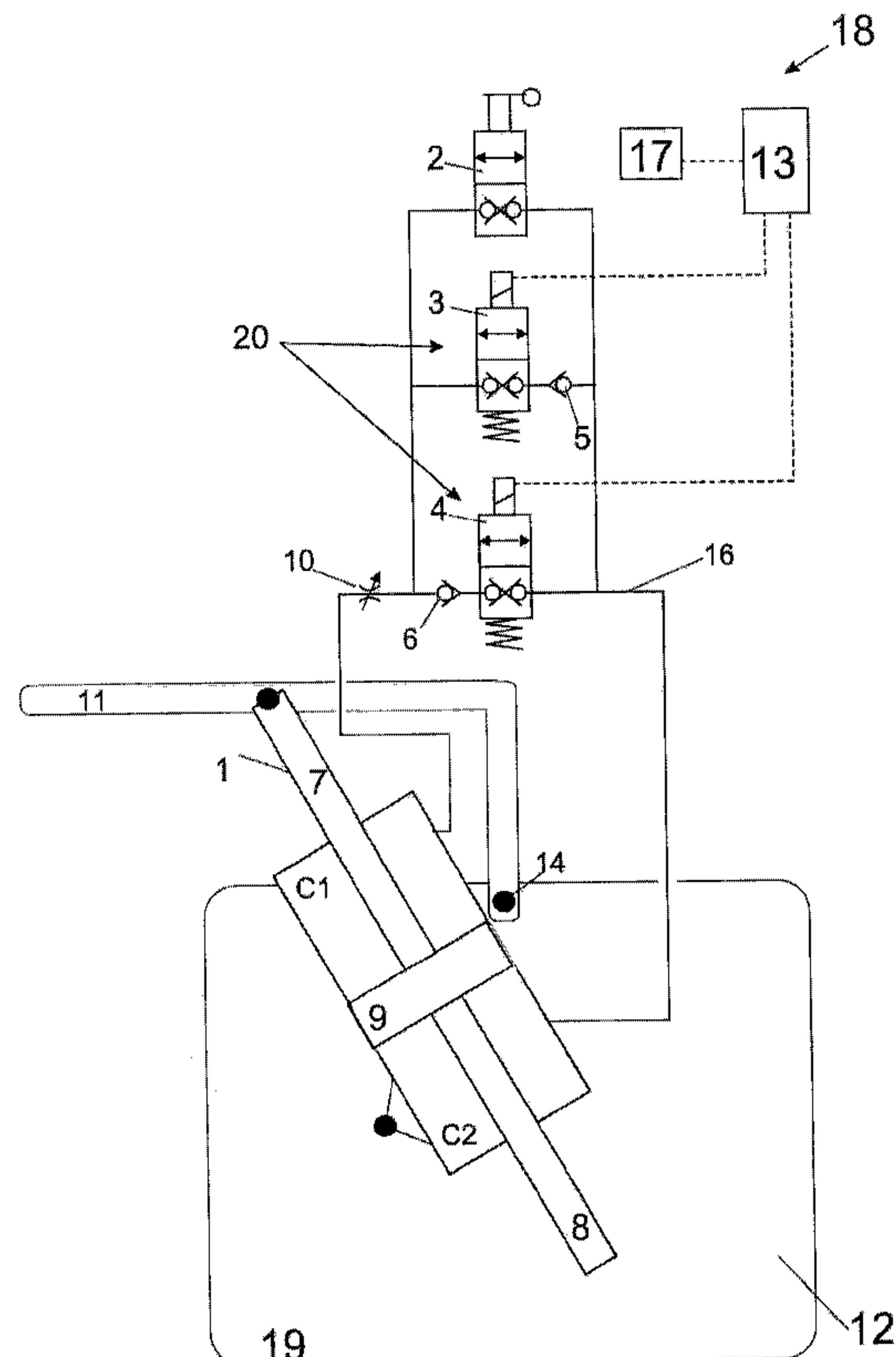




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(57) **Abrégé/Abstract:**

A lifting apparatus (19) suspendably mounted on a holding apparatus (11), wherein during operation a pivot angle of the holding apparatus (19) which deviates from a vertical straight line can be limited by a safety apparatus (18), wherein the pivot angle can be monitored and limited in two opposite directions, wherein swinging of the lifting apparatus (19) back towards the vertical straight line is not impeded.

Abstract

A lifting apparatus (19) suspendably mounted on a holding apparatus (11), wherein during operation a pivot angle of the holding apparatus (19) which deviates from a vertical straight line can be limited by a safety apparatus (18), wherein the pivot angle can be monitored and limited in two opposite directions, wherein swinging of the lifting apparatus (19) back towards the vertical straight line is not impeded.

