An energy-saving method and an energy-saving device for operating a single-acting cylinder device provided with a return function, which comprises a cylinder part (2) with an interior duct (50) and a piston (4) which is arranged in a movable manner in the duct (50) and which defines a working chamber (5) and a return chamber (6) in the duct (50). The piston (4) executes a working stroke and a return stroke in the duct. The method of operating the cylinder device comprises the steps of causing a first fluid to flow into the working chamber (5) from a pressure source (39), which has an output pressure, and thereby operating the working stroke of the piston (4), closing the return chamber (6), so that a second fluid in the return chamber (6) is compressed during the working stroke of the piston, and opening the working chamber (5) after the working stroke, so that the first fluid is permitted to flow out of the working chamber (5) to the atmosphere and the second fluid compressed in the return chamber (6) returns the piston (4) during the return stroke. By reducing the pressure of the second fluid in the return chamber (6) if this pressure exceeds an upper pressure value, which is the pressure reached first of either the output pressure of the pressure source (39) or a maximum pressure value, which corresponds to a maximum permissible pressure in the return chamber (6) during operation, the building up of an undesirable pressure in the return chamber (6) is avoided.
CYLINDER MEANS OF SINGLE ACTING TYPE WITH A RETURN FUNCTION AND METHOD OF OPERATING THE SAME

TECHNICAL FIELD

[0001] The present invention relates to an energy-saving method of operating a single-acting cylinder means or cylinder device provided with a return function in accordance with the preamble to appended claim 1. Furthermore, the present invention relates to a single-acting energy-saving cylinder device with a return function in accordance with the preamble to appended claim 8.

TECHNICAL BACKGROUND

[0002] A cylinder device of the kind stated by way of introduction with a so-called energy-saving function is described in the Applicant’s patent SE-9600875, from which patent application WO97/33093 claims priority. According to this document, a back pressure is built up in the return chamber and in the associated storage tanks during the working stroke of the piston, said back pressure returning the piston to its initial start position as the fluid pressure in the working chamber drops. At the end of the working stroke, a valve opens, which is arranged on a piston rod connected to the piston, so that pressurised fluid can flow from the working chamber into the return chamber and the storage tanks. The storage tanks consist of cavities in the piston rod and a bore extending axially in the cylinder part on the outside of the duct. One drawback of this cylinder device is that it comprises a great number of movable parts, such as springs and sleeves. Furthermore, the strength of the piston rod is low since it is hollow. The complicated design and function of the cylinder device also results in a comparatively long cycle time of the piston. It has been found that the transmission of fluid from the working chamber to the return chamber is critical since undesired leakage often occurs between the chambers.

[0003] Another cylinder device is already known from DE-A-3211232, which corresponds to GB 2,095,759. In this cylinder device, use is also made of an energy-saving function for returning the piston in the return stroke. Part of the pressurised fluid which operates the working stroke of the piston is also used to execute the return stroke after opening the working chamber. This is achieved by the pressure between the working chamber and the return chamber being equalised when the piston has executed its working stroke. In order to permit the piston to move the entire length of the stroke in its subsequent return stroke, use is made of the built-up pressure of the fluid in the return chamber and a reservoir communicating with the return chamber. The reservoir is arranged at a distance from the cylinder, which makes the design unwieldy and sensitive to external action. The complicated design with a number of valves also makes it impossible to operate the cylinder device with a short cycle time. Moreover, the reservoir must be dimensioned for the length of the cylinder.

[0004] Yet another cylinder device with an energy-saving function is disclosed in patent application WO 98/21487. This cylinder device has a valve means in one of its ends. In spite of its compact design, the cylinder device still suffers from the above-mentioned problems.

[0005] Another drawback of the above prior-art cylinder devices is that in many cases they are not completely capable of meeting the security requirements that the users may have. There is a certain risk of explosion since high back-pressures can be generated in the return chamber when a great amount of kinetic energy from the work of the cylinder device is supplied to heavy objects. Furthermore, mechanical locking devices must be arranged in connection with the piston rod to block the position of the piston in the case of accidents or undesirable pressure drops.

SUMMARY OF THE INVENTION

[0006] One object of the present invention is to provide a single-acting energy-saving cylinder device provided with a return function and a method of operating the same, which eliminate the above-mentioned problems.

