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(54) Title: MEDIUM VOLTAGE CIRCUIT BREAKER ARRANGEMENT OPERATED BY SPECIAL TRANSMISSION MEANS

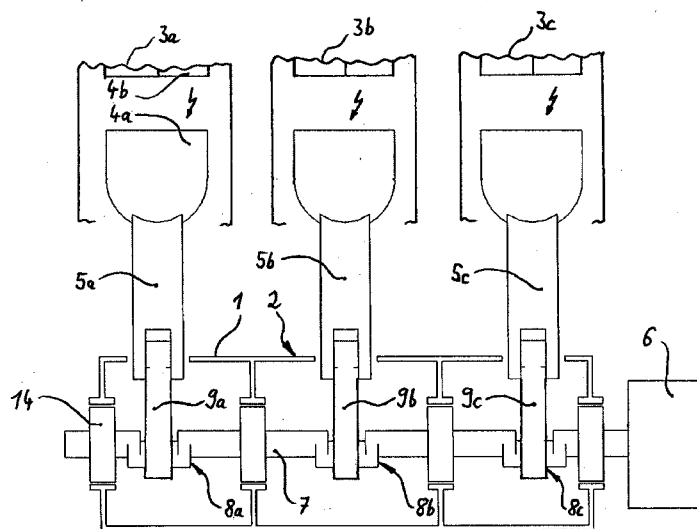


Fig. 1

(57) Abstract: Circuit breaker arrangement comprising at least one pole part (3a - 3c) for switching an electrical medium to high voltage circuit by a respective pair of corresponding inner electrical contacts (4a, 4b), wherein a pushrod (5a - 5c) of a respective movable electrical contact (4a) is operated by a common actuator unit (6), which is mechanically connected to each pushrod (5a - 5c) via transmission means for transferring the switching force from the actuator unit (6) to each pushrod (5a - 5c), wherein the transmission means comprise a crankshaft (7) having at least one crank (8a - 8c) which is pivotally attached to one end of a connection rod (9a - 9c), wherein further the opposite end of the connection rod (9a - 9c) is pivotally attached to the end of the pushrod (5a - 5c) of the corresponding pole part (3a - 3c).

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**Medium voltage circuit breaker arrangement
operated by special transmission means**

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Field of the invention

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The invention relates to a circuit breaker arrangement comprising at least one pole part for switching an electrical medium voltage to high voltage circuit by a respective pair of corresponding inner electrical contacts, wherein a pushrod of a respective movable electrical contact is operated by a common actuator unit, which is mechanically connected to each pushrod via transmission means for transferring the switching force from the actuator unit to each pushrod.

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Circuit breakers of that kind interrupt the current by creating and extinguishing the arc in a vacuum container. Modern vacuum circuit breakers tend to have a longer live expectancy than former air circuit breakers. Usually, a vacuum circuit breaker comprises one electrical pole per phase, wherein each pole part comprises an interrupter chamber, that can be a vacuum interrupter or a chamber filled with SF₆ or oil. Further, the poles comprise a drive rod for operating a movable electrical contact of the pair of electrical contacts, which is accommodated inside the interrupter chamber. Circuit breakers of the present inventions are used in the field of medium – voltage to high – voltage applications.

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The document EP 0 817 225 A1 discloses a medium-voltage circuit breaker arrangement with three pole parts mounted on a common mounting surface of a housing for accommodating drive means for synchronously operating the moveable electrical contact of each pole part.

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Each pole part contains a pair of electrical contacts which are arranged inside of a switching chamber insulator, which is supported on a mechanism chassis attached to the box-type housing.

5 A pivot shaft running transverse to the switching direction is arranged in each mechanism chassis of each pole part, penetrating the mechanism chassis and the housing. A rocker arm is fixedly secured to that part of the shaft running inside of the mechanism chassis, and is connected to the moveable electrical contact by an insulating rod arranged as a pushrod. The pushrod is articulated to the rocker arm at
10 one end and the moveable electrical contact on the other end. All shafts are on a common level and are parallel to each other. The preferred pivot angle of the rocker arms is within an angular range of 50° to 130° . Both end-point positions of the rocker arms correspond to the off position of the circuit breaker. The part of each shaft within the housing has a bifurcated rocker link, both arms of which are provided with a slot
15 running radially relative to the shaft axis. A respective lever, also arranged in the housing, is provided for other services of the arms. These auxiliary levers are parallel to each other and are connected to each other by a rod or a bolt, protruding through the slots of the bifurcated rocker link, thereby forming a crank-type structure.

