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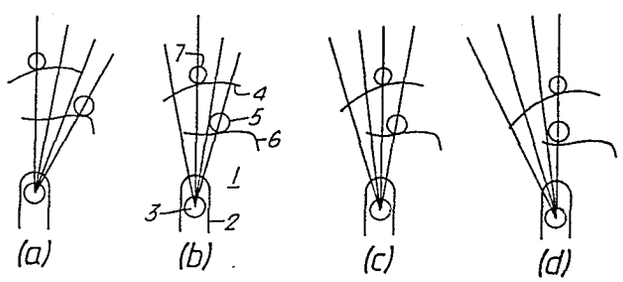
(54) Actuator.

(57) An actuating mechanism for a vacuum interrupter which requires a smaller force than hitherto for actuating the switch and yet provides adequate load on the contacts when closed comprises a movable member (14) which holds the load producing member (17) by means of a cam (14) away from the contacts without producing a load on the contacts until the movable member (14) is in such a position following a second cam (16) that the first cam (14) allows the load (17) to act via the member (14) directly on the contacts which are closed.



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Actuator

This invention relates to actuators and more particularly to an actuating mechanism for a member constrained to move along a path between first and second terminal positions especially such a mechanism for operating a short stroke switch, such as a vacuum switch.

Vacuum switches generally have short stroke cycles which are between 5 and 12mm in length and are usually spring operated. The closing mechanism for such switches is such that it must be able to store enough energy within the mechanism to enable the switch to open when desired. In addition there must be enough force exerted on the contacts when they are closed to prevent them blowing apart in the event of a short circuit. This force can be quite high, for example in a 20kA switch a force of 150 kg pressure is needed. This pressure is required at the end of the closing cycle when a spring operated mechanism is usually exerting the lowest force of its cycle. Thus conventionally, a further load is introduced at the end of the closing stroke to provide the required pressure on the contacts. This means, however, that the force required to maintain the contact pressure, the stored energy, must also be quite high and so the force required to actuate the switch closing and opening mechanism is high.

An object of the present invention is to provide an actuating mechanism suitable for operating short stroke electric switches which may be actuated using a much smaller force than for conventional switches.

Accordingly the present invention provides an actuating mechanism for a member constrained to move along a path between first and second terminal positions, comprising a first movable cam, a second cam and biassing means for providing a force on said member urging it towards said second terminal position wherein said first cam is so shaped that movement thereof causes said member to move between said first and second terminal positions and said second cam is so shaped that the full force of the biassing means is not allowed to act on said member until the member is approaching said second terminal position.

In one preferred embodiment of the invention the actuating mechanism comprises a fixed cam, a rotatable cam pivotally linked to the movable member and carrying a first cam follower engageable with the fixed cam, and biassing means operable to urge the movable member towards the second terminal position and carrying a further cam follower engageable with the rotatable cam, the shapes of the fixed and rotatable cams being such that rotation of the rotatable cam from a position in which the movable member is in its first terminal position produces a movement of the member toward the second terminal position under the action of the biassing means, which movement is constrained by the fixed cam, until the member approaches the second terminal position whereupon the fixed cam ceases to act on the respective cam follower and allows the full force of the biassing means to act on the movable member.

The member may be constrained by means of a slot in a plate, which may or may not be part of the fixed cam.

When the mechanism is employed as a switch activator the movable member is arranged to open and close the contacts of the switch, which may be a vacuum switch, as it moves between its first and second terminal positions. The member

may, however, be arranged to control any device which needs to be moved from one position to another, and which requires a bias to remain in either position.

The rotatable cam may be a double cam carrying two cam followers engageable with a double fixed cam so as to be operable on rotation of the rotatable cam in either direction, and this form of mechanism can be used, for example, in a double action switch. Such a switch is preferably used in a vacuum interrupter/isolator assembly in which the member is arranged to open and close the contacts of a vacuum switch and the movement of the drive means of the rotatable cam causes an isolating mechanism to operate.

The invention will now be more fully described with reference to the drawings in which:-

Figure 1 (a - d) diagrammatically shows the way in which the invention works;

Figure 2 shows one embodiment of the invention;

Figure 3 shows a second embodiment of the invention;

Figure 4 shows a third embodiment of the invention;

Figure 5 shows a fourth embodiment of the invention;

Figure 6 shows one embodiment of the invention in combination with a vacuum interrupter assembly; and

Figure 7 shows a further embodiment of a modified form of the invention.

