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(54) An assembly for grinding sheets of glass

(57) An assembly (6) for grinding sheets (2) of glass, in which a grinding head (9) is movable towards and away from a sheet (2) to be worked under the action of a hydropneumatic actuator (15) activated by a control system (15a) having a pneumatic circuit (27) for delivering compressed air into a first chamber (20) of the actuator (15) thereby moving the head (9) into an advanced grinding position; the hydraulic circuit (22) having a pressurised reservoir (23) and a shut-off valve (25) which can be switched pneumatically so as to cut off the second chamber (21) from the reservoir (23) and thereby hold the head (9) in a fixed position.

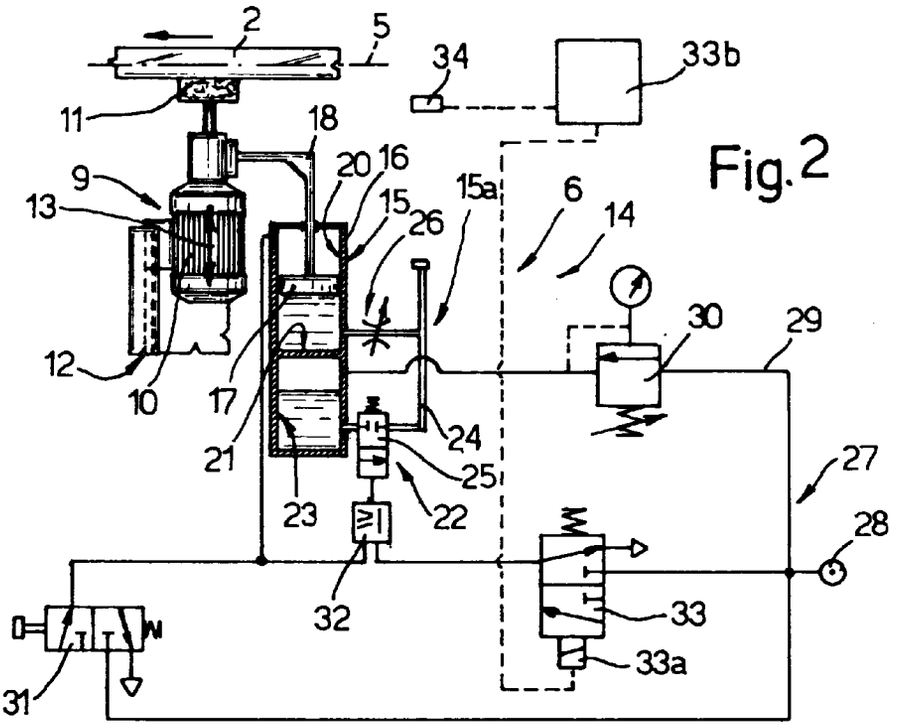

Fig. 2

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Description

The present invention relates to an assembly for grinding sheets of glass.

The invention may be applied particularly, though not exclusively, in the field of polishing semi-finished sheets of glass and the following description will refer explicitly thereto, without thereby limiting the generality of the invention.

For finishing sheets of glass, the glass industry currently uses plants which, in most cases, comprise grinding equipment which in turn includes a conveyor for advancing a succession of sheets of glass along a grinding path, a plurality of fixed grinding wheels arranged along the path for rough grinding and finishing the sheets, and one or more polishing assemblies also arranged along the grinding path for polishing the surfaces worked by the fixed grinding wheels.

In general, each of the polishing assemblies includes a grinding head with a respective grinding wheel and equipment for driving and controlling the grinding head which in turn includes a pneumatic linear actuator for moving the grinding head towards and away from a sheet to be worked and a pneumatic circuit for controlling the linear actuator itself.

In prior art grinding equipment of the type described above, it is vital to keep the said grinding heads in a specific predetermined waiting position during the periods of time between the end of polishing of one sheet and the start of polishing of the next one.

For this reason, prior art grinding equipment includes a brake for each polishing assembly, the brake having a pad of high-friction material urged against the associated head by resilient elements, usually springs, so as to clamp the head in the said waiting position. During a polishing step, the brake is disengaged pneumatically and the pad is held in a rest position spaced from the associated grinding head.

Prior art grinding equipment of the type described above, although used, has several disadvantages, all connected with the design of the drive and control assemblies for the grinding heads.

