

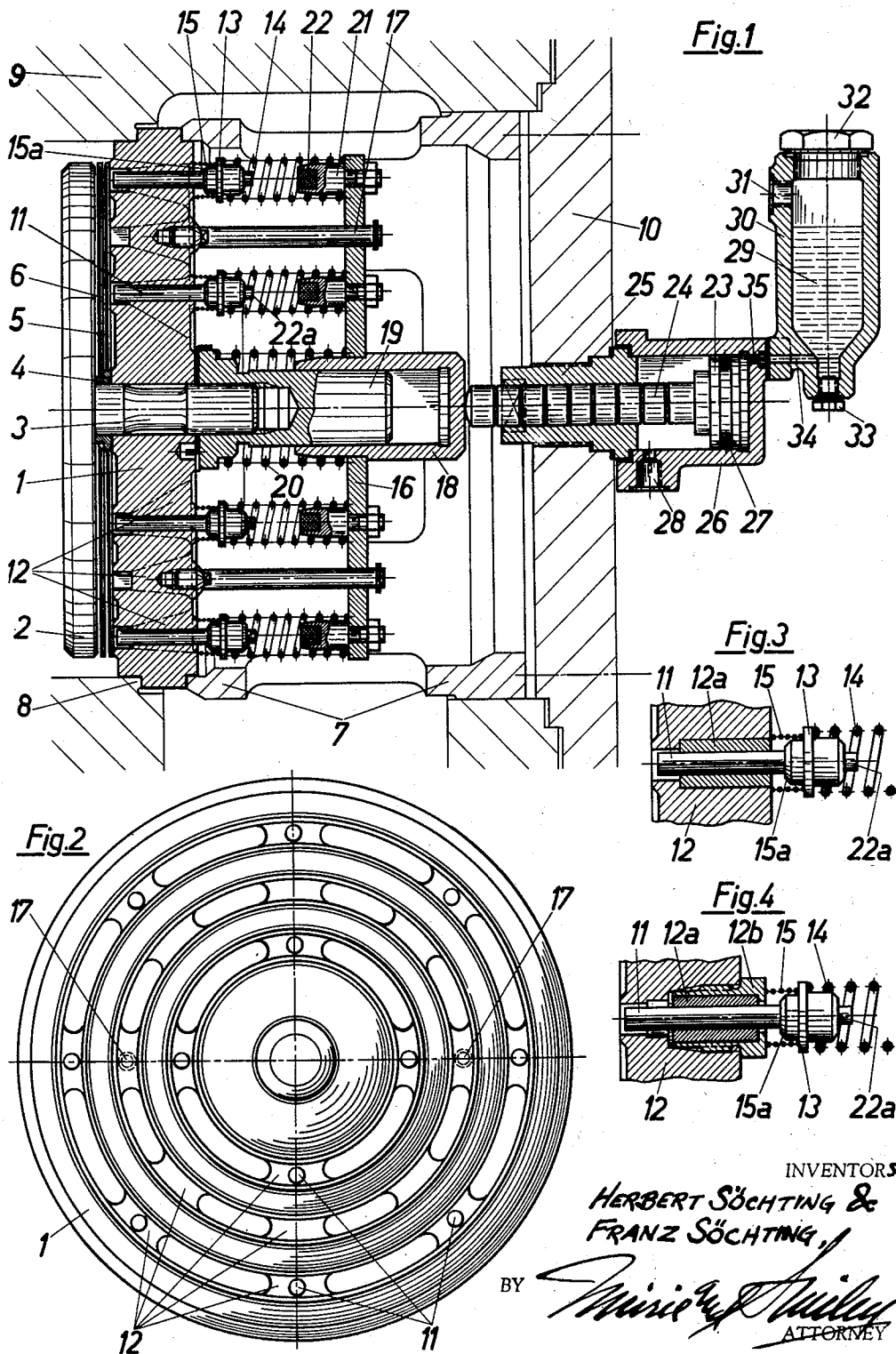
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H. SÖCHTING ET AL

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STEPLESS DELIVERY GOVERNORS FOR DISPLACEMENT COMPRESSORS

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## STEPLESS DELIVERY GOVERNORS FOR DISPLACEMENT COMPRESSORS

Herbert Söchting and Franz Söchting, Vienna, Austria,  
assignors to Hoerbiger & Co., Vienna, Austria

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The known system of so-called "static head" or "reflex" governing of displacement or piston compressors is based on the property inherent in the manner of working of such machines, that when the suction valve plate is held open the medium flowing back into the suction pipe during the compression stroke exerts a force tending to close said valve. Owing to the periodic variation of the piston speed between zero and a maximum the force thus exerted likewise is of a magnitude varying periodically between zero and a maximum, the peak value of the dynamic forces acting on the valve plate experiencing a time lag with regard to the peak piston speed by virtue of the occurring throttling phenomena.