Referring firstly to Figure 1, there is shown an actuating mechanism according to the invention. The mechanism consists of a fixed cam plate 1 having a slot 2 in which a member 3 is engaged. A rotatable cam 4 is pivotally linked to the member 3 and carries a cam follower 5, conveniently in the form of a roller, which is engaged with a cam 6 on the fixed cam plate 1. The rotatable cam 4 is engaged in turn by a biassing means 7 which acts downwards as seen in Figure 1 in order to bias the member 3 to move along the slot 2. Parts a - d of Figure 1 illustrate the movement of the member 3 as the rotatable cam

4 is rotated anticlockwise as seen in Figure 1. The cams 4 and 6 are so shaped that they are engaged by the biassing means 7 and the cam follower 5 respectively when the member 3 is at the first terminal position at the uppermost end of the slot 2 as shown in Figure 1a. As the cam 4 is rotated through the positions shown in Figures 1b and 1c by any suitable means the cams 4 and 6 are so arranged that the member is allowed to move along the slot 2 under the action of the cam follower 5 moving along the cam 6 but with the biassing means 7 being held up by the cam 4. As the member 3 approaches the second terminal position shown in Figure 1d, the shape of the cam 6 is such that it disengages from the cam follower 5 and the full force of the biassing means 7 is allowed to act on the member 3. By suitably shaping the cam surfaces, movement of the biassing means, as the member travels between the two terminal positions, may be kept small, or in some cases virtually eliminated.

Figure 2 shows one embodiment of an actuating mechanism in accordance with the invention. In this embodiment, the fixed cam plate 11 has a double cam 16

engaged by two cam followers 15 and 18. The cam followers 15 and 18 are carried by a rotatable cam 14 which is pivotable about a member 13 engaged in a slot 12 in the fixed cam plate 11. A biassing means 17 is engaged with the rotatable cam 14 and is biassed in the direction of arrow 19 by any means desired. This mechanism is a double-action mechanism in that the rotatable cam 14 may be rotated in either direction from its rest position, in which the member 13 is in the first terminal position as shown, to cause the member 13 to be moved into the second terminal position as described above.

The embodiment shown in Figure 3 comprises a fixed cam plate 21 having a slot 22 and a single cam 26. A rotatable cam 24 pivots around a member 23 engaged in the slot 22 and carries a cam follower 25 engageable with the fixed cam 26. A biassing means 27 is biassed by means of a spring 28 in the direction of arrow 29 to act on the member 23 when it is allowed to approach the second terminal position at the lower end of the slot 22 by the rotation of the cam 24.

The embodiment shown in Figure 4 is a variation of that described above with reference to Figure 3. In this embodiment the fixed cam plate 31 has one slot 32 in which a member 33 is engaged and a further slot 40 in which a protrusion 30 from a biassing means 37 is engaged to constrain the biassing means to act only in the direction of the arrow 39. The other parts of the mechanism are the same as described in the embodiment shown in Figure 3.

Figure 5 shows a variation of the embodiments of the invention shown in Figures 3 and 4 in which similar parts are not numbered for convenience. The rotation of the cam 44 is produced by movement of the cam follower 45 around the fixed cam 46 and in this embodiment this is caused by movement of one arm 43 of a bell crank 42 in the direction of the arrow 48. The other arm of the

crank 42 is pivotally connected to link 41 which is also pivotally joined to the cam follower. As the arm 43 is moved the bell crank pivots around a point 49 and causes the cam follower 45 to move around the fixed cam 46 and hence results in the rotation of the cam 44.

Figure 6 shows a vacuum interrupter assembly comprising a vacuum switch 62, a conducting isolator bar 60 and an actuating mechanism according to the invention. The vacuum switch is of any known type and is coupled to the member 53 of the actuating mechanism in order to actuate the switch and provide sufficient force on the contact to prevent them being blown apart in short-circuit conditions.