In each of these assembles the respective head is driven by a pneumatic actuator which is not normally able to urge the grinder against the sheet with the desired degree of constancy or, therefore, the desired contact pressure between the grinder and the sheet being worked.

The above is due essentially to the fact that, owing to the relatively heavy weight of the grinding heads and the compressibility of air, in order to avoid discontinuous or jerky movements of the grinding heads, the actuator must be supplied with a greater pressure than is required to provide the desired contact pressure between the grinding head and the sheet being worked.

In addition, during the polishing of the sheet, the actuator, again due to the compressibility of air, is unable to resist changes in the characteristics of the cutting forces acting mutually between the grinding head and the sheet, with the result that the grinding head is made to oscillate in the direction of movement of the head itself; naturally the finish of the polished surface and the geometry of the surface depend on the frequency and amplitude of this oscillation and, in many cases, the surface of the sheet is wavy.

Each of these assemblies also has a brake which is activated by resilient elements and the braking action varies in dependence on the degree of wear of its moving parts and on variations in the resilience of the resilient elements themselves.

For these reasons, prior art equipment requires constant maintenance and the periodic replacement of the brakes, thereby increasing costs considerably since grinding equipment normally includes a large number of polishing assemblies.

The object of the present invention is to provide an assembly for grinding sheets of glass which provides a simple solution to the problems outlined above and is at the same time both easy and inexpensive to produce.

Accordingly, the present invention provides as assembly for grinding sheets of glass which includes at least one grinding head and equipment for driving and controlling this head, the drive equipment including a linear actuator coupled to the grinding head for moving it towards and away from a working position and means for activating the actuator, characterised in that the actuator is a hydropneumatic actuator including a piston connected to the grinding head, a first variable-volume chamber for compressed air and a second variable-volume chamber for containing a quantity of pressurised oil which acts on the piston in use to advance the grinding head into its advanced working position; the activating means including means for supplying pressurised oil, a duct connecting the supply means to the second chamber, shut-off means arranged in the duct, and control means for displacing the shut-off means between a first operative position, in which the shut-off means disconnect the second chamber hydraulically from the supply means, and a second operative position in which the shut-off means enable oil to flow freely through the duct.

The invention will now be described with reference to the appended drawings which illustrate a non-limitative example thereof, and in which:

Figure 1 is a schematic illustration, with parts removed for clarity, of equipment for finishing glass sheets and having a plurality of polishing assemblies according to the present invention;
Figure 2 is a schematic illustration of a preferred embodiment of the polishing assemblies according to the present invention shown in Figure 1; and
Figure 3 is a schematic illustration of a variant of the polishing assembly of Figure 2.

In Figure 1, equipment for grinding sheets 2 of glass is generally indicated 1. The equipment 1 includes a support framework 3, a known conveyor 4 connected to the framework 3 for advancing a succession of sheets 2 of

glass, standing on their edges, along a rectilinear grinding path 5, a first plurality of fixed grinding wheels, known and therefore not shown, arranged along the path 5, and a second plurality of polishing assemblies 6 also arranged along the path 5 for polishing the surfaces of sheets 2 ground by the fixed wheels (not shown).

More particularly, the conveyor 4 includes two endless belts 7 which pass around a pair of motor-driven rollers 8 carried by the framework 3 with respective delivery passes facing each other and parallel both to each other and to the path 5.

With reference to Figure 1 and, especially, to Figure 2, each assembly 6 includes a grinding head 9 located beneath the conveyor 4 and in turn including an electric motor 10, and a grinding wheel 11 keyed to the output shaft of the electric motor 10. Alternatively, in a variant which is not illustrated, the grinding head 9 can include, in addition to the electric motor 10, a reduction gear assembly, for example of the belt type, the input shaft of which is connected in known manner to the output shaft of the motor 10 and the output shaft of which is keyed to the grinding wheel 11.

Each assembly 6 also includes a guide and slide unit 12 for guiding the head 9 towards and away from a sheet to be polished in a substantially vertical direction 13, and equipment 14 for driving and controlling the head 9.

The equipment 14 includes a hydropneumatic linear actuator which in turn comprises a cylinder 16 and a piston head 17 which is securely fixed to the respective grinding head 9 by its rod 18 and is housed in the cylinder 16 which it divides internally into two variable-volume chambers, indicated 20 and 21.

