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(71) Applicant(s)
Asco Joucomatic SA

(72) Inventor(s)
Bunel, Patrick;Duffour, Thierry;Libet, Jacques

(74) Agent / Attorney
Davies Collison Cave, Level 15 1 Nicholson Street, MELBOURNE, VIC, 3000

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(71) Déposant *(pour tous les États désignés sauf US)* : **ASCO JOUCOMATIC SA** [FR/FR]; 32, avenue Albert 1er, F-92500 Rueil-malmaison (FR).

(72) Inventeurs; et

(75) Inventeurs/Déposants *(pour US seulement)* : **BUNEL, Patrick** [FR/FR]; 8, Impasse de la Tourette, F-28260 Sorel-Moussel (FR). **DUFFOUR, Thierry** [FR/FR]; 11, rue de Touraine, F-28300 Mainvillers (FR). **LIBET, Jacques** [FR/FR]; 4, allée Jacques Prévert, F-92500 Rueil-Malmaison (FR).

(74) Mandataires : **MICHARDIERE, Bernard** et al.; 3, avenue Bugeaud, F-75116 Paris (FR).

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(54) **Title** : DEVICE FOR CONTROLLING AN AIR CYLINDER

(54) **Titre** : DISPOSITIF DE COMMANDE D'UN VÉRIN PNEUMATIQUE

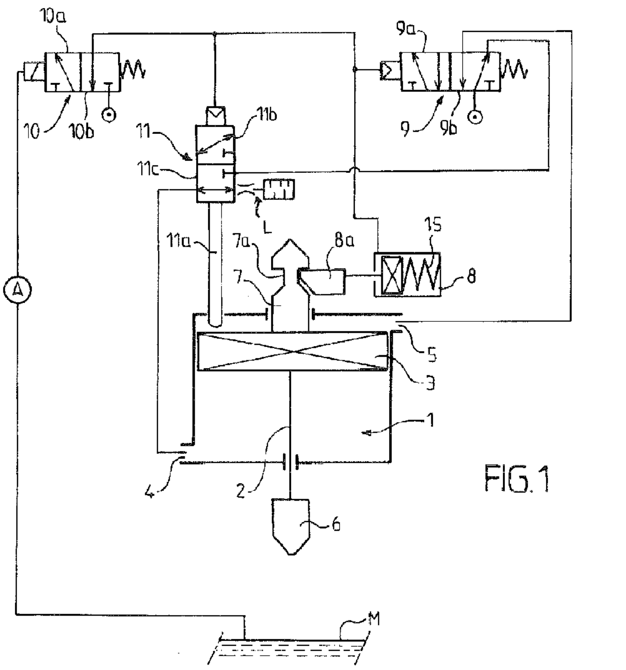

FIG.1

(57) **Abstract** : The invention relates to a device for controlling a crust breaker air cylinder (1), said device including a distributor (9) and a valve (11), the cylinder (1) being vertically arranged above the surface (M) of a molten metal, the shaft (2) of the cylinder (1) being provided with a wedge (6) that is arranged opposite the surface (M) of the metal, the device including a means (8) for mechanically locking the shaft (2, 3, 7) of the cylinder (1).

(57) **Abrégé** : Dispositif de commande d'un vérin pneumatique (1) briseur de croûte comprenant un distributeur (9) et une vanne (11), le vérin (1) étant disposé verticalement, au dessus de la surface (M) d'un métal en fusion, la tige (2) du vérin (1) équipée d'une pointerolle (6) étant disposée face à la surface (M) du métal, le dispositif comprenant un moyen de verrouillage mécanique (8) de la tige (2, 3, 7) du vérin (1).

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DEVICE FOR CONTROLLING AN AIR CYLINDER

The present invention relates to a device for controlling a pneumatic cylinder.

The context of the invention is that of the pneumatic automatic controls for the manufacturing industry and the method industries in particular for aluminum smelters.

