Dec. 27, 1966 J. OTT ETAL 3,294,314

LIFTING DEVICE FOR COMPRESSOR VALVES

Filed March 22, 1966

FIG. 1

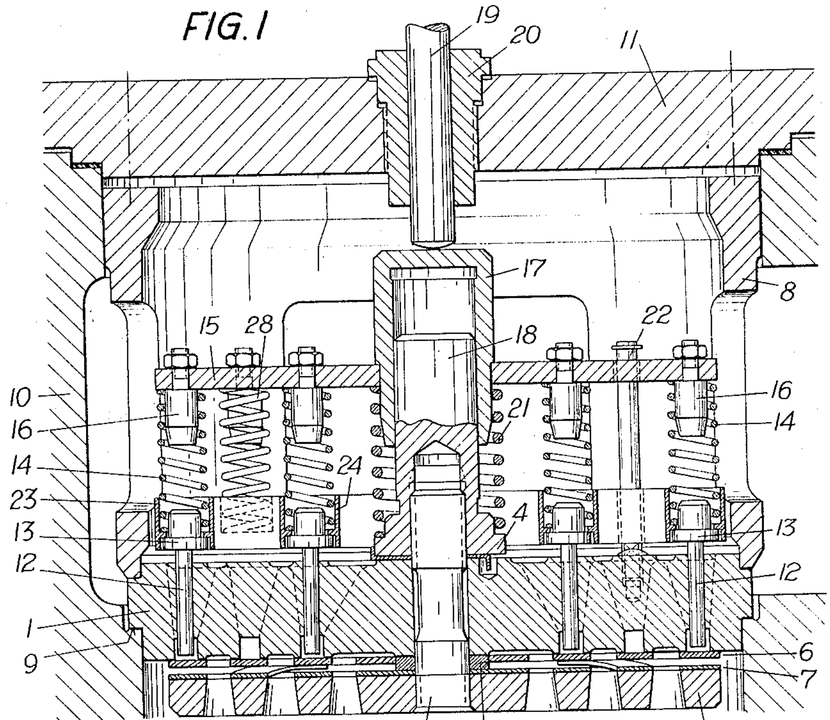


FIG. 2

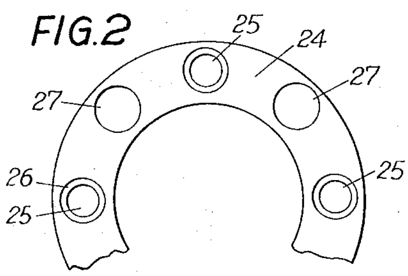


FIG. 4

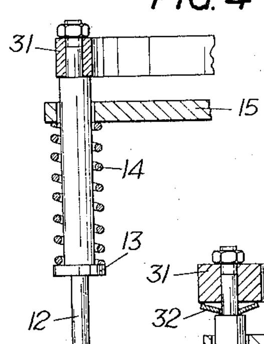


FIG. 5

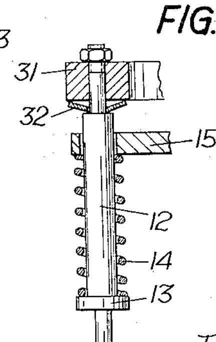
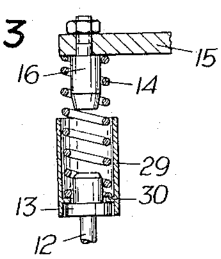


FIG. 3



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United States Patent Office

3,294,314

Patented Dec. 27, 1966

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LIFTING DEVICE FOR COMPRESSOR VALVES

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Filed Mar. 22, 1966, Ser. No. 536,377
Claims priority, application Austria, Mar. 24, 1965, A 2,650/65
10 Claims. (Cl. 230—24)

The invention relates to a lifting device for compressor valves serving for the infinitely variable control of the delivery volume of piston-type compressors, comprising lifting pins preferably guided in the valve seat and connected by means of lifting springs with a pressure plate pressing against an adjusting drive.

It is the purpose of conventional lifting devices used in piston-type compressors for the control of the delivery volume to retard the closing of the suction valve as a result of which the piston will push part of the medium contained in the cylinder back into the suction pipe during the compression stroke, the elements of the lifting device resting upon the valve plate working like the valve plate itself in accordance with the stroke cycle of the compressor. In order to keep the stresses in the valve plate and in the lifting device, particularly of high-speed piston-type compressors, as low as possible, it is desirable to reduce the mass of the lifting device following the stroke cycle to the minium. In conventional lifting devices of the type hereabove described this aim is achieved to a considerable extent by the provision of comparatively short lifting pins connected with the pressure plate only by means of lifting springs. Since the pressure plate does not follow the stroke motions, this design permits of a substantial reduction of the moving mass as compared with other conventional devices comprising so-called rigid lifting grippers guided in coaxial relation inside the valve and loaded by means of a single spring arranged between the lifting gripper and the adjusting drive.