The equipment 14 also includes a system 15a for activating the actuator 15 which comprises in turn an hydraulic circuit 22. The circuit 22 includes a reservoir 23 of pressurised oil, a duct 24 connecting the reservoir 23 to the chamber 21 and a monostable, oleodynamic slide valve 25 connected into the duct 24, this being of the two-way, two-position type which is normally closed. Alternatively, in an embodiment not illustrated, the valve 25 is an obturator valve with two working positions. When in a first working position, specifically in its closed position, the valve 25 completely closes the duct 24 and isolates the chamber 21 hydraulically from the tank 23 while in its second working position, that is open, it allows oil to flow through the duct 24. Finally, the circuit 22 includes a regulable throttle 26 arranged, in the embodiment described, in a portion of the duct 24 between the chamber 21 and the valve 25 and operable, in use, to reduce the section of the duct 24 and, together with the actuator 15 and that portion of the duct between the actuator 15 and the throttle 26, to define an adjustable damper for the head 9.

With reference still to Figure 2, the system 15a further includes a pneumatic circuit 27 connected to a known source 28 of compressed air for enabling the chamber 20 and the tank 23 to be pressurised in use and for controlling the valve 25.

In particular, the circuit 27 includes a first line or branch 29 connecting the tank 23 to the source 28 and including a valve 30 for regulating the pressure in the tank 23 and, as a result, the force with which the grinding wheel 11 is urged against the sheets 2 to be polished. The circuit 27 also includes a three-way, two position bistable pneumatic valve 31 which can be operated, in this example manually by an operator, to move the grinding wheel 11 away from the path 5 of advance of the sheets 2. The inlet of the valve 31 is connected to the source 28 while its outlet is connected both to the chamber 20 and to a first inlet of a known "OR" element 32 the outlet of which is connected to the valve 25 to control the opening of the valve 25 itself.

Finally, the circuit 27 includes a further monostable, three-way, pneumatic valve 33 with two working positions, an inlet of which is connected to the source 28 and an outlet of which is connected to a second inlet of the "OR" element 32. The valve 33 can be switched by an associated known electric actuator 33a, itself controlled by a known control unit 33b, to cause the slide of the valve 33 to move in response to a presence signal transmitted in known manner to the control unit 33b from a sensor 34 arranged, preferably along the path 5, to detect the presence of a sheet 2 to be worked near the associated grinding wheel 11.

The operation of the equipment 1 will now be described with reference, for the sake of simplicity, to only one grinding head 9, starting from the condition in which a single sheet 2 to be worked is advanced by the conveyor 4 towards the head 9, the valve 25 being in its closed position and the valves 31 and 33 being arranged so that the chamber 20 and the element 32 are cut off from the source 28 while the head 9 is held in is rest position solely by the action of the pressurised oil trapped in the chamber 21.

Starting from this condition, as soon as a sheet 2 approaches the grinding wheel 11 of the head 9 under consideration, the sensor 34 detects the presence of this sheet 2 and sends a presence signal to the control unit 33b which in turn activates the actuator 33a which, in response, switches the valve 33. The switching of the valve 33 causes a pressure signal to be sent to the element 32 and the immediate switching of the valve 25 to its open position, in which it is maintained. At this point, the chamber 21 communicates directly with the pressurised reservoir 23 and the oil which flows into the chamber 21 moves the piston 17 and thereby urges the wheel 11 against the sheet 2 which has, in the meantime, reached a position opposite this wheel, with a predetermined substantially constant force which can be regulated by variation of the pressure in the reservoir 23 by means of the regulating valve 30.

The condition just described lasts for the duration of the polishing of the sheet 2, that is, until the sensor 34 no longer detects the presence of the sheet 2 and stops the signal, the absence of the signal causing the slide of the valve 33 to be returned to its original position by the resilient means of the valve itself.

At any moment during the polishing of the sheet 2, or during a waiting period between the completion of work on one sheet 2 and the start of work on the next, the head 9 can be moved into its withdrawn, rest position by manual operation of the valve 31. As a result of manual switching of the valve 31, a control signal is sent to the "OR" element 32 which switches the valve 25 to its open position if it is closed, so that the chamber 20 is pressurised and causes the piston 17 to withdraw so that the grinding wheel 11 is moved away from the grinding path 5.