When the value of the force holding the valve open is made to vary continuously between zero and a maximum a time lag occurs in the establishment of the equilibrium condition between the open holding force and the sum of all forces acting to close the valve. This enables the commencement of closing of the valve to be arbitrarily varied between two points in the compression period (at the commencement thereof and the point corresponding to the maximum of the closing force) whereby the delivery volume of the compressor can likewise be caused to vary infinitely between full output and a minimum value.

The holding open of the suction valve plate has hitherto been performed principally by finger- or crown-shaped lifting devices (so-called "grippers"), usually welded of sheet metal and projecting with their prongs through the passages in the valve seatings to actuate the valve plate.

Since, as already mentioned, the motion of the valve plate is periodic, the grippers must likewise be given a more or less similar periodic action. The consequent acceleration and retardation phenomena and the considerable mass of the existing forms of the grippers give rise to exceptionally high stresses in the valve plate and lifting elements, particularly in the case of a high speed compressor, making undisturbed operation well nigh impossible.

In order to reduce the mass of weight of the grippers and obtain more effective guiding of the lifting elements, it has been proposed to divide the crown-shaped gripper ring into individual pins and to guide such pins in the valve seat, in particular in the localities of the crossing points of the radial arms with the annular seating ribs. The saving in moving mass is in this case very slight.

Suggestions for performing static pressure volume governing have also been made according to which grippers or lifters transmitting the spring force to the valve plate are interconnected by shock-absorbing linking elements not participating in the governor action. Such shock-absorbing linking elements are of an elastic substance such as rubber or plastic or the like enclosed between each lifting pin and a corresponding surrounding sleeve.

The subject of the present invention is an infinitely variable delivery volume control or stepless governor for

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displacement of piston compressors, in particular compressors for high running speeds, acting by retarding the closing of the suction valve by varying the open holding force acting on the valve plate by means of a plurality of helical springs, in which the masses moving in direct conjunction with the valve plate or plates (individual rings) and consequently the forces exerted by these (accelerations, retardations and shocks) are reduced to the greatest possible extent.

By way of example an embodiment of the invention is illustrated in the accompanying drawing.

Fig. 1 represents a general arrangement showing the governor in mid-section.

Fig. 2 is a partial view of the suction valve seating from the compressor cylinder side.

Fig. 3 is a section through a lifting pin in a pressed-in bush.

Fig. 4 is a section through a lifting pin in a screw-in intermediate sleeve with a pressed-in bushing.

The suction valve comprising the valve seat 1, valve guard plate 2, central screw spindle 3, guide ring 4, valve plate 5 and damping plate 6, is held by the distance sleeve 7 against the seating 8 of the cylinder 9 which is closed by the valve cover 10.

Differing from known arrangements, the spring forces are transmitted to the valve plate 5 by means of single-piece lifting pins 11 passing through smooth holes in the radial ribs 12 of the suction valve seat 1 or through guide bushes 12a which are either press-fitted in the radial ribs 12 (Fig. 3) or are screwed in together with intermediate guide bushings 12b (Fig. 4) and which consist of a material with suitably low friction properties such as sintered metal, carbon, graphite, plastic with special fillers or the like.

The lifting pins 11 are formed in their parts nearest to the valve cover 10 as spring plates 13 against which bear on the one hand the lifting springs 14 and on the other hand the pin returning springs 15. The spring plates 13 of the lifting pins or more precisely the faces 15a thereof abut against the valve seat 1 (or against a fixed stop thereon, not shown) before the valve plate 5 has been fully lifted, i.e. before the valve has been completely opened. Guide pins 21 for the lifting springs 14 are provided and are so dimensioned that, when these springs are compressed to a value corresponding to the maximum reflux or the required minimum output, they bear directly on the lifting pins 11 in such a manner that a direct transmission of force to the lifting pins takes place with elimination of the action of said springs and consequently the suction valve plate 5 is continuously held open (no load position).

For the purpose of transmitting the force exerted by the spring tension to the lifting pins 11 a pressure plate 16 is provided which is vertically movable with reference to the valve seat 1 and is secured against twisting or rotating by essentially known means such as guide pins 17 fixed to the valve seat. This pressure plate 16 is positioned on the central screw spindle 3 of the valve by a pressure plate bush 18 and a locating nut 19. A pressure plate return spring 20 presses the pressure plate away from the valve seat 1.

Lateral buckling of the lifting springs 14 is prevented by the already mentioned guide pins 21 the ends of which have pads 22 of some shock absorbing material such as rubber or the like, or metallic damping elements such as spring washers or rings or plate springs, in order to prevent the occurrence of disturbing noises due to intermittent contact of the lifting pins 11 and the guide pins 21 immediately preceding the minimum output position. The drawing (Fig. 1) shows an embodiment in which the ends 22a of the lifting pins 11 that are nearest the pressure plate 16 are of smaller diameter than the

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pads 22 of the guide pins 21. This has the purpose of affording some degree of play for the mass of each pad 22 in the event of abrupt collision between the parts 22 and 22a.