The assembly comprises a base part 61 holding the vacuum switch 62, a fixed plate 51 having a fixed cam 56, a short vertically-extending slot 52 and an elongate transversely-extending slot 65 therein attached to the base part 61, a moving plate 66 having an elongate slot 67 in correspondance with the elongate slot 65 and a cut out portion 68, and the conducting isolator bar 60, which is connected to one contact of the vacuum switch and which has a U-shaped saddle member 53 attached thereto. The saddle member is engaged by a roller 64 which travels within the slots 65 and 67. The moving plate 66 is slidably supported from the fixed plate 51 by means of pegs 70 carried by the fixed plate and extending into transversely-extending slots 71 in the moving plate 66 as shown. Recesses 69 formed at each end of the upper edge of the cut out portion 68 of the moving plate 66 engage with respective cam followers 55 in order to move one or other of the followers around the fixed cam 56. The cam followers 55 are carried by a rotatable cam 54 which pivots around a member 53 engaged in the short slot 52 in the fixed plate 51. The isolator bar is transversely slidable to connect with contacts (not shown) at one end or the other, to make a connection with a busbar or earth.

However it is required that this connection be made before current flows in the circuit and be broken after current has stopped flowing in the circuit. Thus the making or breaking of current flow should take place only within the vacuum switch itself. In the position shown, the vacuum switch is open and the assembly is isolated from any other parts of a circuit by the isolator bar which is in its central position.

To connect the interrupter assembly into a circuit, the isolator bar 60 is moved e.g. to the left as seen in the drawing by movement of the roller 64 in the appropriate direction, as this initially engages the U-shaped member 63, which is fixed to the bar. The roller 64 is constrained to move along the elongate slots 65 and 67 until the bar 60 makes contact with a contact (not shown) e.g. to a busbar. At this time the vacuum switch is still open so no current is flowing. The roller is then forced to move up out of the U-shaped member 63 by a step in the slots 65 and 67 so that continued movement of the roller no longer produces any movement of the bar 60. The slot 67 in the moving plate 66 is shorter than slot 65 so when the roller reaches the end of slot 67 it forces the moving plate 66 to move along until it reaches the end of the slot 65. As the moving plate 66 is moved to the left as seen in the Figure it forces the right-hand cam follower 55 (as shown in the drawing) to follow the fixed cam 56 and thus rotates the cam 54 around its pivot member 53, the cams 54 and 56 being so shaped that the member 53 is allowed to move within the slot 52 only when the cam follower 55 approaches the central position. At this time, the follower 55 leaves the cam 56 and thus allows the full force of the biassing roller 57, which has been following the cam 54 as it has rotated, to act on the member 53 and move it along the slot 52. The shape of the cam 54 is such that the biassing roller 57 stays substantially stationary. The roller is urged against the cam by being mounted on a

pivoted lever 59 biassed downwards by a spring 58. As the member 53 is allowed to move within the slot 52, it closes the contacts of the vacuum switch 62, and when the full force of the biassing roller 57 acts on it, the contacts of the vacuum switch are held together with the required force. The mechanism operates in a similar fashion when the roller 64 is moved along the slots 65, 67 in the opposite direction, the isolator bar 60 being moved to the right to make, for example, an earth connection, and the left-hand cam follower 55 then being carried around the respective part of the fixed cam by the continued movement of the moving plate 66.

Clearly this arrangement may be used with any short-stroke devices and may also be used to actuate the opening springs of conventional circuit breakers thus simplifying their main mechanism.

In a modified form of the invention the rotatable cam may be replaced by a linearly movable cam. An embodiment of this modified form of the invention is illustrated in Figure 7. In this embodiment, a fixed plate 80 has a slot 85 in which a roller 86 is allowed to move. The roller 86 is connected to the vacuum contacts 88 so as to open the contacts when it is moved in one direction along the slot and to close them when moved in the opposite direction. The roller 86 is also constrained by a staggered slot 84 in a movable plate 82 which moves perpendicularly to the slot 85 between rollers 83 and 87. A spring 81 provides a downwards force on the plate 82 which, in one position of the plate, is transferred to the roller 86 and thus to the contacts 88. In the position shown the contacts 88 are closed and the force from the spring 81 is acting via the plate 82 and the roller 86 to hold the contacts closed. The plate 82 has a cut-out portion 89 which is positioned next to the roller 87 so that all the force is acting on the contacts. To open the contacts the plate 82 is moved to the left, as shown in the figure, whereby the roller 87 is then contacted by the edge of the plate 82 as the roller 86 is forced to ride up the slot 85 due to the stagger in the slot 84 which is moving to the left. This means that the force of the

of the spring is taken by the roller 87 carried by the fixed plate 80 and is no longer acting on the roller 86, so that the contacts are easily opened without requiring undue force.