The variant illustrated in Figure 3 relates to a polishing assembly 36 which is similar to the assembly 6 and has parts indicated, where possible, by the same reference members as those of the corresponding parts of the assembly 6. The assembly 36 is particularly suitable for use in cases where the grinding wheel 11 is arranged at a level above the surface of the sheet 2 to be worked and below the motor 10 whereby, if it were not controlled, the head 9 would move axially towards the path 5 under its own weight. The assembly 36 can also be used to advantage to drive and control rough- finishing wheels and, more generally, in all cases in which the grinding head 9 needs to be held constantly in the same working position.

The assembly 36 differs from the assembly 6 in that, in the circuit 27, the valve 33 is replaced by a monostable, five-way, two-position, valve 37 having an inlet connected to a first inlet of the "OR" element 32, the second inlet of which is connected to the outlet of the valve 31. The valve 37 also has a second outlet connected to a first inlet of an additional known "OR" element 38, arranged between the valve 31 and the chamber 20, as well as a second inlet also connected to the outlet of the valve 31 itself.

The assembly 36 also differs from the assembly 6 in that it includes an absorption sensor 39 arranged in a supply line for the motor 10 for detecting the power absorbed by the motor 10, this sensor being connected electrically to the control unit 33b.

In use, if the grinding head 9 is a polishing head, the assembly 36 operates in the manner described for the assembly 6, the only difference being that, when the valve 25 is switched to its closed position, the valve 37 pressurises the chamber 20 through the element 38.

In this way, the piston 17 is held in a fixed axial position by the oil trapped in the chamber 21 and by the action of the compressed air in the chamber 20, whereby the head 9 remains perfectly static despite the axial force exerted on the head by its own weight.

If, on the other hand, the head 9 is either a rough-grinding, semi-finishing or finishing head, that is, in general a grinding head that must be held in a strictly fixed working position relative to the path 5, during a step of setting the position of the assembly 36, the valve 37 is controlled by the control unit 33b to displace the valve 25 into its open position to move the grinding head 9 into its working position. Once in this position, the valve 37 once again switches the valve 25 into its closed position thereby restoring the first condition described, with the piston 17 held in an axially fixed position and the head 9 held in its working position; the sheets 2 are then advanced in succession to be ground by the head 9.

During the grinding operation, the sensor 39 and the control unit 33b control the valve 37 and thus the valve 25 so as to compensate for wear of the head 9.

In particular, the sensor 39 detects the magnitude of the current taken, or absorbed, by the motor 10 and sends the unit 33b a signal proportional to this value. The control unit 33b, in a block 42, compares the absorption value detected with a lower threshold value memorised in the block 42 corresponding to an acceptable limit of wear of the head 9 and, when the value detected becomes equal to this lower threshold value, that is, the head 9 has reached this acceptable wear limit, the control unit 33b activates the actuator 33a and switches the valve 25 to its open position by means of the valve 37.

The switching of the valve 25 causes oil to flow from the reservoir 23 into the chamber 21, thereby moving the grinding head 9 towards the path 5. During this movement, the sensor 39 continues to send a signal proportional to the value of current absorbed by the motor 10 to the control unit 33b which compares this detected value with an upper threshold signal, again memorised in the block 42, and, when the detected signal reaches the upper threshold value, activates the actuator 33a to switch the valve 25 back to its closed position. In this way, the head is moved progressively towards the path 5 during the working of the sheets 2 so as to compensate for wear of the head 9 itself.

It is clear from the above that the assemblies 6 and 36 described are not only highly reliable and effective in use but this reliability is maintained over time.

In fact, each assembly 6, 36 enables its grinding wheel 11 to be kept constantly in the same position relative to the sheets 2, or to the path 5, since the positioning means consist of a hydraulic fluid which is virtually incompressible and is thus able to provide a substantially rigid fixed stop for the head 9 when this is in its waiting/working position.

As regards the urging of the grinding wheels 11 against the sheets 2 to be worked, in each assembly 6, 36 this is achieved by means of a hydropneumatic control system designed so that the pressure between the surface of the wheel 11 and the sheet 2 being worked can be adjusted extremely accurately and the pressure set can be kept constant despite the gradual wear of the wheel 11 itself.