20 The rod or bolt of the center pole part is linked by a respective coupler to the bolt of the other pole parts. A drive coupler is articulated to the bolt of the interrupter unit, and is linked to one end to the driver lever. The driver lever is situated on a drive shaft of a common actuator unit. The transmission means for transferring the switching force from the actuator unit to each pole part base on a drawbar principle. The drawbar runs
25 from the common drive unit along the housing and is connected to each pole part as described above. Many single parts are necessary on the transmission part.

The document US 3,806,684 discloses a special transmission mechanism for converting a hand-operated circuit breaker to a motor-operated circuit breaker.

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The circuit breaker comprising a metallic housing structure and a circuit breaker mechanism is supported on the housing structure. The housing structure comprises a

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base plate and a pair of side plates connected to the base plate with a pair of spaced generally parallel center plates.

5 A crank shaft is supported on this center plates with a closing cam supported on the crank shaft between the center plates. A pair of springs is connected to the crank shaft, at the opposed sites of the center plates, to provide suitable energy means for closing the circuit breaker contacts.

10 A jack shaft that is common to all of the pole parts and pivotally moveable to operate the moveable contacts for all of the pole parts is supported at the opposite ends thereof in bearings mounted on the side plates. The bearings on the center plates are open at one site to permit movement of the jack shaft into the open center plate bearings to provide assembly of the circuit breaker. A link that is supported on the side of the center plates engages a trip bar to ledge the circuit breaker in the reset operating position.
15 Ledgeing forces act on the trip bar in proximity to center plate.

The closing cam comprises twin cam members with a roller ledge supported between the twin cam members. A closing ledge engaged the roller ledge to hold the closing cam in the charged position until it is desired to close the circuit breaker there upon the
20 closing ledge is operated to release the roller and the start energy of the closing springs services to operate the crank to thereby operate the jack shaft to close the electrical contacts.

25 Due to the double-function of the disclosed technical solution the transmission means for transferring the switching force to each pole part have a complex design. However, the transmission means base on a rotation principal of a common jack shaft, on which lever arms are attached for operating the pushrods of each pole part.

30 It is an object of the present invention to provide a circuit breaker arrangement on the basis of a rotation shaft for transferring the switching force to each pole part comprising a few single parts which are easy to manufacture and to assemble into a small housing of the circuit breaker arrangement.

Summary of the Invention

According to the invention a circuit breaker arrangement is provided comprising a special designed crank shaft arrangement for transmission purpose. The special transmission means comprise a crank shaft having – according to the number of the pole parts – at least one crank which is pivotally attached to one end of a connection rod, wherein the opposite end of the connection rod is pivotally attached to the end of the pushrod of the corresponding pole part.

For operating the pushrod of each pole part only a corresponding connection rod is necessary which is connected to the common crank shaft. No further levers or other linkage means are necessary. Another advantage of the present invention is that only a few single parts have to be assembled inside the housing of the circuit breaker arrangement during the mounting process.

Preferably, all pole parts of the circuit breaker arrangement are arranged one to another in a line formation on a common other surface of the housing in order to ensure an exact positioning of the pole parts relative to the crank shaft.

For ensuring a simultaneously closed electrical switching position of all pole parts it is recommended that all cranks of the crank shaft have a common upward position in the direction of the neighbouring pole parts. The open electrical switching position of all pole parts preferably differs from the closed electrical switching position by a torsion angle of 180° of the crank shaft.

In order to generate the closed switching position as well as open switching position the common actuator unit preferably generates a rotary motion for pivotally operating the crank shaft. Thus, the common actuator unit could be an electric motor.

According to one further aspect of the invention, the crank shaft can rotate in the same direction for changing the electrical switching position. Thus, a first rotation of about 180° brings the pole parts from the open switching position into the closed switching position, while a second rotation with the same direction brings the pole parts into the

open switching position again. Alternatively, the drive unit can be chosen in a way that the rotation is forward and back. In this case, the first rotation of about 180° brings the pole parts from the open switching position into the closed switching position, while the second rotation in opposite direction brings the pole parts back into the open position.

