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COAXIAL SUCTION AND DELIVERY VALVE ARRANGEMENT FOR HIGH PRESSURE COMPRESSORS AND PUMPS

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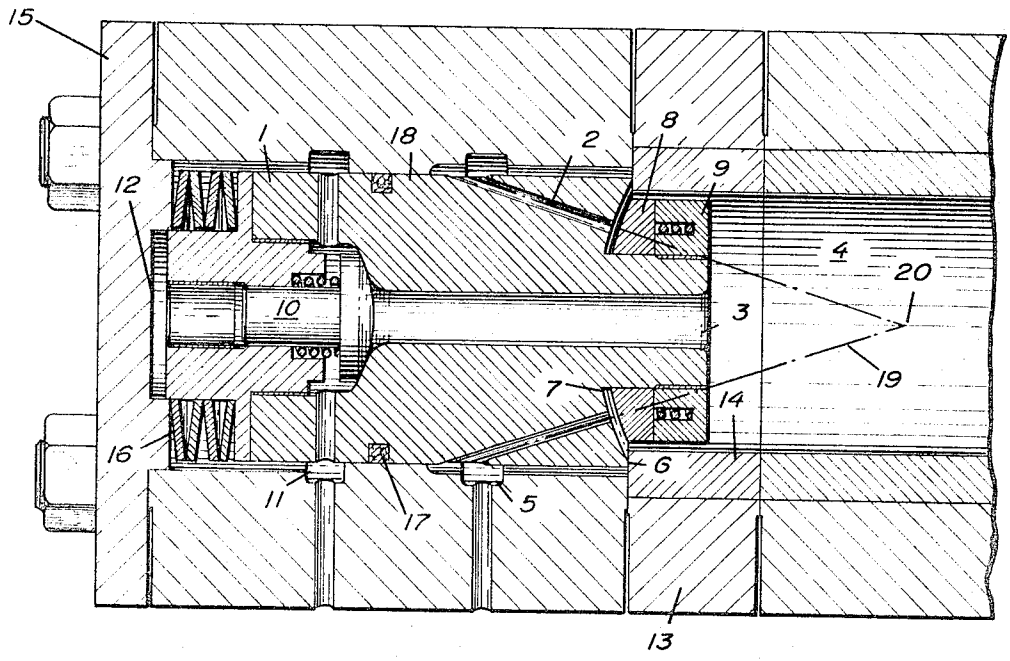

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COAXIAL SUCTION AND DELIVERY VALVE ARRANGEMENT FOR HIGH PRESSURE COMPRESSORS AND PUMPS

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The present invention has for its object improvements in arrangements including coaxial suction and delivery valves for high pressure compressors and pumps.

Such high pressure valve arrangements are known wherein a central body carrying the valve is provided with an axial channel or bore cooperating with the delivery valve and, round said axial channel or bore, with sloping channels leading to the suction valve. Said sloping channels connect an annular chamber inside which the suction pressure prevails and which surrounds the central body with the seat of the suction valve.

In valves of such a type intended for pumps and compressors operating under service pressures which may reach several thousand atmospheres, the material forming the different parts of the valve elements is subjected to stresses which are much higher than the stresses which are generally allowed in the execution of machines under conventional pressures. The constant modifications in the value of the pressure during the suction and compression strokes produce, in particular in registry with the sharp ridges and acute angles in the fluid conveying channels in the valve arrangement, load peaks which may lead readily through excess straining to breakage. It is possible to reduce such stresses by suitably rounded connecting surfaces and by machining the sharp ridges, but it is impossible thus to cut out completely the stresses.

In cylinders and containers subjected to a high constant inner pressure, these load peaks and stresses have generally no detrimental action, since upon a local rise above the stress limit of the material at the possible points of shearing, the stress peak for the material considered is compensated by a sufficient elongation obtained through extrusion and plastic deformation; with a localization of the extrusion area, there is no risk of breaking after a certain time. In coaxial suction and delivery valve arrangements fitted in high pressure compressors and pumps, in contradistinction, the pressure varies at each cycle between suction pressure and compression pressure and this has an action chiefly on the central valve-carrying body inside which the delivery and suction channels are formed, said modifications in pressure acting more particularly in the area extending between the surface fluidtightly closing the suction valve and the surface fluidtightly closing the delivery valve. During said modifications in pressure, the maximum stress involved is unimportant whereas, what is important as far as the risk of breakage is concerned is the difference between the maximum and minimum stresses.

