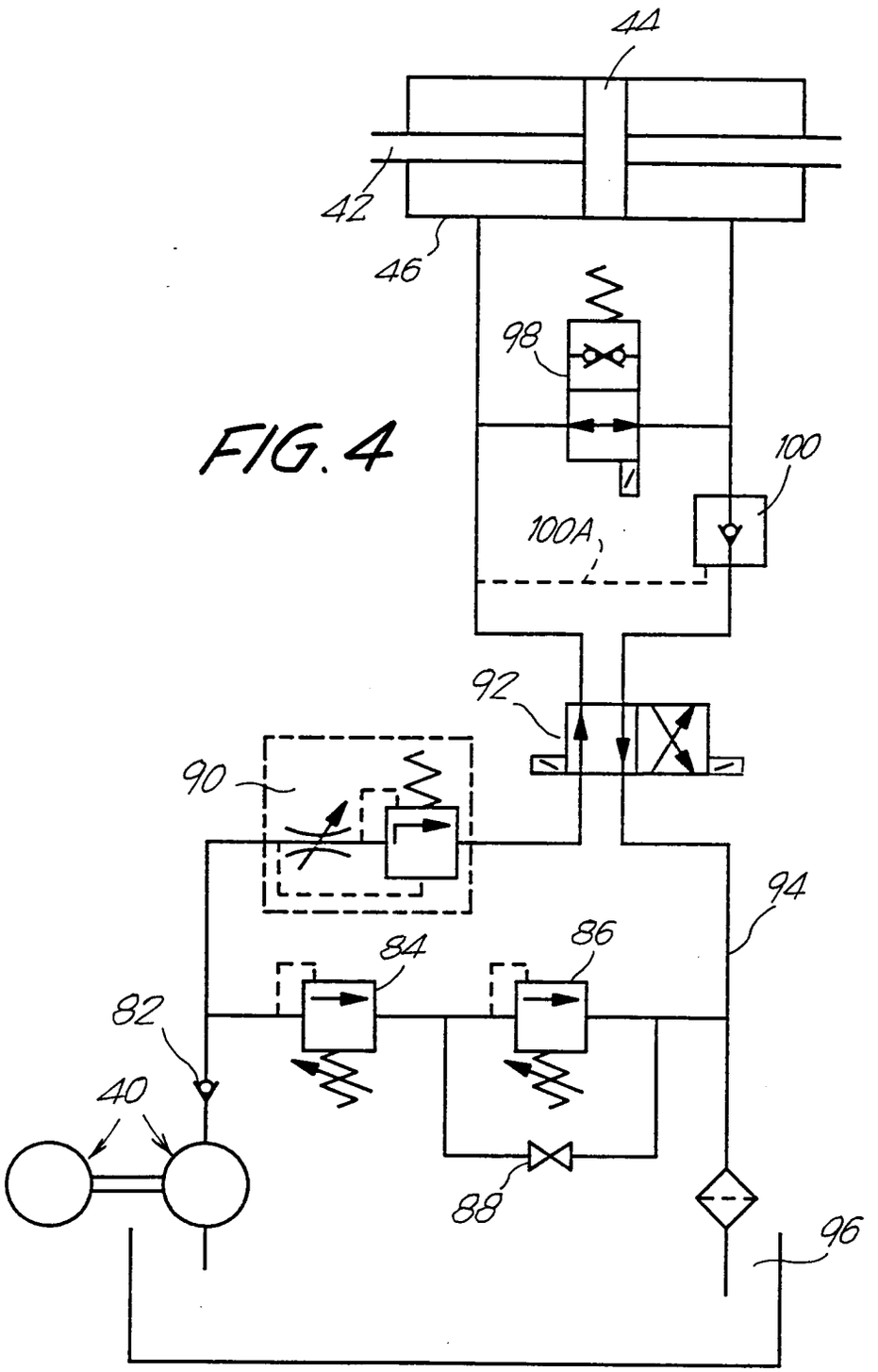


FIG. 4

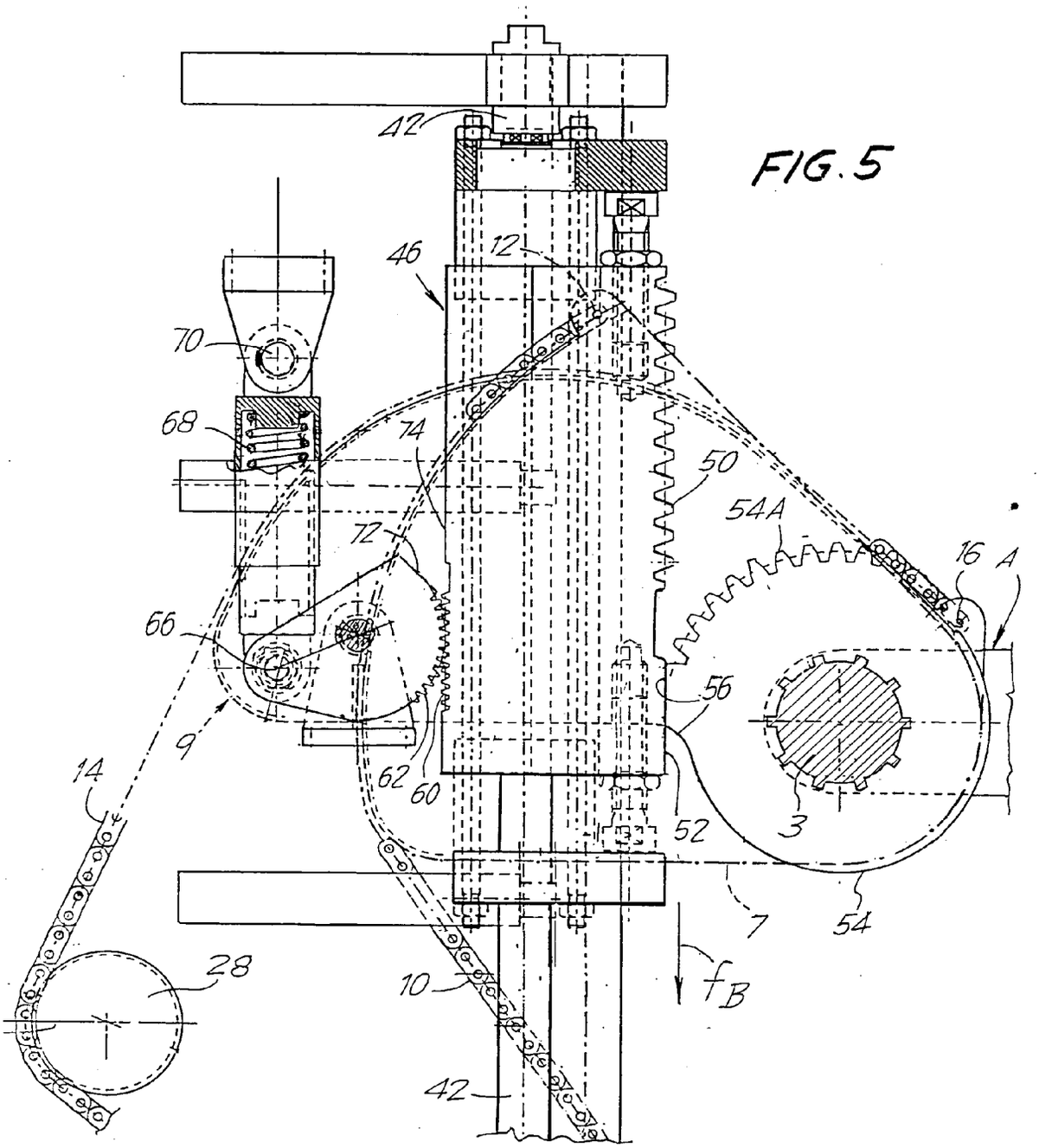


FIG. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 93 83 0223

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
P,A	EP-A-0 487 755 (SCHEIDT & BACHMANN) * column 7, line 6 - line 38; figure 1 *	1-4	E01F13/00
A	FR-A-2 289 984 (C. DORNEMANN) * page 5, line 2 - line 13 * * page 10, line 13 - page 11, line 19; figure 7 *	1,2	
A	EP-A-0 422 710 (FAAC) * column 2, line 32 - line 41; figures *	1	
A	US-A-4 133 140 (L.N. BERARD) * column 6, line 26 - line 51; figure 4 *	1,2	
A	FR-A-2 669 075 (ERO AUTOMATISME) * page 8, line 11 - page 9, line 11 * * page 13, line 12 - page 14, line 14; figures *	8	
A	US-A-1 412 878 (T. LAURENT)		

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

E01F
E05F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	25 AUGUST 1993	VERVEER D.

CATEGORY OF CITED DOCUMENTS

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