[0007] Another object of the present invention is to provide a cylinder device having a safe and reliable operation.

[0008] Yet another object of the present invention is to provide a method of operating the cylinder device having an energy-saving function, said method reducing the use of compressed fluid.

[0009] These and other objects, which will appear from the subsequent description, are achieved by providing the method and the cylinder device of the types stated by way of introduction with the features stated in the characterising parts of appended claims 1 and 8. Preferred embodiments of the method and the cylinder device are stated in the dependent claims.

[0010] As the accumulated pressure of the second fluid in the return chamber is only generated by a volume reduction of the return chamber as a consequence of the working stroke of the piston, an advantageous energy-saving function is provided in the cylinder device according to the invention. The step of reducing the pressure of the second fluid in the return chamber if this pressure exceeds an upper pressure value, which is the pressure reached first of either the output pressure of the pressure source or a maximum pressure value, which corresponds to a maximum permissible pressure in the return chamber during operation, makes it possible to prevent on the one hand an undesirable lack of equilibrium between the first and the second fluids in the system and, on the other, an uncontrolled return stroke of the piston in case of a sudden pressure drop of the pressure source or an undesirable pressure rise in the return chamber. In addition, the risk of an explosion can be substantially eliminated.

[0011] According to a preferred embodiment of the invention, the return chamber is opened via a nonreturn valve unit if the pressure of the second fluid in the return chamber exceeds the output pressure of the pressure source counteracting the nonreturn valve unit. Thus, in this case the upper pressure value is determined by this output pressure. As a result the nonreturn valve unit is actuated automatically if an undesired pressure drop should occur in the working chamber and then prevents the piston from being returned in an undesired return stroke. Thus, it is not necessary to use a mechanical locking which blocks the position of the piston in case of a pressure drop or a safety stop. The non-return valve unit also makes the cylinder device explosion-proof.

[0012] According to yet another preferred embodiment, the second fluid is caused to flow out of the return chamber via a high-pressure regulator unit at least as long as the
pressure of the second fluid in the return chamber exceeds the maximum pressure value. In this case, the upper pressure value is determined by this maximum pressure value, which can be set depending on the desired properties of the cylinder device. As a result, the pressure in the return chamber is not allowed to exceed a maximum permissible working pressure. Thus, the occurrence of an undesired increase in the amount of fluid in the return chamber is avoided during operation, and the backpressure in the return chamber is kept below a certain level so as not to prevent the piston from executing its working stroke. Such an undesired increase in the amount of fluid in the return chamber may, for instance, occur by fluid leaking past the piston from the working chamber to the return chamber. Furthermore, the high-pressure regulator unit is preferably open only until the pressure of the second fluid in the return chamber is on a level with the adjustable maximum pressure value. Thus, the opening of the return chamber will be of brief duration and will not interfere with the operation of the cylinder device more than necessary.

[0013] According to a preferred embodiment, the flow resistance of the first fluid is controlled so as to be lower out of the working chamber than into the same. As a result, it is possible to quickly drain the working chamber after a completed working stroke, thereby allowing a minimisation of the resistance of the first fluid in the working chamber during the return stroke of the piston and a reduction of the cycle time of the cylinder device.

[0014] According to another preferred embodiment, the second fluid is caused to flow into the return chamber via a low-pressure regulator unit at least as long as the pressure in the return chamber is lower than a minimum pressure value, which corresponds to a minimum permissible pressure in the return chamber during operation. This ensures that a necessary amount of the second fluid is always present in the return chamber during operation, more specifically as much fluid as to provide a sufficient back pressure in the return chamber to accomplish an adequate return stroke. Preferably, the low-pressure regulator closes the return chamber when the pressure of the second fluid in the return chamber is on a level with the minimum pressure value. This prevents an excessive amount of the second fluid from being supplied to the return chamber. In addition, the cycle time can be kept short.

[0015] The above discussion of preferred embodiments of the method according to the invention is equally applicable to the cylinder device according to the invention.