Work cage

The invention concerns a lifting apparatus mounted suspendably to a holding apparatus, wherein in operation a pivotal angle of the lifting apparatus deviating from a vertical straight line can be limited by way of a safety apparatus, a crane having such a lifting apparatus and a vehicle having such a crane.

Such lifting apparatuses are already known from EP 2 433 898 A1. In that specification the lifting apparatus involves for example a work cage which is mounted in gravitationally levelling relationship to a rotary mounting and can be blocked and damped by way of a hydraulic cylinder. The hydraulic cylinder is blocked by way of a blocking valve disposed in a compensating line between the two chambers C1 and C2 of the hydraulic cylinder. That valve is controlled by a controlling unit and enables or closes off the through-flow between the chambers C1 and C2 of the hydraulic cylinder. In addition there is a throttle action between the two chambers and thus the swinging movement of the lifting apparatus is damped. That damping admittedly causes a slowing of the swinging movement of the lifting apparatus but it does not prevent the lifting apparatus inclining severely when the operator leans out. For that reason the blocking valve is disposed in the compensating line between the chambers C1 and C2.

European Standard 280 requires that in precisely such a situation the lifting apparatus may not incline further than 5° relative to the horizontal. If that 5° angle is exceeded the swinging movement must be automatically stopped. Furthermore the European Standard 280 requires that, if a lifting angle movement is nonetheless continued, which is performed for example by way of the lifting apparatus which is connected to the crane, a further inclination above 10° is automatically stopped at the lifting apparatus. The above-mentioned patent specification discloses that only one blocking valve is installed in the compensating line. That gives rise to the disadvantage that, at any inclination above 5° up to 10° the blocking valve is blocked by way of the controlling unit and no compensation can take place between the

chambers C1 and C2 at the hydraulic cylinder. The operator therefore has to connect the two chambers together by means of deactivation of the safety apparatus in order to be able to horizontally orient the lifting apparatus.

The object of the invention is to avoid that above-described disadvantage and to provide a system which is improved over the state of the art. In the lifting apparatus according to the invention that is achieved in that the pivotal angle is adapted to be monitorable and limitable in two mutually opposite directions, wherein swinging settlement of the lifting apparatus back in the direction of the vertical straight line remains unimpeded.

According to a further embodiment it can be provided that the safety apparatus on the lifting apparatus comprises at least one sensor, for example an angle sensor, a controlling unit and a blocking apparatus like for example at least one blocking valve in the form of a blocking valve. The angle sensor referred to by way of example, co-operating with the controlling unit, monitors permanently and in a fraction of a second the inclination of the lifting apparatus. As long as the inclination remains in a range below a first threshold value which can be predetermined by the controlling unit the blocking apparatus remains open and the through-flow between the chamber C1 and the chamber C2 is enabled. In that range therefore the lifting working platform can freely swing. In that case the operator of the lifting apparatus can now horizontally orient the lifting apparatus by displacement of weight and then block it in position by way of the blocking apparatus. The lifting apparatus should no longer swing in that position but should form a platform which is as stable as possible to be able to make the work easier.

In this example of use blocking is effected by way of two blocking valves, for example solenoid valves, which close the communication between the chambers C1 and C2 and no longer ensure a through-flow between the two chambers. If however the crane moves the lifting apparatus should be able to swing freely. In that case both valves are opened as long as the lifting apparatus does not exceed an inclination of the previously input first threshold value. As soon as now a sensor registers an

inclination beyond the first threshold value, which is caused for example by an operator leaning out, the safety apparatus immediately blocks the corresponding valve. Further tipping in that direction is therefore no longer possible. The second valve however remains opened and thus the operator can move the lifting apparatus back into a range below the first threshold value by moving his own weight without for example having to stop the crane movement or actuate a further valve. Thus a return to below the first threshold value can always be possible without interrupting the travel movement and opening a further valve, and this can be extremely convenient for the operator of the lifting apparatus. Nonetheless there can be the possibility that the cage is fixed in the working position by way of both blocking valves and that therefore affords a stable working surface.

According to an aspect of the present disclosure, there is provided a system comprising: a lifting apparatus to be suspended from a holding apparatus, for gravitational levelling of the lifting apparatus by pivotal movement of the lifting apparatus relative to the holding apparatus, a hydraulic cylinder to be mounted between the lifting apparatus and the holding apparatus, the hydraulic cylinder comprising first and second chambers connected together by a compensating line, and a safety apparatus coupled to the hydraulic cylinder to monitor a pivotal angle of the lifting apparatus, and to limit the pivotal angle of the lifting apparatus deviating from a vertical straight line in two mutually opposite directions by blocking displacement of oil between the first and second chambers through the compensating line by the pivotal movement, wherein swinging settlement of the lifting apparatus back in the direction of the vertical straight line by weight displacement in the lifting apparatus is damped by displacement of oil between the first and second chambers through the compensating line by a pivotal movement of the lifting apparatus back in the direction of the vertical straight line but otherwise remains unimpeded.