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According to another favourable aspect of the present invention, at least one rotating mass is arranged on the crank shaft in order to increase the rotary inertia. Thus the rotating mass supports the dynamic of the actuator unit and optimises the travel curve of the pole parts. Preferably a single rotation mass is positioned at one end of the crank shaft and the common actuator unit is positioned at the other end of the crank shaft. If necessary, several bearing discs can be inserted into the housing in order to pivot-mounting the crank shaft inside the housing. Bearing discs support the crank shaft and minimise tolerances during operation.

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It is advantageous to choose the open position and closed of the pole parts to the top and bottom dead centres of the cranks, as than the force that the drive has to generate to maintain this position is quite low. For eventually latching said switching positions it is furthermore advantageous to rotate the crank shaft a little bit beyond the top dead centre and then to block it from further rotation. It is advantageous to choose the close and open position of the pole parts to the top. Than the force from the contact springs of the moveable electrical contact between the pushrods and the pole parts will latch the circuit breaker arrangement in the closed switching position. For switching into the open switching position, one would let the drive rotate back, or release the blocking and rotate further in the same direction.

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Preferably, the connection rods of the transmission means each consist of two symmetrically shaped parts, wherein each part has a first semicircle opening for pivotally attaching to the crank and second semicircle opening for pivotally attaching to the pushrod. In other words, the connection rod is splitted into two halves and after insertion of the pushrods and the crank shaft to assemble these two halves as the last step to connect pole parts and common drive. The assembly of the halves can be made with one or more transverse running screw connections or with a tensible belt around the connection rod.

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The foregoing and other aspects of the invention will become appeared following the detailed description of the invention when considered in conjunction with the enclosed drawings.

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Brief description of the drawings

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Figure 1 is a schematic front view of a circuit breaker arrangement with transmission means comprising a special crank shaft,

Figure 2 is a schematic perspective view of a transmission means in the closed switching position,

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Figure 3 is a schematic perspective view of a transmission means in the open switching position,

Figure 4 is a perspective view of a first embodiment of a connection rod, and

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Figure 5 is a perspective view of a second embodiment of a connection rod.

Detailed description of the drawings

25

The circuit breaker arrangement according to figure 1 principally consists of a housing 1 with another mounting surface 2 on which three pole parts 3a to 3c are in line mounted.

30

Each pole part 3a to 3c contains a pair on corresponding inner electrical contacts 4a and 4b for switching a three-phase medium voltage circuit. The electrical contact 4a of each pole part 3a to 3c is axially moveable arranged operated by a respective pushrod 5a to 5c. The opposite electrical contact 4b is fixed within the corresponding pole part 3a to 3c.

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All pushrods 5a to 5c are synchronously operated by a common actuator unit 6, which is mechanically connected to each pushrod 5a to 5c via a special transmission means.

Said special transmission means for transferring the switching force generated by the actuator unit 6 to each pushrod 5a to 5c is realised by a crank shaft 7 having three cranks 8a to 8c. Each crank 8a to 8c is pivotally attached to one end of a connection rod 9a to 9c respectively. The opposite end of the connection rod 9a to 9c is pivotally attached to the end of the pushrod 5a to 5c of the corresponding pole part 3a to 3c. Furthermore, the crank shaft 7 is pivot-mounted into the housing 1 by several bearing discs 14.

According to Figure 2 the common actuator unit 6 generates a rotary motion for pivotally operation of the crank shaft 7. A common upward position of all cranks in the direction of the neighbouring pole parts 3a to 3c – as shown – causes a closed electrical switching position of all pole parts 3a to 3c. Furthermore, an additional rotating mass 9 is arranged at one end of the crank shaft 7. The common actuator unit 6 is positioned at the opposite end of the crank shaft 7. Due to the common actuator unit 6 the crank shaft 7 rotates in the same direction for changing the electrical switching position.

Figure 3 shows the crank shaft 7 in a common downward position of all cranks 8a to 8c in which the pole parts 3a to 3c are in the open electrical switching position.

According to Figure 4 the connection rod 9 (exemplary) consists of two symmetrically shaped parts 10a and 10b. Each part has a semicircle opening 12a for pivotally attaching to the – not shown – crank and a second semicircle opening 12b for pivotally attaching to the – not shown – pushrod. Both parts 10a und 10b of the connection rod 9 are assembled by a schematically shown transverse screw connection 13.