The invention relates to a device for controlling a cylinder and more particularly a control device of a crust-breaking cylinder. Such crust-breaking cylinders are used in steel and aluminum plants so as to be able to break the superficial crust forming on the surface of a molten metal, the crust-breaking cylinder is then used to form a hole in this crust making it possible to incorporate additives. The forces used may be considerable, depending on the thickness and the rigidity of the crust formed; the same applies when the cylinder is raised again in order to "take off" the slag and residues stuck to the taper, which requires the use of a cylinder of large size. If the crust formed is thinner or more friable, the maximum breaking or cleaning force will not be reached. Consequently, the application of maximum pressure will not in this instance be necessary and a lesser pressure will allow a reduction in consumption and hence a considerable source energy saving.

AU 27128/84 describes such a control device using a 5/2 directional flow valve, a pressure-reducing valve and a 3/2 valve driven directly by a programmable industrial controller. A sensor is used to detect the end of the thrust and to inform the controller thereof.

Keeping such a cylinder permanently pressurized therefore causes very great consumption of resources notably in the event of leaks.

Embodiments of the present invention seek to provide a device for controlling a cylinder that makes it possible to achieve an energy saving notably by adapting the supply pressure to just the force necessary to break the crust and raise the cylinder while cleaning the taper.

According to the invention, there is provided a device for controlling a pneumatic crust-breaking cylinder comprising a directional flow valve and a valve, the cylinder being placed vertically above the surface of molten metal, the rod of the cylinder fitted with a taper being placed facing the surface of the metal, characterized in that it comprises a mechanical means for locking the rod of the cylinder allowing the cylinder rod to be held in the high position without the use of the pneumatic power, the controlling device being configured for placing the lower chamber of the cylinder at atmosphere when the cylinder rod arrives at the end of an ascending phase.

The mechanical locking means may comprise a bolt capable of interacting with a stopping means provided on a finger secured to the rod of the cylinder.

The stopping means may be a spline or a shoulder.

The bolt may comprise an orifice which the finger can enter.

Advantageously, the device also may comprise a valve fitted with a mechanical sensor.

The mechanical sensor may be a probe.

The probe may interact with an inclined surface provided on a trigger capable of interacting with the rod.

More advantageously, the device may be incorporated into the body of the cylinder.

The device may allow the supply pressure to be adapted to just the force necessary to break a resistance and raise the cylinder while breaking the possible friction forces of the application.

The device may comprise a means for detecting the low position of the rod by electrical contact between the taper and the metal.

The exhaust of the valve may comprise a flow limiter.

The drawings described herein are for illustration purposes only and are not intended to limit the scope of the present teachings.

Fig. 1 is a diagram of the connections of the elements of a device according to the invention.

Fig. 2 is a view from below of the bottom of a cylinder according to one embodiment of the invention.

Fig. 3 is a cross section along the line of Fig. 2 illustrating one embodiment of the locking device according to the invention.

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Fig. 4 is a cross section along the line IV-IV of Fig. 2 illustrating one embodiment according to the invention of a 3/2 valve and of its mechanical triggering finger, and

Fig. 5 is a view in perspective of the bottom of the cylinder of Fig. 2.

Throughout the following description of an embodiment of a device according to the invention, relative terms such as "upper", "lower", "front", "rear", "horizontal" and "vertical" are to be interpreted when the cylinder associated with the device D according to the invention is installed vertically, the taper being oriented downward, in an operating situation.

The control device is shown schematically in figure 1. It shows the cylinder 1 comprising a rod 2 secured to a piston 3. The cylinder comprises in the lower portion an orifice 4 and in the upper portion an orifice 5. The lower end of the rod 2 is secured to a taper 6. The upper portion of the piston 3 comprises a finger 7 furnished with a spline 7a. The spline 7a is capable of interacting with the bolt 8a moved by the spring 15 of a locking device 8.

The taper is above the surface M of the molten metal. The surface M of the molten metal is electrically connected to the control portion of an operating device 10 by means of a programmable controller A.