[0016] According to an additional preferred embodiment, the cylinder part comprises an elongated casing, which on the inside defines said duct, and at least one end wall portion which is arranged to close the duct in an associated end of the casing. On the outside of the duct, the casing comprises an elongated, double-wall portion which defines at least one expansion chamber which is in fluid communication with the return chamber. This means that the dimensions of the expansion chamber or chambers can be optimised to define a maximum volume for receiving the second fluid, which reduces the back pressure which has to be generated in the return chamber for the return stroke. This also allows a compact construction whose outer dimensions can easily be standardised, which facilitates the installation of the cylinder device. This type of casing is also easy to manufacture while providing great strength and a small thickness of material, for instance, by extrusion or injection moulding.

[0017] Preferably, the duct or the ducts in the end wall portion are formed to have a low flow resistance by at least two expansion chambers being in fluid communication with the return chamber and with each other via the duct or the ducts in the end wall portion. This makes it possible for the second fluid to move faster and for the cycle time of the stroke of the piston to be reduced.

[0018] Preferably, the double-wall portion contains several expansion chambers for receiving a maximum volume of the second fluid. These expansion chambers are preferably in fluid communication with each other and/or the return chamber via ducts in the first end wall portion and/or in a second end wall portion which closes the duct in a second associated end of the casing. By connecting the expansion chambers with each other via an end wall portion, a considerable reduction of the flow resistance of the second fluid is provided, which in turn makes it possible to increase the cycle speed of the cylinder device.

[0019] According to another preferred embodiment, one expansion chamber is in fluid communication only with the return chamber and another expansion chamber is in fluid communication only with the working chamber. Thus, a sufficient volume is obtained on both sides of the piston so as to build up a backpressure which is needed for a return stroke of the piston without the supply of additional fluid. It is possible to simply invert the working stroke and the return stroke in the cylinder unit, which is desirable when the direction of the powerful working stroke needs to be varied.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] Below, the invention will be described in more detail with reference to the accompanying drawings, which by way of example show a currently preferred embodiment of the invention.

[0021] FIG. 1 is a schematic perspective view of the preferred embodiment according to the present invention.

[0022] FIG. 2 is a schematic block diagram of the preferred embodiment.

[0023] FIG. 3 is a longitudinal section view along the line A-A in FIG. 1.

[0024] FIG. 4 is a schematic section view along the line BB in FIG. 3.

[0025] FIG. 5 is a schematic sectioned view of a first end wall portion.

[0026] FIG. 6 is a view similar to FIG. 2 showing an alternative, in some cases preferred embodiment.

DESCRIPTION OF PREFERRED EMBODIMENTS

[0027] The cylinder device 1 according to a preferred embodiment of the invention is of single-acting type with a return function and is shown in FIGS. 1-6. A cylinder part 2 in the cylinder device 1 has an elongated casing 3, which on the inside about its geometrical centre line defines an elongated duct 50. The cylinder part 2 can have many different geometrical shapes, such as parallelepipedal, astral, oval-cylindrical or circular-cylindrical. According to the
invention, the structure of the casing 3 is of such good strength that it can be used as a supporting element in installations. The duct 50 accommodates a piston 4, which is arranged in a movable manner and which together with, among other means, the duct 50 defines a working chamber 5 and a return chamber 6. In one end of the cylinder part 2, the return chamber 6 is closed by means of a first end wall portion 7 and in the other end of the cylinder part the working chamber 5 is closed by means of a second end wall portion 8. The end wall portions 7, 8 are fixedly anchored to the ends of the casing 3 by means of, for instance, bolts 9 in, for instance, threaded holes 9 such that a sealing abutment is provided between the casing 3 and the end wall portions 7, 8. According to the preferred embodiment, the piston 4 has a piston rod 10 arranged so as to extend in the longitudinal direction of the duct 50 from the piston head 11, through the return chamber 6 and out through the first end wall portion 7. The piston rod 10 may, of course, in different embodiments be arranged on one or the other side of the piston head 11 or constitute a piston rod extending through the entire cylinder part 2. By varying the position and length of the piston rod, it is possible to obtain a desired direction and function of the working stroke.