In addition, the characteristics of the hydropneumatic system enable it to counter any variation in the mutually-acting cutting forces between the wheel 11 and the sheet 2 in use in an effective and regulable manner. In fact during work on a sheet 2, it is possible, by means of the throttle, to hold the head 9 in a substantially fixed position or, at any rate, in a state of oscillation which is acceptable both as regards the surface finish and the geometry of the worked surface.

It is therefore clear from the above that, due to the use of a substantially incompressible fluid and the absence of mechanical control parts whose reliability and effectiveness depends on their degree of wear, the assemblies 6, 36 described enable all the sheets 2 advanced along the path 5 to be polished with the same geometric and dimensional precision.

It is also clear from the above that the use of the assemblies 6, 36 described enables maintenance of the machine 1 to be reduced drastically, and that the polishing assemblies 6 and 36 described can be substituted for prior art polishing assemblies extremely easily, without altering the basic structure of the equipment and without the need to call in highly specialised personnel.

Finally it is clear from the above that modifications and variations may be made to the assemblies 6, 36 described without thereby departing from the protective scope of the present invention. In particular, the valves 25, 31, 33 and 37 can be replaced by valves of other types while each assembly 6, 36 may include more than one grinding head 9 and each head 9 may be controlled by more than one linear actuator 15.

In addition, the unit 12 in the assemblies 6, 36, can be replaced by a different guide system which enables the position of the direction 13 along which the head 9 is movable relative to the sheet 2 to be worked to be adjusted.

Finally, the control unit 33b of the assemblies 6, 36 may be connected to a control unit (not shown) of the equipment 1 so as to make the latter fully automatic.

Lastly, it is clear that the heads 9 of the assemblies 6, 36 described can be fitted with wheels of any type, including ones for rough-grinding, semi-finishing and finishing of the sheets 2.

Claims

1. An assembly (6; 36) for grinding sheets (2) of glass which includes at least one grinding head (9) and equipment (14) for driving and controlling this head (9), the drive equipment (14) including a linear actuator (15) coupled to the grinding head (9) for moving the head (9) towards and away from a working position, and means (15a) for activating the actuator (15), characterised in that the actuator (15) is a hydropneumatic actuator including a piston (17) connected to the grinding head (9), a first variable-volume chamber (20) for pressurised air and a second variable-volume chamber (21) for containing a quantity of pressurised oil which acts on the piston (17) in use to advance the grinding head (9) into its advanced working position; the activating means (15a) including means (22) for supplying pressurised oil, a duct (24) connecting the supply means to the second chamber (21), shut-off means (25) arranged in the duct (24) and control means (31, 32) (32, 33; 32, 37) for displacing the shut-off means (25) between a first operative position, in which the shut-off means (25) disconnect the second chamber (21) hydraulically from the supply means (23), and a second operative position in which the shut-off means (25) allow oil to flow freely through the duct (24).

2. An assembly according to Claim 1, characterised in that the supply means comprise a reservoir (23) for containing a quantity of oil and means (28, 30) for pressurising the reservoir (23).

3. An assembly according to Claim 2, characterised in that the pressurising means (28, 30) are pneumatic means and include means (30) for regulating the pressure in the reservoir (23).

4. An assembly according to any one of the preceding claims, characterised in that it also includes throttle means (26) arranged in the duct (24) for narrowing a portion of this duct (24).

5. An assembly according to Claim 4, characterised in that the throttle means (26) can be regulated to vary the extent to which the portion of the duct (24) is narrowed.

6. An assembly according to any one of the preceding claims, characterised in that the control means (31, 32) (32, 33; 32, 37) are pneumatic control means.

7. An assembly according to Claim 6, characterised in that it includes sensor means (34) for transmitting a signal indicating the presence of a sheet (2) of glass to be worked, and in that the control means include first pneumatic valve means (32, 33; 32, 37) for connection to a source (28) of pressurised air and connected to the shut-off means (25) for switching the shut-off means (25) to their second operative position in response to the signal indicating the presence of the sheet (2).

8. An assembly according to Claim 7, characterised in that the control means (31, 32) further include second pneumatic valve means (31, 32) for connection to the source of pressurised air and connected to the first chamber (20) and to the shut-off means (25) so as, in use, to direct pressurised air into the first chamber (20) while, at the same time, moving the shut-off means (25) to their first operative position.