The control device also comprises a directional flow valve 9 of the 5/2 type. In the position shown in figure 1 in which the spool is in the position 9b, the delivery of pressure from the directional flow valve 9 supplies a 3/2 valve 11, while the orifice 5 of the cylinder 1 is connected to the exhaust of the directional flow valve 9. In the other position 9a of the directional flow valve 9, the delivery of pressure supplies the orifice 5, the orifice 4 being switched to exhaust.

The valve 11 is shown in a position in which the spool is again in a position 11c allowing the lower chamber of the cylinder 1 to be set to exhaust via the orifice 4.

The directional flow valve 9, the locking device 8 and the valve 11 are controlled by the operating device 10. The cylinder is then at rest in the high position.

The operating device is shown in fig. 1 with its spool in a position 10b in which the delivery of pressure is blocked while the duct to the locking device 8, the directional flow valve 9 and the valve 11 is set to exhaust. In another position 10a, the duct to the locking device 8, the directional flow valve 9 and the valve 11 is connected to the pressure inlet.

Nevertheless, the valve 11 can also be operated mechanically by means of a probe 11a. Specifically, the operating device 10 makes it possible to cause the spool of the valve 11 to descend but the probe 11a is capable, in contact with the piston 3, to control the raising of the spool of the valve 11.

In Fig. 1, the piston 3 is shown at the end of the upstroke and thereby actuates the probe 11a causing the spool of the valve 11 to move toward the position 11c. In the position 11c, the orifice 4 is connected to the exhaust of the valve 11 and the pressure originating from the directional flow valve 9 is blocked.

The operation takes place in the following manner.

In the rest position, there is no pressure in the chambers of the cylinder. The switching on of the operating device 10 and the passage of its spool to position 10a has as a consequence:

a) the unlocking of the locking device 8 by the delivery of pressure and the compression of the spring 15; here, it should be noted that the device is designed so that this unlocking takes priority, the conveying channels incorporated in the bottom of the cylinder 1 are therefore designed specially in order to allow this priority operation. The unlocking causes the rod 2 and the taper 6 to descend under the action of their own weight;

b) the spool of the directional flow valve 9 moves to position 9a which allows the pressurization of the upper chamber of the cylinder 1 via the orifice 5. The cylinder 1 is exhausted through the valve 11, of which the spool moves to position 11b, connected to the atmosphere via the directional flow valve 9;

c) the rod 2 and the taper 6 therefore continue their descent under pressure; in this case, as the lower chamber is subjected to only atmospheric pressure, the pressure in the upper chamber is extremely low.

Secondly, when the taper 6 comes into contact with the molten aluminum M, the cylinder in contact with the aluminum behaves like an electrical contact. Specifically, the cylinder 1 is made so that there is electrical continuity between the taper 6 and the rear bottom of the cylinder. Accordingly, a metal bearing, not shown, is used and, when the taper 6 makes contact with the aluminum M, an electric signal can supply a programmable controller A and cause the operating device 10 to be switched off and to travel to position 10b.

This travel to position 10b causes the change of state of the directional flow valve 9 to position 9b and the locking device 8 to be idled. The locking device 8 therefore returns to the locked position in which the bolt 8a comes out under the action of the spring 15. The valve 11 remains in position 11b.

The orifice 4 is then connected to the supply of the directional flow valve 9 through the valve 11. The rod 2 and the taper 6 then begin to rise again.

In this case, since the upper chamber of the cylinder is subjected to only a low pressure, the pressure in the lower chamber is low. At the upper end of travel, the upper portion of the finger 7 retracts the bolt 8a because of its shape. This allows the bolt 8a to interact with the spline 7a and blocks the rod of the cylinder.

Moreover, the piston 3 causes the probe 11a to retract. When arriving at the top, during the rising, the piston 3 and the rod 7 travel slightly beyond the triggering of the bolt 8a in order to ensure the complete tilting of the valve 11 in the position 11c. This change of state causes the lower chamber of the breaking cylinder to be placed at atmosphere.

Then the piston 3 and the rod 7 descend slightly for the coupling of the bolt which takes place without impact because a flow limiter L provided on the exhaust prevents a sudden descent of the piston 3 until the spline 7a butts against the bolt.