The elongated casing 3 has a double-wall structure, which provides good strength and makes it possible to optimise the internal as well as the external dimensions due to the small thickness of the wall, and is usually manufactured by extrusion or injection moulding of aluminium or some other suitable material. The inner wall 3 of the casing is the wall which defines the elongated duct 50. The outer wall 3 of the casing 3 defines the outer dimensions of the cylinder part 2, which preferably satisfy international standards. Thus the cylinder according to the invention satisfies e.g. the VDMA and/or the ISO standard. Between the inner wall 3 and the outer wall 3, expansion chambers 20, 21, 22, 23 are defined which are in fluid communication with the return chamber 6 and with each other via ducts 40 in the first end wall portion 7. The expansion chambers may also communicate with each other via ducts 41 in the second end wall portion 8. This reduces the flow resistance of the second fluid during operation. The casing also defines smaller ducts 24 which are used to lead cables or fluid from a pressure source 39 to one of the chambers 5, 6.

FIG. 3 shows that in a preferred embodiment the piston 4 has brake cones 12, 13 on each side of the piston head 11 to co-operate with recesses 14, 15 in the end wall portions 7, 8 at the respective end positions of the working stroke and of the return stroke. The brake cones 12, 13 and the corresponding recesses 14, 15 cause the respective strokes to slow down at the same time as the working chamber and the return chamber get a slightly larger volume. A plate 16 of shock-absorbing material, such as plastic or rubber, is arranged in the recess 15 on the piston rod 10 in order to absorb the shock of the brake cone 13 as it hits the plate 16 with great force. Thus, a metal-against-metal collision is avoided.

FIG. 5 shows a sectional view of the end wall portion 7. It clearly appears that some of the ducts 40 are inclined in relation to the longitudinal direction of the cylinder part 2 to reduce the air flows therein, which makes it possible to reduce the cycle speed of the cylinder device 1. In a cylinder device having a diameter of 40 mm and a length of the stroke of 200 mm, it has been possible to attain cycle speeds of about 0.3 seconds, which permits great savings for the industry implementing the cylinder device and yields more work during operation. Many of the ducts 40 are V-shaped and have other ducts 40 which are connected to the V-shaped expansion ducts.

With special reference to FIGS. 1 and 2, the control unit 30 is shown to be connected to the cylinder part 2 via the second end wall portion 8. The control unit 30 has a valve means 31, which controls the flow to and from the working chamber 5 and the return chamber 6, a sound absorber 35, two measuring connections 36, 37 for the working chamber 5 and the return chamber 6, respectively, and a connection 38 for the supply of fluid from the pressure source 39. The control unit 30 also comprises a pressure regulator device 30, which has a nonreturn valve unit 32, a high-pressure regulator unit 33 and a low-pressure regulator unit 34. The valve means 31 has a valve piston 31 which moves in a valve body 31 in order to open and close, respectively, ducts 60 which extend from the pressure source 39 to the cylinder part 2 or other parts of the control unit 30. The sound absorber 35 dampens the piercing noise that arises when the working chamber 5 is opened via the valve means 31 or when the return chamber 6 is opened via the pressure regulator device 30 to reduce the pressure in the same. The sound absorber 35 may also be provided with a throttling, making it possible to control the speed of the return movement of the piston 4.

The function of the cylinder device 1 consists in a first fluid flowing from the pressure source 39, such as a compressor, to the connection 38 of the system pressure. The valve means 31 of the control unit 30, which for instance be manufactured by MAC Valves Inc., is set by means of the valve piston 31 so that a duct 61 is opened with the supply of a first fluid from the pressure source 39 to the working chamber 5. At the same time, there is a second fluid in the return chamber 6. When the first fluid flows into the working chamber 5, a working pressure forms which acts on the piston 4 so that a working stroke is executed. During the working stroke, the return chamber 6 is closed so that the second fluid in the return chamber 6 and the associated expansion chambers 20, 21, 22, 23 are compressed and a back pressure is built up. This is the backpressure which is subsequently used to return the piston 4 during the return stroke without any supply of additional fluid.

A common pressure in the working chamber of a pneumatic cylinder device is preferably in the range of about 1-7 bar, and most preferably about 6 bar. The back pressure which is built up in the return chamber is then preferably in the range of about 1-6 bar, and most preferably about 3 bar, depending on the desirable speed of the piston. The high-pressure regulator unit 33 and the low-pressure regulator unit 34 of the pressure regulator device 30 make it possible to maintain the built-up back pressure in the return chamber 6 in an interval between a maximum pressure value and the minimum pressure value in the return chamber during operation.