Alternatively, according to Figure 5 another embodiment of the connection rod 9' also consists of two parts 10a und 10b which are shaped symmetrically. Both parts 10a und 10b are assembled one to another by a surrounding tensible belt 11.

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Reference signs

	1	housing
	2	mounting surface
5	3	pole part
	4	electrical contact
	5	pushrod
	6	actuator unit
	7	crank shaft
10	8	crank
	9	connection rod
	10	part of connection rod
	11	tensile belt
	12	semi circle opening
15	13	screw connection
	14	bearing discs

Patent Claims

1. Circuit breaker arrangement comprising at least one pole part (3a – 3c) for switching an electrical medium to high voltage circuit by a respective pair of
5 corresponding inner electrical contacts (4a, 4b), wherein a pushrod (5a – 5c) of a respective movable electrical contact (4a) is operated by a common actuator unit (6), which is mechanically connected to each pushrod (5a – 5c) via transmission means for transferring the switching force from the actuator unit (6) to each pushrod (5a – 5c),
10 **characterized in that** the transmission means comprise a crankshaft (7) having at least one crank (8a – 8c) which is pivotally attached to one end of a connection rod (9a – 9c), wherein the opposite end of the connection rod (9a – 9c) is pivotally attached to the end of the pushrod (5a – 5c) of the corresponding pole part (3a – 3c).
2. Circuit breaker arrangement according to Claim 1,
15 **characterized in that** all pole parts (3a – 3c) are arranged one to another in a line formation.
3. Circuit breaker arrangement according to Claim 2,
20 **characterized in that** a common upward position of all cranks (8a – 8c) of the crankshaft (7) in the direction of the neighbouring pole parts (3a – 3c) causes a closed electrical switching position of all pole parts (3a – 3c).
4. Circuit breaker arrangement according to Claim 2,
25 **characterized in that** the closed electrical switching position is realized by a torsion angle of 180° of the crankshaft (7) from the closed electrical switching position.
5. Circuit breaker arrangement according to Claim 1,
characterized in that the common actuator unit (6) generates a rotary motion for pivotally operating the crankshaft (7).

6. Circuit breaker arrangement according to Claim 1,
characterized in that the crankshaft (7) rotates in the same direction for changing the electrical switching position.
- 5
7. Circuit breaker arrangement according to Claim 1,
characterized in that a rotating mass (9) is arranged on the crankshaft (7).
8. Circuit breaker arrangement according to Claim 7,
10 **characterized in that** the rotation mass (9) is positioned at one of the ends of the crankshaft (7) or in case of several pole parts (3) between two pole parts.
9. Circuit breaker arrangement according to Claim 1,
characterized in that the common actor (6) positioned at one of the ends of the
15 crankshaft (7), or in case of several pole parts (3) between two pole parts.
10. Circuit breaker arrangement according to Claim 1,
characterized in that the connection rod (9) consists of two symmetrically shaped parts (10a, 10b), wherein each part (10a, 10b) has a first semicircle opening (12a) for
20 pivotally attaching to the crank (7) and a second semicircle opening (12b) for pivotally attaching to the pushrod (5).
11. Circuit breaker arrangement according to Claim 10,
characterized in that both parts (10a, 10b) of the connection rod (9) are assembled by
25 at least one transverse screw connection (13).

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12. Circuit breaker arrangement according to Claim 10,
characterized in that both parts (10a, 10b) of the connection rod (9) are assembled by
a surrounding tensible belt (11).
- 5 13. Circuit breaker arrangement according to Claim 1,
characterized in that several bearing disks (14) are provided for pivot-mounting the
crankshaft (7) inside a housing (1).
- 10 14. Circuit breaker arrangement according to Claim 1,
characterized in that the housing (1) supports the pole parts (3a – 3c) mounted in line
on a common outer mounting surface (2).