The present invention has for its object a coaxial suction and delivery valve arrangement operating under high pressures, wherein the detrimental action of the variations in stresses and consequently the shearing efforts, in particular as concerns the channels formed in the central body of the valve-carrying arrangement, are considerably reduced while the risk of breaking after a certain time is cut out to a large extent.

To this end the outer periphery of the central body extending between the packing which is to make the central body fluidtight with reference to the valve casing and the seat of the suction valve and including the sloping channels, is subjected to a constant suction pressure over a length substantially equal to the length of the central passage or channel subjected to the varying pressure prevailing in the cylinder. Thus, the stresses produced by the variations in pressure are reduced as far as the central body is concerned.

Furthermore, in order that the variable stresses which may still appear in the area corresponding to the sloping passages surrounding the central channel, may not act detrimentally by a shearing action or by an increase in the stresses, the present invention also provides, according to a further advantageous feature, a reduction in the shearing action by giving the surface ensuring fluidtightness with the annular suction valve a part-spherical shape, whereas the bearing surface forming an extension of said spherical surface of the central body is urged under pressure against a ring constituted by a material having a high modulus of elasticity. Thus, as a consequence of the friction along the bearing surface associated with the fluidtight surfaces forming the output area for the sloping channels, the modifications in shape in the central body are reduced to a large extent.

Further features and advantages of the invention will appear in the reading of the following description, reference being made to the accompanying drawing, the single figure of which is an axial sectional view of a preferred embodiment of a coaxial valve arrangement according to the invention.

The arrangement illustrated forms an assembly of coaxial suction and delivery valves for high pressure compressors and pumps. The fluid passes during the suction stroke of the piston into the cylinder bore **4** through the sloping channels **2** arranged in the central body **1**, said channels **2** being distributed round the axial channel **3**. During the compression stroke, the fluid passes through the axial channel **3** in the central body.

During the suction stroke of the pump or compressor operating under high pressure, the fluid, passing out of an annular chamber **5** formed in the valve casing subjected to the suction pressure and surrounding the central body **1**, enters the sloping passages or channels **2** so as to reach the seat **7** of the member **8** forming the suction valve, following which the fluid passes over the latter and the stop **9** projecting into the bore **4** of the cylinder so as to reach finally the said bore **4**.

During the compression stroke, the fluid to be compressed passes through the channel **3** into the central body **1**, passes over the plate-shaped member **10** forming the delivery valve and reaches the annular chamber **11** beyond said valve, said annular chamber **11** being subjected to the compressor pressure.

By reason of the pressure prevailing in the annular chamber **11** and acting on the front surface **12** of the coaxial suction and delivery arrangement projecting into the annular chamber **11**, the central body **1** is urged towards the front surface **6** of the inner ring **14** fitted inside the intermediate ring **13**. The front surface **6** and the cooperating surface of the body **1** engaging said surface **6** are machined in a manner such that the pressure acting in said central body allows obtaining fluidtightness.

In order to ensure a perfectly reliable engagement on the bearing surface **6**, for instance at the moment of the starting of the compressor before any compression is obtained, there is inserted between the front surface **12** of the valve arrangement and the cover **15** forming the cylinder head, an elastic member **16** as known per se. The fluidtightness between the chamber **11** inside which a constant pressure prevails and the suction chamber **5**

formed inside the cylinder head and also subjected to a constant pressure, is obtained by means of an annular packing **17** and consequently the portion of the cylinder bore **18** in the cylinder head extending between the annular suction chamber **5** and the annular compression chamber **11** forms a guide for the central body **1**.

According to the invention, the area of the central body **1**, registering with the central channel **3** subjected to the variable pressure prevailing inside the cylinder and extending between the incurved surface **7** closing the annular body **8** forming the suction valve and the fluidtight surface on the member **10** forming the delivery valve, is sujected together with the oblique channels to a constant suction pressure over a length which is substantially equal to its outer periphery between the packing **17** and the bearing surface **6**. Thus, by reason of the suction pressure exerted on said peripheral area of the central body **1**, the stresses to which the latter is subjected under the action of the varying pressure are reduced.