By using the expansion chambers and the ducts in the end wall portions, a sufficiently large volume is obtained for providing a back pressure which can execute the return stroke when the pressure in the working chamber simultaneously decreases due to an opening of the working chamber to the atmosphere via the valve means 31. The decreasing of
the pressure in the working chamber lowers the force which the return stroke has to overcome to move the piston 4 all the way back to its original position. At the same time as the backpressure will not be as high as to cause any risk of explosion or the like. The nonreturn valve unit 32 communicates with the return chamber 6 via a duct 63 on one side and with the pressure source 39 via a duct 64 on the other side. When a pressure drop occurs in the connection 38 or in the duct 64 or if the pressure in the duct 63 becomes excessively high, the nonreturn valve unit 32 opens. (The duct 64 is bored within the block, why a pressure drop is possible, but not likely in the duct 64) Then the second fluid flows out of the return chamber, which causes a return stroke, if any, to stop. If the connection 38 is unbroken the fluid is returned to the pressure source 39, otherwise it is let out into the atmosphere.

[0035] The high-pressure regulator unit 33 communicates with the return chamber 6 and the expansion chambers via the duct 63. When the pressure in the return chamber exceeds the adjustable maximum pressure value the high-pressure regulator unit 33 opens and the second fluid flows out to the atmosphere via the duct 65 and the sound absorber 35. If desired, the second fluid can be led away from the cylinder device 1 via the duct 65 as it is not desirable to release the fluid to the atmosphere near the cylinder device 1. Usually, there is always some leakage past the piston head 11 during the operation of a cylinder device. After a great number of cycles, this leakage may result in the backpressure in the return chamber getting so high as to stop the working stroke. It is then important that the excess fluid in the return chamber is removed from the system via the high-pressure regulator unit.

[0036] FIG. 6, shows an alternative to the above-described embodiment. The only difference is that another sound absorber 67 is provided in addition to the sound absorber 35. As is shown in FIG. 6, there is no direct connection between the sound absorber 35 and the duct 65. The duct 65 is instead connected to the sound absorber 67. When the pressure in the return chamber in this embodiment exceeds the adjustable maximum pressure value this embodiment exceeds the adjustable maximum pressure value. The high-pressure regulator unit 33 opens, just as in the above described embodiment, but the second fluid flows out to the atmosphere via the duct 65 and the sound absorber 67 instead of via the sound absorber 35. In all other aspects the embodiments are the same.

[0037] According to the described preferred embodiment, the first and the second fluids are preferably the same, for instance air. Different fluids could, however, be used in the cylinder device.

[0038] The low-pressure regulator unit 34 communicates with the return chamber 6 and the expansion chambers via the duct 63. It also communicates with a fluid source which feeds the second fluid to the return chamber via the duct 63 when the pressure in the return chamber is lower than the minimum pressure value, which can be adjusted as required. If as described above the first and the second fluids are the same, the pressure source and the fluid source are also the same source. The function of the low-pressure regulator unit 34 is thus to always permit the supply of more fluid to the return chamber when the pressure therein gets too low for the return stroke to be executed.

[0039] Regarding the relation between the pressure opening the nonreturn valve unit 32 and the pressure opening the high-pressure regulator unit 33, the situation is as follows. The pressure opening the nonreturn valve unit 32 is a fixed pressure value determined by the pressure source 39. The opening pressure is equal to the output pressure of the source 39. The pressure opening the high-pressure regulator unit 33 is the maximum pressure value corresponding to the maximum permissible pressure in the return chamber. This value is adjustable.

[0040] For applications where the pressure in the return chamber is below the output pressure of the pressure source 39, e.g. for light loads on the piston rod 10, the opening pressure for the high-pressure regulator unit 33 is adjusted into being lower than the pressure opening the nonreturn valve unit 32. In such a case the nonreturn valve unit 32 is inactive for most applications. Only cases with very quick movements of the piston will cause the nonreturn valve unit 32 to open.

[0041] E.g. the maximum pressure value is adjusted 0.1-0.2 bars higher than the highest expected pressure in the return chamber. Fluid leakage from the working chamber into the return chamber causing the piston to stop after a number of movements will thereby be taken care of by the high-pressure regulator unit 33 letting the excess fluid out into the atmosphere. Only very small amounts of fluid leak from the working chamber into the return chamber, causing only very small amounts of fluid to be let out into the atmosphere.