CLAIMS

1. An actuating mechanism for a member (3) constrained to move along a path between first and second terminal positions, comprising a first movable cam (4), a second cam (6) and biassing means (7) for providing a force on said member (3) urging it towards said second terminal position, characterised in that said first cam (4) is so shaped that movement thereof causes said member (3) to move between said first and second terminal positions and said second cam (6) is so shaped that the full force of the biassing means (7) is not allowed to act on said member (3) until the member is approaching said second terminal position.

2. An actuating mechanism according to Claim 1 characterised in that said first movable cam is a rotatable cam (14) pivotally linked to the movable member (13) and carrying a first cam follower (15, 18) engageable with said second cam which is a fixed cam (16), the biassing means (17) also carrying a further cam follower (17) engageable with the rotatable cam (14), the shapes of the fixed and rotatable cams being such that rotation of the rotatable cam from a position in which the movable member is in its first terminal position produces a movement of the member towards the second terminal position under the action of the biassing means, which movement is constrained by the fixed cam, until the member approaches the second terminal position whereupon the fixed cam ceases to act on the respective cam follower and allows the full force of the biassing means to act on the movable member.

3. An actuating mechanism according to Claim 2 characterised in that said rotatable cam is a double cam carrying two cam followers engageable with a double fixed cam so as to be operable on rotation of the rotatable cam in either direction.

4. An actuating mechanism according to Claim 1 characterised in that said first movable cam is a staggered slot (84) in a movable plate (82) in which said member is

engaged and said second cam (89) is also movable and engageable with a fixed cam follower (87).

5. An actuating mechanism according to any preceding claim characterised in that said member is constrained by means of a slot (2) in a plate (1).

6. An actuating mechanism according to any preceding claim characterised in that said member is arranged to open and close the contacts of a switch as it moves between its first and second terminal position.

7. An actuating mechanism according to Claim 6 characterised in that said switch is a vacuum switch.

8. A vacuum interrupter/isolator assembly incorporating an actuating mechanism according to any preceding claim.

Fig.1.

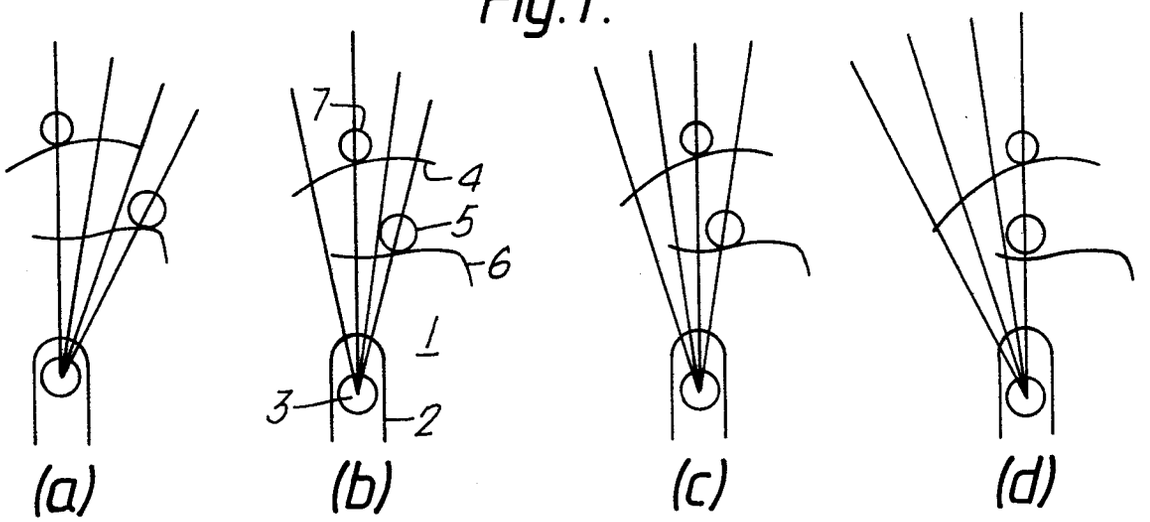


Fig.2.