In order that the varying stresses still extend in the area registering with the channels **2** surrounding the central bore **3** may not lead to a detrimental shearing effect or to an increase in the tensioning stresses, such increases in stresses arising in the area corresponding to the sloping channels **12** and which are transmitted with an increased value towards the surface **7** fluidtightly engaging the suction valve **8** are considerably reduced in accordance with the invention by reason of the central body **1** being subjected to a suction pressure throughout the area extending between the packing **17** and the bearing surface **6** engaging the ring **14** fitted in the intermediate ring **13**, and is furthermore subjected in registry with said surface **6** engaging the ring to a large superficial pressure, while said ring **14** is constituted by a material having a modulus of elasticity which is much higher than that of the material forming the central body **1**.

The deformations of the ring **14** are reduced by reason of its high modulus of elasticity and the friction exerted on the bearing surface **6** also reduces the deformation of the adjacent area of the body **1**. Similarly, the strain to which the central body **1** is subjected and which is proportional to the modifications in shape are reduced in conformity with Hooke's law. The fluidtight seat surface **7** and the corresponding surface on the annular body **8** forming the suction valve are curvilinear. The axes of the sloping channels coincide preferably with radii of said incurved surfaces so as to reduce the risk of shearing.

The pressure exerted on the bearing surface **6** and the higher modulus of elasticity of the ring **14** with reference to the modulus of the material forming the central body are such that the peaks of the stresses arising in registry with the incurved fluidtight surface **7** and ascribable to a shearing action, are reduced in a manner sufficient to cut out in practice any risk of a break.

Numerous modifications and additions may be brought to the system of coaxial valves described hereinabove, without widening the scope of the invention as defined in the accompanying claims, only one embodiment having been described by way of example and in a non-limiting sense.

What we claim is:

1. In a high pressure fluid compressing machine, the combination with the machine cylinder of a valve carrying body provided with an axial channel and with a plurality of sloping channels surrounding the axial passage and converging towards the cylinder, the surface of the body facing the cylinder having a part spherical concave section into which the sloping channels open and a flat outer extension for said part spherical section, an annular suction valve having a surface matching said part spherical surface and cooperating with the openings of the sloping channels facing the cylinder, a delivery valve cooperating with the opening of the axial channel in the body at the end thereof facing away from the cylinder, and means whereby the portion of the outer periphery of the body extending between said openings of the sloping channels and said opening of the axial channel is subjected to suction pressure over a length equal to that of the axial channel subjected to the pressure in the machine cylinder.

2. A coaxial suction and delivery valve arrangement adapted to equip high pressure compressors and pumps of the cylinder-and-piston type and provided at the top of the cylinder, inside a central body carrying a delivery valve with an axial channel for the delivery of fluid and a suction valve with sloping channels for suction which latter are distributed round said axial channel and connect an annular chamber subjected to suction pressure and surrounding the central body with an incurved seat surface of the suction valve, said arrangement being characterized by the fact that the length of the outer peripheral portion of the central body extending between the incurved seat surface engaging fluidtightly the suction valve and the surface fluidtightly engaging the delivery valve, is equal to the length of the axial channel subjected to the pressure prevailing inside the cylinder.

3. An arrangement as claimed in claim **2**, wherein the risk of shearing is reduced by reason of the surface forming a seat for the suction valve being constituted by a fraction of a sphere surface, and the surface of the central body extending beyond said part spherical seat surface is urged under pressure against the end surface of a cylindrical ring inside the cylinder constituted by a material having a high modulus of elasticity whereby the deformations of the central body are considerably reduced by the friction to which said ring end surface is subjected and by the shape given to said seat of the suction valve as a fraction of a sphere surface.

4. In a high pressure fluid compressing machine, the combination with the machine cylinder of a valve carrying body provided with an axial channel and with a plurality of sloping channels surrounding the axial passage and converging towards the cylinder, the surface of the body facing the cylinder having a part spherical concave section into which the sloping channels open and a flat outer extension for said part spherical section, an annular suction valve having a surface matching said part spherical surface and cooperating with the openings of the sloping channels facing the cylinder, a delivery valve cooperating with the opening of the axial channel in the body at the end thereof facing away from the cylinder, and means whereby the portion of the outer periphery of the body extending between said openings of the sloping channels and said opening of the axial channel is subjected to suction pressure over a length equal to that of the axial channel subjected to the pressure in the machine cylinder.

5. In a high pressure fluid compressing machine, the combination as set forth in claim **4**, wherein the center of the radius of curvature of said part spherical concave section coincides with the converging point of the axes of all sloping channels.

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