The system is now stable without pressure and ready for the next maneuver.

Advantageously, the control device may be incorporated into the cylinder 1. Figures 2 to 5 illustrate an embodiment of the bottom of the cylinder 1 modified to accommodate the control device according to the invention.

In such a case, embodiments respectively of the locking device 8 and of the valve 9 are illustrated in Fig. 3 and Fig. 4.

Fig. 3 shows the finger 7, mounted so as to slide in a housing 13 provided in the bottom of the cylinder 1, which comprises a thread in its upper portion allowing it to be attached to the piston 3. The lower portion of the finger 7 comprises a shoulder 7b which serves as a stopping means.

The bolt 8a is made in the form of a spool guided in translation, at right angles to the direction of movement of the finger 7, in a second housing 14 provided in the bottom of the cylinder 1 and made in the form of a blind cylindrical orifice.

A spring 15 is interposed between the wall of the housing 14 and the bolt 8a while the housing 14 is closed by a plug 16. A pin 17 secured to the plug 16 and mounted so as to slide in the bolt 8a prevents the bolt 8a from rotating.

The bolt 8a comprises an orifice 8b which the finger 7 can enter. The orifice 8b has an inner lip 8c capable of interacting with the shoulder 7b.

Fig. 4 shows the valve 11 incorporated into the bottom of the cylinder 1. The spool 20 of the valve 11 and the probe 11a are mounted so as to slide in a housing provided in the bottom of the cylinder 1 and closed by a plug 21. The probe in this instance is not in direct contact with the piston 3.

A trigger 12 is installed in a housing provided in the bottom of the cylinder 1 and closed by a plug 19 comprising an orifice allowing one end of the trigger 12 to pass through. A spring 18 applies a force to the trigger 12 tending to hold the trigger 12 against the plug 19 so that the end of the trigger 12 protrudes slightly beyond the plug 19. The movement of the trigger is a movement in translation along an axis parallel to the direction of movement of the piston 3.

The trigger 12 comprises an inclined surface 12a capable of interacting with the rounded end of the probe 11a. In this manner, when the piston 3 comes into contact with the end of the trigger 12 and causes the trigger 12 to move into its housing, the surface 12a applies a force to the probe 11a which causes the spool 20 of the valve 11 to move.

This mechanism therefore allows the detection of the arrival of the piston 3 in the high position and thus causes the change of state of the valve 11 and takes the pressure off the inlet 4 of the piston 1.

This therefore shows the value of this device which makes it possible to avoid the system being kept pressurized outside the operating phases. In order to avoid any rise in pressure, the exhaust of the cylinder 1 is oversized. In the same manner, the delivery of pressure comprises a low flow so as to prevent too great a pressure rise in the drive chambers. In this manner, it is possible to achieve full pressure in approximately 7 s. The maximum pressure is approximately 7 bar. Nevertheless, during raising and depending on the degree of soiling of the taper, this pressure is often not necessary. Specifically, 1 bar is sufficient to raise the cylinder taking account of the weight coupled to the rod. In the descent phase, the pressure rise occurs only if the resistance of the crust requires it.

The invention has been described by way of non-limiting example only and many modifications and variations may be made thereto without departing from the spirit and scope of the invention.

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Throughout this specification and the claims which follow, unless the context requires otherwise, the word "comprise", and variations such as "comprises" and "comprising", will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

The reference in this specification to any prior publication (or information derived from it), or to any matter which is known, is not, and should not be taken as an acknowledgment or admission or any form of suggestion that that prior publication (or information derived from it) or known matter forms part of the common general knowledge in the field of endeavour to which this specification relates.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A device for controlling a pneumatic crust-breaking cylinder comprising a directional flow valve and a valve, the cylinder being placed vertically above the surface of molten metal, the rod of the cylinder fitted with a taper being placed facing the surface of the metal, comprising a mechanical means for locking the rod of the cylinder allowing the cylinder rod to be held in the high position without the use of the pneumatic power, the controlling device being configured for placing the lower chamber of the cylinder at atmosphere when the cylinder rod arrives at the end of an ascending phase.