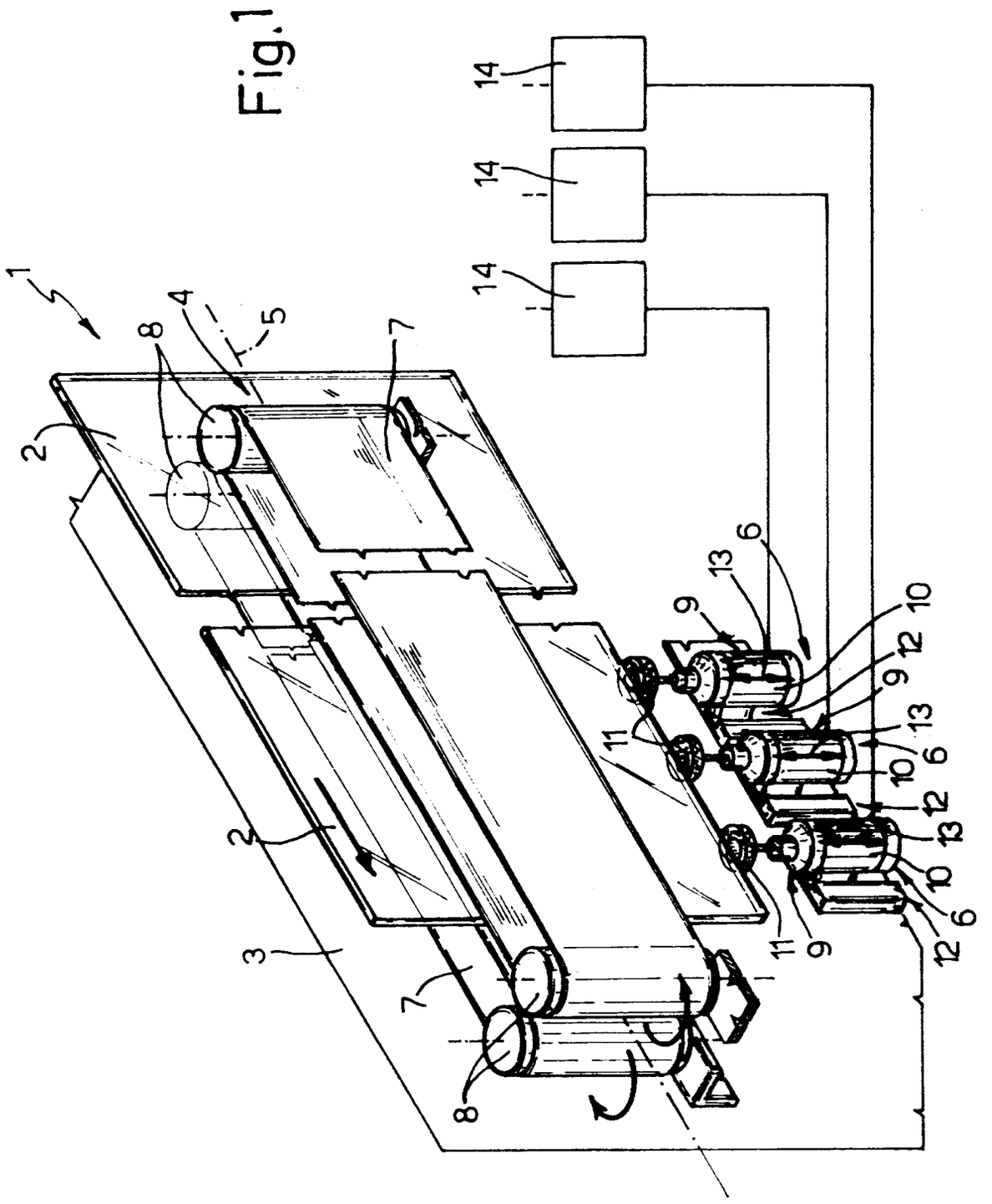
9. An assembly according to any one of the preceding claims, characterised in that it includes sensor means (34) for transmitting a signal indicating the presence of a sheet (2) of glass to be worked, and in that the control means further include third pneumatic valve means (37, 38) for connection to a source (28) of pressurised air and connected to the first chamber (20) so as to pressurise this chamber (20) when there is no presence signal.