However, experience goes to show that with various kinds of piston-type compressors, and in particular those operating within a regulating range below 70 percent of their full delivery volume, in spite of a substantial reduction of the masses of the elements of the lifting device following the stroke cycle of the compressor, breakage of the suction valve plates is liable to occur already after a few hours of operation. This may be caused by the fact that under the influence of the frequently substantial closing forces exerted by the medium flowing back into the suction pipe, the valve plates impinge upon the valve seats with considerable speed. The remedy usually tried in such cases, consisting in a reduction of the valve stroke and a reinforcement of the valve plate, was not always conducive to satisfactory results, apart from the fact that as a result of these problematic measures the cross-sectional area of flow of the valve is greatly reduced and the mass of the valve plate increased which is particularly objectionable in the case of high-speed piston-type compressors.

It is the object of the invention to provide an efficient remedy while avoiding the drawbacks inherent in the reduction of the stroke and in the reinforcement of the valve plate, considering that by providing an appropriate relationship between the masses of the elements moving in the valve on the one hand, and the structural features of the valve and the operational data of the compressor on the other hand, hard impacts of the valve plate upon the valve seat can be attenuated to a considerable extent.

The invention consists in a lifting device for compressor valves serving for the infinitely variable control of the delivery volume of piston-type compressors, comprising lifting pins acting on the valve plate, lifting springs and a pressure plate pressing against an adjusting drive, the lifting springs connecting the lifting pins with the pressure plate, wherein the lifting pins are provided with adjusting weight detachably placed thereupon for the purpose of adapting the masses of the lifting pins to the operating conditions of the compressor, in particular with regard to speed, pressure and valve stroke. By means of this simple expedient it is possible to adapt the lifting device to existing operating conditions merely by changing the adjusting weights without altering the basic structure of the lifting device. It will therefore, not be necessary to manufacture a separate device adapted to given operating conditions. Furthermore, the invention offers an additional advantage insofar as the increase of the masses of the lifting pins is effective with throttled operation only, so that when the compressor operates at full delivery volume, where the stresses in the valve plate are known to be substantially less than in controlled operation, the moving masses of the valve are not increased.

Preferably the adjusting weights consist of sleeves inserted between the lifting springs and the spring caps provided on the top of the lifting pins. The sleeves are pressed against the spring caps by means of the lifting springs and it is therefore, not necessary to provide special means of attachment for the sleeves which greatly facilitates their fitting. Moreover, the sleeves may encompass the lifting springs over a considerable section of their length, thereby providing appropriate protection for the lifting springs and preventing broken springs or parts of same from dropping out into the valve.

According to another embodiment of the invention, the adjusting weights are formed by rings provided in the valve in coaxial relation to same and interconnecting at least part of the lifting pins. In addition to augmenting the masses, the said rings provide better guidance of the valve plate by the lifting pins, while permitting proper adaptation of the lifting device to the motion of the valve plate within certain limits, such as when the valve plate is placed in an oblique position. Another advantage of this design resides in the fact that according to the invention, at least part of the lifting springs may be so arranged as to rest upon the rings interconnecting the lifting pins in staggered relation to the lifting pins in such a manner that for example, each lifting spring is located between two adjacent lifting pins. This arrangement permits of accomodating a larger number of lifting springs than had been possible with conventional designs, without, however, increasing the number of pins.

In such cases where the lifting pins are concentrically arranged on at least two circles, the lifting pins located on each circle can be provided with a ring of their own, thereby preserving the mobility of the lifting device and the adaptability of the same to the motions of the valve plate, in addition to preventing the rings from impeding the proper flow of the medium in the suction chamber in front of the valve seat. Furthermore, the lifting pins and the lifting springs are preferably inserted with their ends in bores of the rings in order to achieve a firm hold for the extremities of the springs. In addition, the rings may be provided with sleeve-shaped extensions around the bores for the lifting springs to be inserted therein with their extremities, so as to prevent fragments of broken springs from dropping out.