[0042] However, it is also possible to adjust the maximum pressure value opening the high-pressure regulator unit 33 into being higher than the pressure opening the nonreturn valve unit 32. In such a case the high-pressure regulator unit 33 is practically inactive. This is done for applications where the pressure in the return chamber is above the output pressure of the pressure source 39, e.g. for heavy loads on the piston rod 10. The pressure in the return chamber can be as high as e.g. 10-15 bars during the working stroke, due to compression of the fluid in the ducts. This excess pressure is returned to the pressure source 39 and thus contributes to the energy-saving in the system. An important aspect of the present invention is the preservation of the kinetic energy. The built up pressure in the return chamber of course requests a high force to be exerted on the piston during the working stroke. This is however compensated by the preservation of the kinetic energy, which is used during the return stroke. According to some teachings of prior art, a constant backpressure is accomplished without compression in the working/return chamber, by the provision of a throttle nonreturn valve in each end of the working/return chamber. In this way full working power can be achieved in both directions of the cylinder. The amount of used pressurised fluid is however twice as big as in the present invention.

[0043] The valve means 31 is controlled such that fluid which flows out of the cylinder part 2 flows through ducts 61, 62 and 66 and fluid which flows into the cylinder part 2 flows in only through the ducts 61 and 66. Hereby one could say that fluid flow out of the cylinder part 2 goes via a duct with a greater cross-sectional diameter than what is the case for flow into the cylinder part 2. This increases the outlet flow by 80% compared with the inlet flow, and as a result the occurrence of undesirable pressures is avoided when fluid is led away from the cylinder part 2. The duct 61 may be provided with a throttle nonreturn valve between the outlet
from the working chamber and the duct 62. This valve does not affect the outlet flow from the working chamber but reduces the flow into the working chamber. Hereby it is possible to control the working stroke. In the preferred embodiment, the valve means 31 has a ½ when fluid flows to the cylinder part 2 and a ½ when fluid flows from the cylinder part. By over-dimensioning the sound absorber 35, there is no formation of backpressure due to the flow of fluid out of the sound absorber.

[0044] According to another embodiment (not shown) of the invention, some of the expansion chambers 20, 21, 22, 23 communicate with each other and the return chamber 6 via ducts 40 in the first end wall portion 7 and some of the expansion chambers communicate with each other and the working chamber 5 via ducts in the second end wall portion 8. As a result, both the working chamber 5 and the return chamber 6 can be used as a return chamber. An actuating means is then used to change the flow of the fluid from the pressure source to the desired chamber 5, 6 and the working stroke can be inverted.

[0045] According to yet another embodiment (not shown), the control unit could be arranged at a distance from the cylinder part 2. This would result in a reduction of the dimensions of the cylinder device in direct connection with the cylinder part, which may be desirable in certain industries. It could also be possible to connect at least two cylinder parts to a control unit. A second cylinder part could be connected to the control unit via the connections 36, 37, which are otherwise used for measuring the pressure in the working chamber and the return chamber. It would constitute a saving in costs to use only one control unit having several cylinder parts since the number of control units is reduced. In test runs of the cylinder device, energy savings on the air consumption of about 50-80% have been achieved depending on the pressure in the working chamber.

[0046] It will be understood that a number of modifications of the above-mentioned embodiment of the invention are possible within the scope of the invention, as defined in the appended claims. For instance, as described above, the ducts 40, 41 in the end wall portions can have obtuse angles, substantially circular shape or some other design which minimises the flow resistance of the fluids in the cylinder device. Use could also be made of end wall chambers in the end wall portions instead of ducts in the end wall portions to connect the expansion chambers to the return chamber. Furthermore, a hybrid of the cylinder device could be provided if a hydraulic liquid is used as the first fluid and a compressible gas is used as the second fluid. Considerably higher pressures could then be applied to the piston in the working stroke than in the case of completely pneumatic cylinder devices.