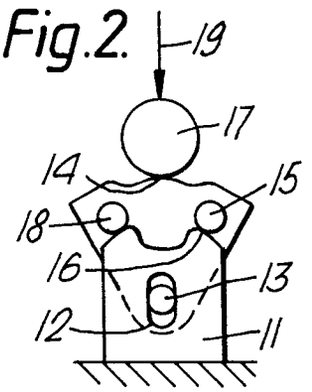


Fig.3.

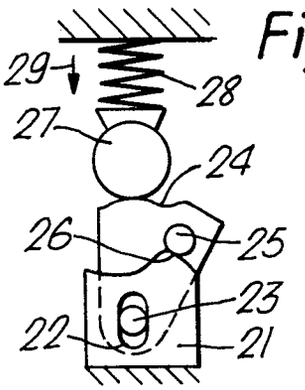


Fig.4.

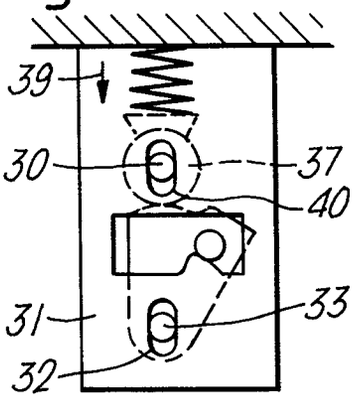


Fig.5.

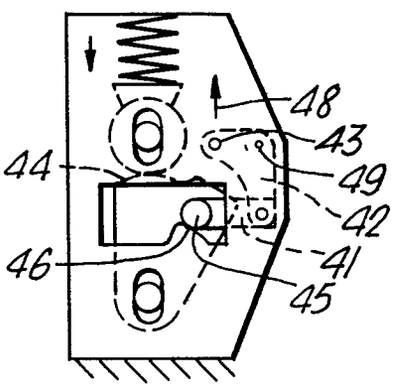


Fig.6.