10. An assembly according to any one of the preceding claims, characterized in that the grinding head (9) incudes an electric motor (10) and in that it includes means (33b, 39) for controlling the control means (32, 37); these control means (33b, 39) including further sensor means (39) for detecting the power absorption of the motor (10), memory means (41) for storing first and second threshold values of this absorption, means (42) for comparing the value detected with the threshold values and for transmitting a correction signal and piloting means (39) for piloting the control moans (32, 37) according to this correction signal.

11. An assembly according to any one of the preceding claims, characterised in that the shut-off means include a valve (25) with two operative positions.

12. Equipment (1) for grinding sheets of glass including conveyor means (4) for advancing a succession of sheets (2) of a glass along a grinding path (5) and at least one grinding assembly (6) arranged along this path (5), characterized in that the grinding assembly (6) is formed in accordance with any one of the preceding claims.

Fig.1



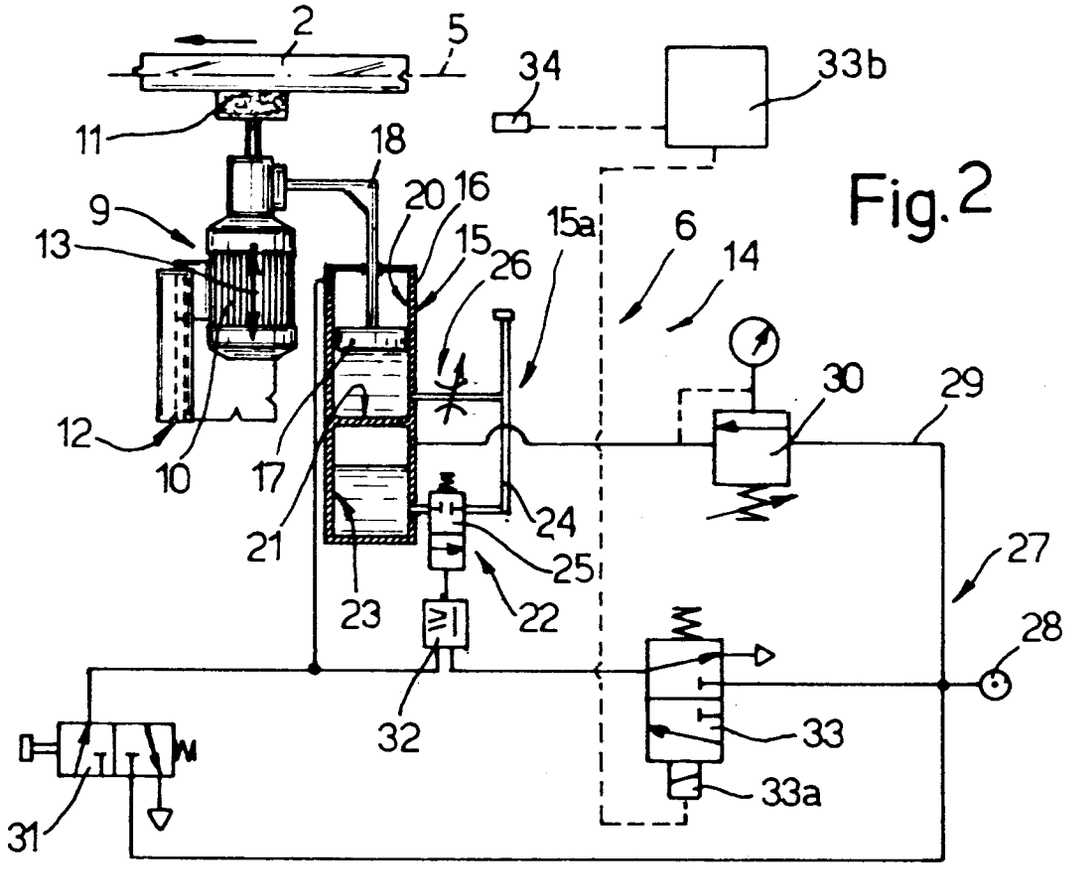