According to another embodiment of the invention, the lifting pins extend in a manner known per se over and above the lifting springs and through the pressure plate, while the adjusting weights, preferably at least one ring interconnecting a plurality of lifting pins, is located on top of the lifting pins above the lifting springs. This particular design is applicable in such cases where the arrangement of adjusting weights between the pressure plate and the valve seat is undesirable or impossible. Since with this arrangement the lifting pins extend entirely through the lifting springs, fragments of a broken lifting spring are prevented from falling out.

Finally, according to the invention, the adjusting weights may be so arranged on the lifting pins as to ensure their axial mobility, an elastic damping member, such as a spring, preferably a cup spring, or a disc made of some elastic material, being provided between the adjusting weights and the lifting pins. By the provision of damping elements stresses due to the action of the lifting pins upon the valve plate are attenuated, so that the increase of masses due to the presence of adjusting weights will not produce any objectionable effect in this respect either.

Further details of the invention are explained hereafter with reference to the accompanying drawing in which:

FIG. 1 shows a sectional view of a lifting device according to the invention as incorporated in a compressor valve;

FIG. 2 represents a plan view of a detail of same;

FIGS. 3 to 5 illustrate three different embodiments of the invention featuring adjusting weights located on the top of the lifting pins.

The valve illustrated in FIG. 1 comprises a valve seat **1** and a valve guard **2** mounted on the valve seat **1** by means of a central screw spindle **3** and a nut **4** screwed thereon. Between the valve seat **1** and the valve guard **2** a guide ring **5** is provided for the guidance of the valve plate **6** and of a spring plate **7**. By means of a distance sleeve **8** the valve seat **1** is tightly held against a seating **9** of the cylinder **10** which is closed outwardly by the valve cover **11**.

Inside the valve seat **1** guided lifting pins **12** are provided, by means of which the controlling forces are transmitted to the valve plate **6**. On the side facing away from the valve plate **6** the lifting pins **12** are provided with spring caps **13** for the lifting springs **14**, the other extremities of which are supported by a pressure plate **15**. For the purpose of securing the spring ends to the pressure plate **15**, guide bolts **16** are screwed into same. The pressure plate **15** is attached to a bushing **17** supported by a cylindrical guide means **18** formed by an extension of the nut **4** so as to be slidable in the direction of the valve axis. The bushing **17** is subject to the action of an adjusting drive formed by a pneumatic or hydraulic cylinder, for example, and acting upon the bushing **17** by means of a pushrod **19** located in a guide bushing **20** in the cover **11**. However, the controlling forces may also be transmitted to the bushing **17** mechanically by means of a spring or the like. A helical spring **21** serves to restore the pressure plate **15** to its initial position and a bolt **22** is provided for the purpose of preventing rotation of the pressure plate **15** and to limit its stroke.

During the controlling operation the lifting springs **14** are loaded by the appropriate adjustment of the common pressure plate **15** in such a manner that the lifting pins **12** press against the valve plate **6**. The lifting pins **12** keep the valve plate **6** open for part of the compression stroke of the compressor piston against the restoring force of the spring plate **7** and the closing forces exerted thereupon by the backflowing medium. As soon as the closing forces acting upon the valve plate **6** exceed the forces exerted by the lifting springs **14**, the valve plate **6** occupies its closing position on the valve seat **1** which it impinges upon with great speed as a result of the considerable forces exerted upon it by the compressing medium. The force of the impact can be attenuated by adapting the masses of the lifting pins **12** following the motions of the valve plate **6** in accordance with the stroke cycle of the compressor to the operating conditions of the compressor. For the

purpose, the lifting pins **12** are topped by detachable adjusting weights which are readily exchanged in accordance with any given operating conditions.

In the embodiment shown in FIG. 1 the adjusting weights are formed by rings **23** and **24** arranged coaxially inside the valve and interconnecting the lifting pins **12** arranged on two concentric circles. The two rings **23**, **24** are arranged concentrically and present bores **25** with an inwardly projecting collar **26** as shown in FIG. 2. The bores **25** present lifting pins **12** inserted therein from below and lifting springs **14** inserted from above, the collar **26** of each bore **25** being located between the spring cap **13** and the extremity of the lifting spring **14** so that the rings **23**, **24** are maintained in close connection with the lifting pins **12**. As appears likewise from FIG. 2, additional bores **27** are provided in the ring **24** in a peripheral direction between the bores **25**, additional lifting springs **28** being inserted in the said bores **27** as shown in FIG. 1, and supported by the pressure plate **15** by means of guide bolts **16**. Consequently, the rings **23** and **24** offer the additional advantage of providing accommodation for a greater number of lifting springs **14**, **28** in the valve without increasing the number of lifting pins **12**. Furthermore, the rings **23**, **24** provide for the approximately parallel guidance of the valve plate **6** as achieved by the use of so-called rigid grippers and occasionally desirable, even if the medium is being delivered under adverse conditions of flow.