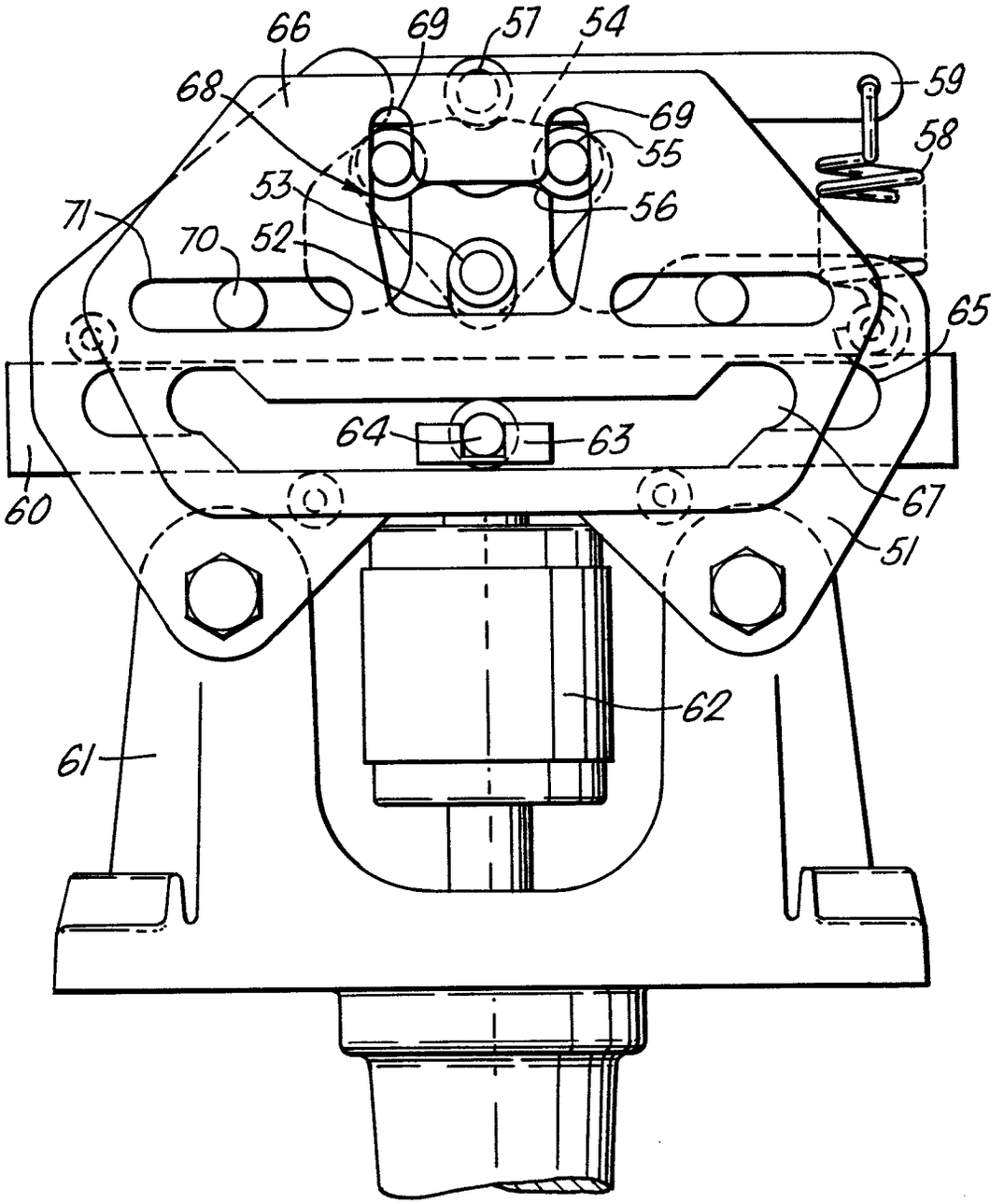
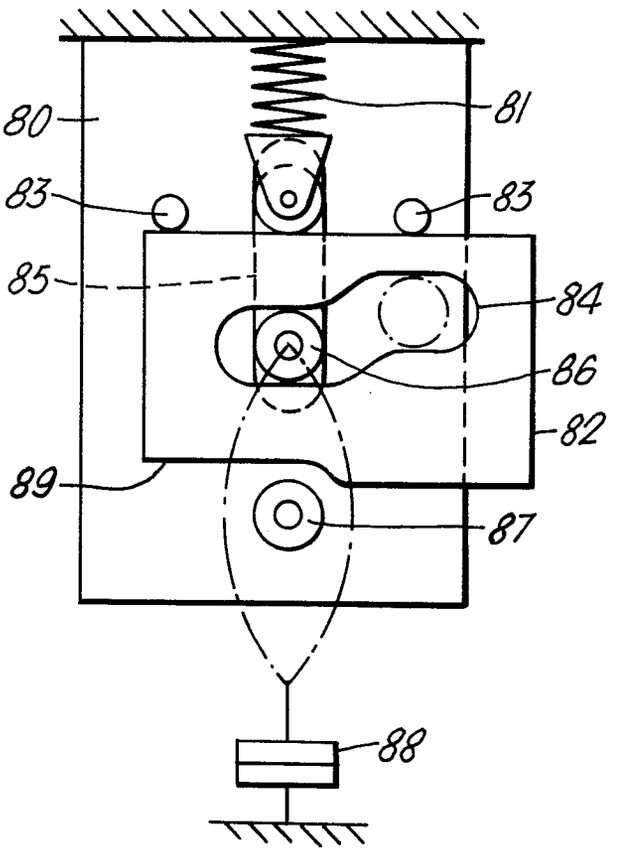


Fig. 7.



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EUROPEAN SEARCH REPORT

EP 84 30 7213

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.4)
A	DE-C- 578 730 (A.E.G.) * page 1, lines 16-34 *	1	H 01 H 33/66 H 01 H 3/42
A	DE-C- 932 849 (LICENTIA) * page 2, lines 17-38 *	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

H 01 H 33/00
H 01 H 3/00
H 01 H 1/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	22-01-1985	LIBBERECHT L.A.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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