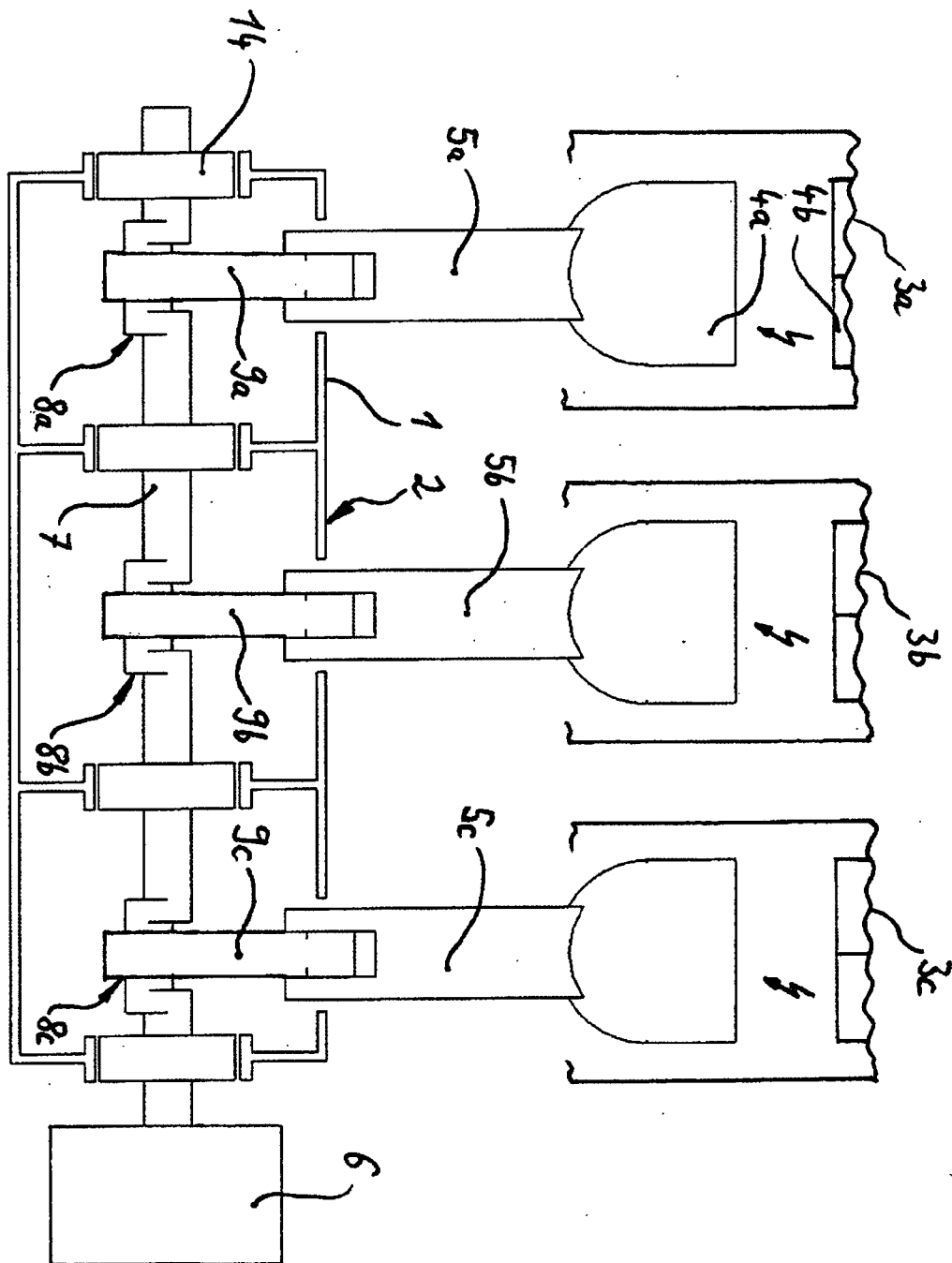
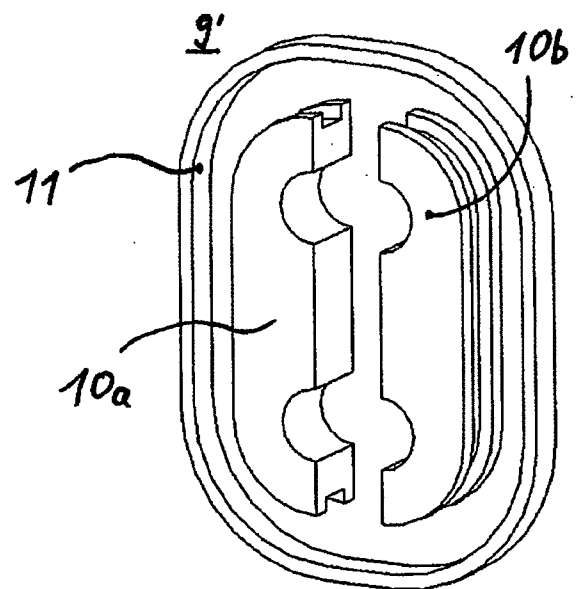
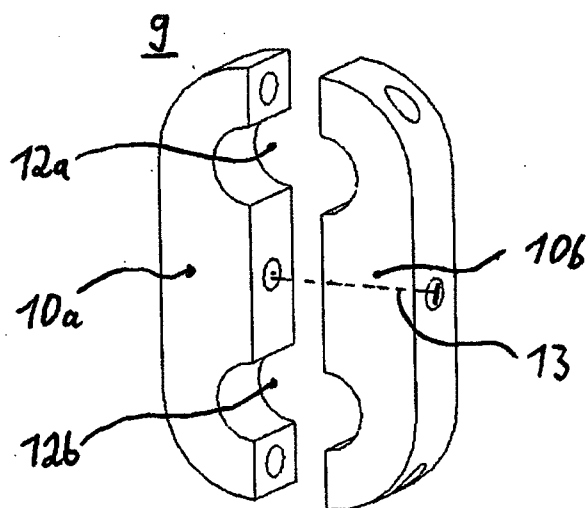
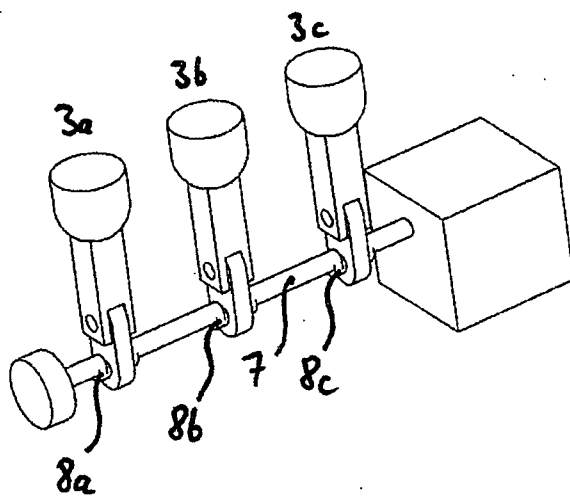
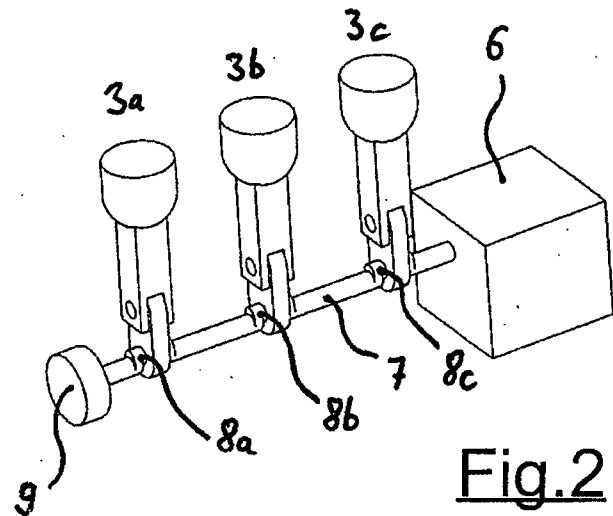


Fig.1



INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER

INV. H01H33/42 H01H3/42
ADD. H01H33/66 H01H9/56 H01H33/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H01H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 563 554 A (PERRENOUD BLAISE [CH]) 7 January 1986 (1986-01-07) column 2, lines 9-32; figures 1,5-8 -----	1,2,4,5, 9,13
X	DE 20 2008 004868 U1 (DRIESCHER SPEZIALFAB FRITZ [DE]) 12 June 2008 (2008-06-12) paragraphs [0029] - [0030]; figure 3 -----	1-5
X	DE 20 2006 005092 U1 (DRIESCHER SPEZIALFAB FRITZ [DE]) 20 July 2006 (2006-07-20) paragraphs [0012], [0022], [0028]; claim 8; figures 1-4 -----	1-5



Further documents are listed in the continuation of Box C.



See patent family annex.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2011/004060

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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