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Fig.2

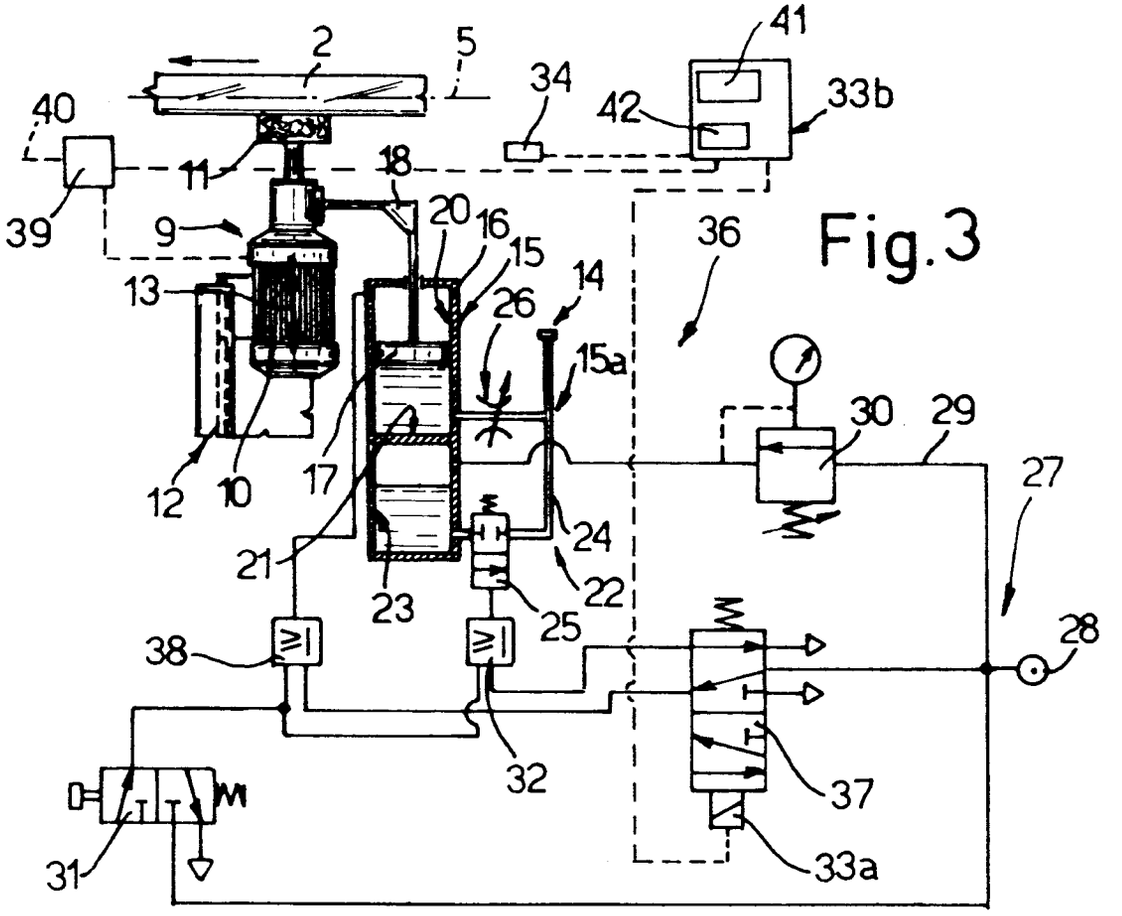
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Fig.3

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EUROPEAN SEARCH REPORT

Application Number
EP 95 10 9960

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.6)
A	FR-A-2 199 277 (RAUTENSTRAUCH MARTIN) 5 April 1974 * page 6, line 19 - page 8, line 27; figure *	1,12	B24B9/10 B24B47/20 B24B49/08
A	FR-A-2 522 568 (SACK GLASTECH) 9 September 1983 * page 8, line 28 - page 9, line 7; claims 29,30; figure 1 *	1,12	
A	GB-A-2 021 993 (BREDA TERMOMECCANICA SPA) 12 December 1979 * page 2, line 55 - line 90; figure 9 *	1	
A	FR-A-2 091 125 (LIBBEY-OWENS-FORD CO.) 14 January 1972 * claims *	1	
A	FR-A-2 413 181 (CLICHY CONST SA) 27 July 1979 * claim; figure *	1	TECHNICAL FIELDS SEARCHED (Int.Cl.6)
A	US-A-5 146 715 (BANDO SHIGERU) 15 September 1992 * abstract *	1	B24B
A	US-A-4 375 141 (GAETANO RIGHETTI) 1 March 1983 * abstract *	1	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	9 October 1995	Eschbach, D

CATEGORY OF CITED DOCUMENTS

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