The transmission of force to the pressure plate 16 is effected by means of a structural assembly consisting of a piston 23 and a pushrod 24. The pushrod is passed gas-tight through the valve cover in a bush 25, and the sealing of the piston in its servo-cylinder 26 is effected by means of a circlip 27. The sealing of the piston 23 in the servo-cylinder can also be effected by grinding in or by other sealing means such as grooved rings, dished collars, piston rings or the like. Any leakages which may become dangerous if inflammable or toxic gases are compressed are intercepted by a lead-off connection 28.

Pressure on the piston 23 of the servo-cylinder is applied through the intermediary of a pressure fluid 29 in a dashpot 30, such pressure fluid being itself acted upon by compressed air or gas entering through a pressure feed pipe 31. The dashpot is equipped with a filling screw plug 32 and a draining screw plug 33. A nozzle 35 following on the connecting passage 34 throttles the fluid supply and thus damps the oscillations of the power transmitting system. The free flow cross section of this nozzle 35 can be varied, for instance by an adjustable nozzle needle.

The essentially known means provided for preventing oscillation of the pressure plate 16 include irreversible or self-locking screw spindles, hydraulic pressure devices or the like. Other essentially known means for damping the oscillating system incorporating the pressure plate include: detuning of the natural frequency relatively to the excitation frequency (compressor running speed) or connecting the pressure plate with auxiliary mechanical or electromechanical linkages for damping the oscillations of said pressure plate. A successful manner of preventing oscillation of the pressure plate is, as in the subject of the invention, the application of a pneumatic pressure, for instance, by a variable gas pressure, the power transmission linkage incorporating an intermediate hydraulic element with throttling damping.

The invention as described above enables the exceptionally high periodic stresses on the gripping elements or lifting pins and valve plate to be reduced in such degree that undisturbed governing action is assured even in the case of high speed compressors.

We claim:

1. A device for the continuous control of the quantity delivered by reciprocating compressors, acting by delaying the closing of the intake valve, comprising a valve seat, a valve guard plate, a centering rod connecting the valve seat with the valve guard plate, a valve plate axially movable between said valve seat and said valve guard plate, a plurality of pins for lifting said valve plate and mutually and independently guided in said valve seat, control means for controlling said pins, springs connecting said pins with a common pressure plate above said valve seat, said pins being axially movable, guided and adjustable by said control means.

2. A device for the continuous control of the quantity delivered by reciprocating compressors, acting by delaying the closing of the intake valve, comprising a valve seat, a valve guard plate, a centering rod connecting the valve seat with the valve guard plate, a valve plate axially movable between said valve seat and said valve guard plate, a plurality of pins for lifting said valve plate and mutually and independently guided in said

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valve seat, control means for controlling said pins, springs connecting said pins with a common pressure plate above said valve seat, said pins being axially movable, guided and adjustable by said control means, and damping means associated with said pressure plate.

3. A device as set forth in claim 1, wherein the guiding of the lifting pins is effected by smooth through holes in radial webs of the valve seat.

4. A device as set forth in claim 2, wherein the guiding of the lifting pins is effected by smooth through holes in radial webs of the valve seat.

5. A device as set forth in claim 1, comprising spring plates formed on one end of each lifting pin, one of the ends of said springs being seated on said spring plates, the other ends of the springs being seated on said guide pins for guiding the springs which act on the lifting pins.

6. A device as set forth in claim 5, wherein at least one of each two opposite ends of the lifting pins and the guide pins is provided with a pad of damping material, the other end of said pins having a smaller front face than the first named pin end, in order to activate the elasticity of the pads.

7. A device as set forth in claim 2, comprising spring plates formed on one end of each lifting pin, one of the ends of said springs being seated on said spring plates, guide pins rigidly attached to the pressure plate, the other ends of the springs being seated on said guide pins for guiding the springs which act on the lifting pins.

8. A device as set forth in claim 7, wherein at least one of each two opposite ends of the lifting pins and the guide pins is provided with a pad of damping material, the other end of said pins having a smaller front face than the first named pin end, in order to activate the elasticity of the pads.

9. A device as set forth in claim 1, comprising non-elastic means transmitting the adjusting forces necessary for regulation to the pressure plate.

10. A device as set forth in claim 2, including gas pressure means for applying pressure to the pressure plate, and an intermediate hydraulic element damping by throttling for preventing oscillation of said pressure plate.

11. A device as set forth in claim 10, wherein a totally enclosed space is provided in the cylinder head, a separate escape pipe connection being branched through said space so that any leakages occurring owing to wear in the valve cover bushing or the clearance between the actuating piston and its cylinder are led off to a place in which they can escape harmlessly.

12. A device as set forth in claim 2, wherein the guiding elements of the valve plate lifting arrangement include sealing elements which produce a damping effect on the oscillations of the pressure plate and the elements connected therewith.

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