According to the embodiment of the invention illustrated in FIG. 3 the adjusting weights comprise sleeves **29** which are placed on the top of the lifting pins **12** instead of the rings **23**, **24**. Each sleeve **29** is maintained in position between the spring cap **13** and the extremity of the lifting spring **14** with an inwardly protruding collar **30**. Furthermore, the length of the sleeves **29** can be relatively great in the area close to the pressure plate **15** so as to encompass the lifting springs **14** over a substantial section of their overall length, thereby providing appropriate protection for the lifting springs and preventing fragments of broken springs from dropping out. In a similar manner, as shown in FIG. 1, the rings **23** and **24** may present sleeve-shaped extensions around the bores **25** and **27**, the extremities of the lifting springs being inserted in the said extensions.

The variants of the invention illustrated in FIGS. 4 and 5 differ from the embodiment shown in FIGS. 1 and 3 chiefly insofar as the lifting pins **12** extend on top over and above the lifting springs **14** and through the pressure plate **15**. Thus the lifting springs **14** are securely maintained in position over their entire length. In that case, the adjusting weights are placed on top of the lifting pins **12** somewhere above the lifting springs **14** and the pressure plate **15**, and are, in the embodiments of the invention illustrated in the drawings, formed by rings **31** interconnecting a number of lifting pins **12**. In the embodiment of the invention shown in FIG. 5 the ring **31** is furthermore supported by the upper extremity of the lifting pin **12** in such a manner as to be movable in the direction of the axis of the said lifting pin, an elastic damping means consisting of a cup spring **32** being provided between the ring **31** and the lifting pin **12**. Another type of spring or a disc made of some elastic material, such as rubber or plastics, may be substituted for the said cup spring.

In each of the embodiments of the invention shown the adjusting weights are easily removable and exchangeable for other adjusting weights, so that the lifting device can be used, depending on given requirements, either without any adjusting weight or with such adjusting weights as have been adapted to suit given operating conditions. preferably adjusting weights with different masses are made available for use if and as required, so that the masses of the members of the lifting device following the motions of the valve plate of the controlled suction valve in accordance with the stroke cycle can be readily adapted to the operating conditions of the compressor.

We claim:

1. A lifting device for compressor valves serving for the infinitely variable control of the delivery volume of piston-type compressors, comprising lifting pins acting on a valve plate, lifting springs and a pressure plate pressing against an adjusting drive, the lifting springs connecting the lifting pins with the pressure plate, wherein the lifting pins are provided with adjusting weights detachably placed thereupon for the purpose of adapting the masses of the lifting pins to the operating conditions of the compressor, in particular with regard to speed, pressure and valve stroke.

2. A lifting device as claimed in claim 1, wherein the adjusting weights consist of sleeves inserted between the lifting springs and spring caps provided on the top of the lifting pins.

3. A lifting device as claimed in claim 2, wherein the sleeves encompass the lifting springs over a substantial portion of the length of the said springs.

4. A lifting device as claimed in claim 1, wherein the adjusting weights are formed by rings in coaxial relation to the valve plate and interconnecting at least part of the lifting pins.

5. A lifting device as claimed in claim 4, wherein at least part of the lifting springs are supported by the said rings interconnecting the lifting pins at points on the adjusting rings where lifting pins are omitted.

6. A lifting device as claimed in claim 4, wherein the lifting pins are concentrically arranged on at least two circles, the lifting pins located on each circle being provided with a ring of their own.

7. A lifting device as claimed in claim 4, wherein the said rings are provided with bores, the lifting pins and the lifting springs are insested with their extremities in said bores.

8. A lifting device an claimed in claim 7, wherein the rings are provided with sleeve-shaped extensions around the said bores wherein the lifting springs are inserted with their extremities.

9. A lifting device as claimed in claim 1, wherein the lifting pins extend over and above the lifting springs and through the pressure plate, the adjusting weights being located on top of the lifting pins above the lifting springs.

10. A lifting device as claimed in claim 1, wherein the adjusting weights are so arranged on the lifting pins as to ensure their axial mobility, an elastic damping member being provided between the adjusting weights and the lifting pins.

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