2. The device as claimed in claim 1, wherein the mechanical locking means comprises a bolt capable of interacting with a stopping means provided on a finger secured to the rod of the cylinder.

3. The device as claimed in claim 2, wherein the stopping means is a spline or a shoulder.

4. The device as claimed in claim 2 or 3, wherein the bolt comprises an orifice which the finger can enter.

5. The device as claimed in any one of claims 1 to 4, wherein it also comprises a valve fitted with a mechanical sensor.

6. The device as claimed in claim 5, wherein the mechanical sensor is a probe.

7. The device as claimed in claim 6, wherein the probe interacts with an inclined surface provided on a trigger capable of interacting with the rod.

8. The device as claimed in any one of the preceding claims, wherein the device is incorporated into the body of the cylinder.

9. The device as claimed in any one of the preceding claims, wherein the device allows the supply pressure to be adapted to just the force necessary to break a resistance and raise the cylinder while breaking the possible friction forces of the application.

10. The device as claimed in any one of the preceding claims, wherein it comprises a means for detecting the low position of the rod by electrical contact between the taper and the metal.

11. The device as claimed in any one of the preceding claims, wherein the exhaust of the valve comprises a flow limiter.

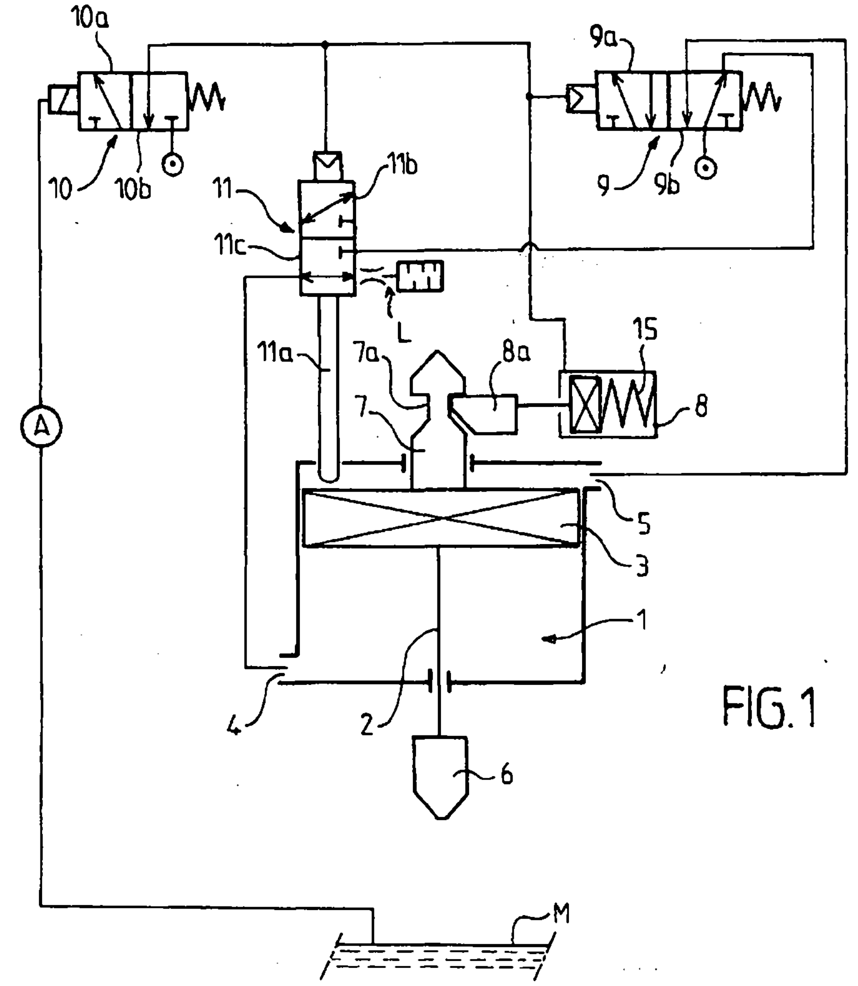

FIG.1

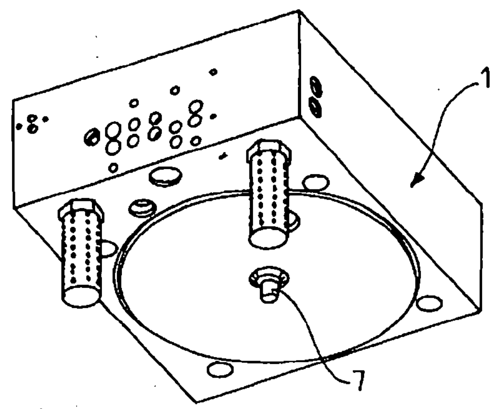

FIG.5

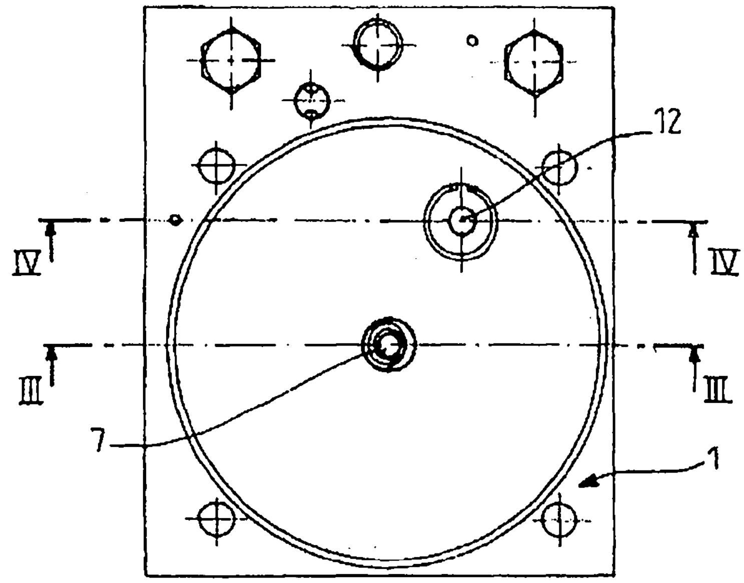

FIG.2

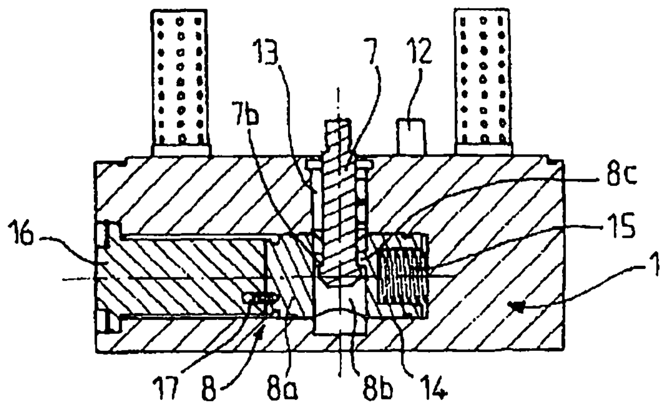

FIG.3

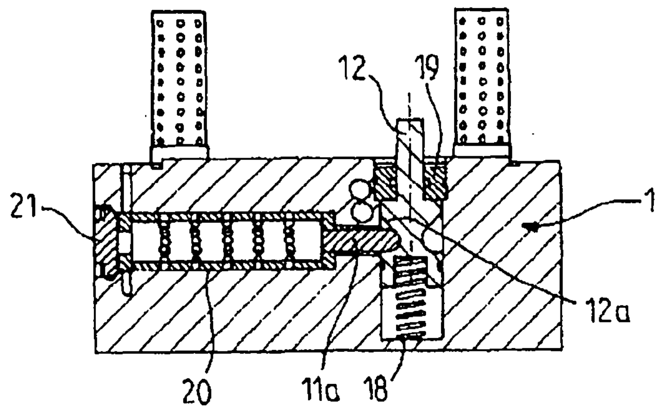

FIG.4