[0047] Moreover, the expansion chambers in the cylinder device are preferably dimensioned such that the total sum of the cross-sectional areas of the return chamber and the expansion chambers minus the cross-sectional area of the piston rod is about 50% greater than the cross-sectional area of the piston head in the working chamber. This results in a sufficient return force being generated by the fluid in the return chamber so that the piston is actually returned in the return stroke. According to one example, the piston of the cylinder unit with a piston diameter of about 6.3 cm has a cross-sectional area of about 31.2 cm² which is exposed to the working pressure in the working chamber. Further, according to this example the cross-sectional area of the piston in the return chamber which is exposed to the return pressure is about 28.06 cm², i.e. about 51.2 cm² minus the cross-sectional area of the piston rod of about 3.14 cm², since the piston rod has a diameter of about 1 cm. The cross-sectional area of the expansion chambers is then preferably at least about 18.9 cm² to provide the desired relation of dimensions which is stated above. Preferably, the above-mentioned relations of the cross-sectional areas are provided at the same time as the cylinder device still satisfies the international dimension standard VDMA. A great volume is provided in the expansion chambers by their extending along substantially the entire length of the cylinder part.

1. A method of in an energy-saving way operating a single-acting cylinder device provided with a return function, which comprises a cylinder part 2 with an interior duct 50 and a piston 4 arranged in a movable manner in the duct 50, said piston defining a working chamber 5 and a return chamber 6 in the duct 50 and executing a working stroke and a return stroke in the same, the method comprising the steps of causing a first fluid to flow into the working chamber 5 from a pressure source 39, which has an output pressure, and thereby operating the working stroke of the piston 4, closing the return chamber 6, so that a second fluid in the return chamber 6 is compressed during the working stroke of the piston 4, and opening the working chamber 5 after the working stroke, so that the first fluid is permitted to flow out of the working chamber 5 into the atmosphere and so that the second fluid compressed in the return chamber 6 returns the piston 4 during the return stroke, characterised by the step of reducing the pressure of the second fluid in the return chamber 6 if this pressure exceeds an upper pressure value, which is the pressure reached first of either the output pressure of the pressure source 39 or a maximum pressure value, which corresponds to a maximum permissible pressure in the return chamber 6 during operation.

2. A method as claimed in claim 1, wherein the return chamber 6 is opened via a nonreturn valve unit 32 if the pressure of the second fluid in the return chamber 6 exceeds the output pressure of the pressure source 39 counteracting the nonreturn valve unit 32, so that the piston 4 is prevented from executing a return stroke in case of a sudden pressure drop of the pressure source 39 or an undesired pressure rise in the return chamber 6.

3. A method as claimed in claim 1 or 2, wherein the second fluid is caused to flow out of the return chamber 6 via a high-pressure regulator unit 33 at least as long as the pressure of the second fluid in the return chamber 6 exceeds the maximum pressure value, which is settable.

4. A method as claimed in claim 3, wherein the high-pressure regulator unit 33 is closed when the pressure of the second fluid in the return chamber 6 is on a level with the maximum pressure value.
6. A method as claimed in any one of the preceding claims, wherein the second fluid is caused to flow into the return chamber (6) via a low-pressure regulator unit (34) at least as long as the pressure in the return chamber (6) is lower than a minimum pressure value, which corresponds to a minimum acceptable pressure in the return chamber (6) during operation.

7. A method as claimed in claim 6, wherein the low-pressure regulator unit (34) is closed when the pressure of the second fluid in the return chamber (6) is on a level with the minimum pressure value.

8. A energy-saving cylinder device of single-acting type with a return function, comprising a cylinder part (2) with an interior duct (50) and a piston (4) arranged in a movable manner in the duct (50), said piston defining a working chamber (5) in the duct (50) for a first fluid and a return chamber (6) for a second fluid and executing a working stroke and a return stroke, and a control unit (30) for controlling the flow of the first fluid between a pressure source (39), which has an output pressure, and the cylinder part (2), characterised in that the control unit has a pressure regulator device (30) which is connected to the return chamber (6) and arranged to reduce the pressure of the second fluid in the same if this pressure exceeds an upper pressure value, which is the pressure-reached first of either the output pressure of the pressure source (39) or a maximum pressure value, which corresponds to a maximum permissible pressure in the return chamber (6) during operation.

9. A cylinder device as claimed in claim 8, wherein the pressure regulator device (30) comprises a nonreturn valve unit (32), which is connected to the return chamber (6) and the pressure source (39) and is arranged to open and release the second fluid from the return chamber (6) at least as long as the pressure of the second fluid in the return chamber (6) exceeds the output pressure of the pressure source (39) countering the nonreturn valve unit (32), so that the piston (4) is prevented from executing a return stroke in case of a sudden pressure drop of the pressure source (39) or an undesired pressure rise in the return chamber (6).

10. A cylinder device as claimed in claim 10, wherein the low-pressure regulator device (34) comprises a high-pressure regulator unit (33), which is connected to the return chamber (6) and which is arranged to open and release the second fluid from the return chamber (6) at least as long as the pressure of the second fluid in the return chamber (6) exceeds the maximum pressure value, which is settable.

11. A cylinder device as claimed in claim 10, wherein the high-pressure regulator unit (33) is arranged to close the return chamber (6) when the pressure of the second fluid in the return chamber (6) is on a level with the maximum pressure value.

12. A cylinder device as claimed in any one of claims 8-11, wherein the pressure regulator device (30) comprises a low-pressure, which is connected to the return chamber (6) and a fluid source (39) and is arranged to open and introduce fluid into the return chamber (6) at least as long as the pressure of the second fluid in the same is lower than a minimum pressure value, which corresponds to a minimum acceptable pressure in the return chamber (6) during operation.

13. A cylinder device as claimed in claim 12, wherein the low-pressure regulator unit (34) is arranged to close the return chamber (6) when the pressure of the second fluid in the return chamber (6) is on a level with the minimum pressure value.

14. A cylinder device as claimed in any one of claims 8-13, wherein the control unit (31) communicates with the working chamber (5) and is arranged to control the first fluid to and from the working chamber (5), such that the flow resistance of the first fluid is lower out of the working chamber (5) than into the same.

15. A cylinder device as claimed in any one of claims 8-14, wherein the cylinder part (2) comprises an elongated casing (3), which on the inside defines said duct (50), and at least one end wall portion (7, 8) which is arranged to close the duct (50) in an associated end of the casing (3), and wherein the casing (3) on the outside of the duct (50) comprises an elongated, double-wall portion which defines at least one expansion chamber (20, 21, 22, 23) which is in fluid communication with the return chamber (6).

16. A cylinder device as claimed in claim 15, wherein each expansion chamber (20, 21, 22, 23) is in fluid communication with the return chamber (6) via at least one duct (40) in the end wall portion (7, 8).

17. A cylinder device as claimed in claim 16, wherein at least two expansion chambers (20, 21, 22, 23) are in fluid communication with the return chamber (6) and each other via at least one duct (40) in the end wall portion (7, 8) to minimise the flow resistance of the second fluid.

18. A cylinder device as claimed in claim 15, wherein each expansion chamber (20, 21, 22, 23) is in fluid communication with the return chamber (6) via an end wall chamber (not shown) in the end wall portion (7, 8).

19. A cylinder device as claimed in claim 18, wherein at least two expansion chambers (20, 21, 22, 23) are in fluid communication with the return chamber (6) and each other via the end wall chamber (not shown) in the end wall portion (7, 8).

20. A cylinder device as claimed in any one of claims 15-19, wherein a second end wall portion (8) is arranged to close the duct (50) in a second associated end of the casing (3).

21. A cylinder device as claimed in claim 20, wherein the second end wall portion (8) defines an end wall chamber (not shown) which is in fluid communication with the return chamber (6), preferably via said at least one expansion chamber (20, 21, 22, 23) in the casing (3).

22. A cylinder device as claimed in claim 20 or 21, wherein the double-wall portion (3, 3') of the casing (3) defines at least two expansion chambers (20, 21, 22, 23), which both are in fluid communication with the return chamber (6) via at least one duct (40) or end wall chamber in the first end wall portion (7) and which are in fluid communication with each other via at least one duct (41) or end wall chamber in the second end wall portion (8).

23. A cylinder device as claimed in any one of claims 20-22, wherein the double-wall portion (3, 3') of the casing (3) defines at least two separate expansion chambers (20, 21, 22, 23), and wherein one expansion chamber (20, 21, 22, 23) is in fluid communication with the return chamber (6) via at least one duct (40) in the first end wall portion (7) and the other expansion chamber (20, 21, 22, 23) is in fluid communication with the working chamber (5) via at least one duct (41) in the second end wall portion (8) to permit an inversion of the function of the return chamber (6) and the working chamber (5).