There is also provided a crane having a system as disclosed herein.

A vehicle having such a crane is also provided.

Further details and advantages of the present invention are described more fully hereinafter by means of the specific description with reference to the embodiments by way of example illustrated in the drawings in which:

Figure 1 shows a diagrammatic view of the safety apparatus in the working position of the lifting apparatus,

Figure 2 shows a diagrammatic view of the safety apparatus during the crane movement and below the first threshold value,

Figure 3 shows a diagrammatic view of the safety apparatus in which the second threshold value was exceeded and the bridging apparatus is activated,

5 Figure 4 shows a diagrammatic view of the safety apparatus with enabled through-flow from cylinder chamber C2 to cylinder chamber C1 at a pivotal angle between the first threshold value and the second threshold value,

10 Figure 5 shows a diagrammatic view of the safety apparatus with opened through-flow from cylinder chamber C1 to cylinder chamber C2 at a pivotal angle between the first threshold value and the second threshold value,

Figure 6a shows an embodiment having a cylinder, fixed at the piston rod side to the holding apparatus and connected at the cylinder casing side to the lifting apparatus,

Figure 6b shows an embodiment with a hydraulic cylinder disposed on a toothed rack,

Figure 7 shows a crane with fitted lifting apparatus, and

Figure 8 shows a vehicle with fitted lifting apparatus on a crane.

5 Figure 1 diagrammatically shows the condition of a blocked lifting apparatus (19), for example a work cage 12. The double-acting hydraulic cylinder 1 comprising two chambers C1 and C2 and a piston 9 with two piston rods 7, 8 has a compensating line 16. A throttle 10 is disposed in the line 16. The throttle 10 is responsible for ensuring that compensation
10 between the chambers C1 and C2 cannot take place too quickly. Therefore the swinging action of the lifting apparatus 19 is damped down by way of that throttle 10. The non-return valve 6 prevents a compensating flow from the chamber C1 to the chamber C2. The non-return valve 5 prevents a compensating flow between the chamber C2 to the chamber C1. The
15 through-flow between the chambers C1 and C2 could be made only by way of the blocking valves 3 and 4. In this embodiment however they are in their closed position as this involves blocking valves which are held in the closed condition by way of a spring as they are not powered. As the hydraulic cylinder 1 is connected to the work cage 12 it therefore remains in
20 position and affords a stable platform for the operator. As long as the work cage 12 was to be in that position and the crane 26 does not move no current is also passed to the blocking valves 3 and 4 by the controlling unit 13.

Figure 2 now shows the safety apparatus 18 during displacement with
25 the crane 26 below a first threshold value, the blocking valves 3 and 4 being powered by the controlling unit 13. It is thus possible for the oil to be displaced out of the chamber C2 into the chamber C1 and the oil to be displaced from the chamber C1 into the chamber C2. That occurs by way of the two opened blocking valves 3 and 4. The oil can further be displaced
30 from the chamber C2 by way of the compensating line 16 by way of the opened blocking valve 4 into the chamber C1 by way of the non-return valve 6. The oil from the chamber C1 can also be displaced by way of the compensating line 16 and by way of the opened blocking valve 3 further

into the chamber C2 by way of the non-return valve 5. The oil flow between the two chambers is in that case damped by the throttle 10. The bridging apparatus 2 always remains in the closed condition in that situation.

Figure 3 shows two unpowered blocking valves 3 and 4 as in this example of use the lifting apparatus 19 has been inclined above an angle of the second threshold value. To be able to prevent further inclination the two chambers C1 and C2 are now blocked and return pivotal movement into the neutral position is now possible when the bridging apparatus 2 is manually actuated. Upon manual actuation of the bridging apparatus 2 the flow between C1 and C2 is restored and the function of the blocking valves 3 and 4 is bridged over. In this case also the return pivotal movement into the neutral position is performed damped by way of the throttle 10. In addition, upon inclination of the lifting apparatus 19 above the second threshold value, the crane is automatically shut down and further displacement with the crane is not possible.

Figure 4 shows how the oil flows from the chamber C1 by way of the compensating line 16 into the blocking valve 3 which is powered by the controlling unit 13. In addition it flows by way of the non-return valve into the chamber C2. It is however not possible for the oil to be displaced back from the chamber C2 into the chamber C1 as the blocking valve 4 is not powered and is thus closed. That switching position occurs when the lifting apparatus 19 is in a position between the first threshold value and the second threshold value. This means that further outward pivotal movement of the lifting apparatus 19 into an unstable position which would lead to danger to the operator is no longer possible, but return pivotal movement into a stable position of the lifting apparatus 19 remains open. The operator of the lifting apparatus 19 can now move the lifting apparatus 19 into a neutral position again simply by weight displacement without having to actuate a valve or shut down the crane. The direction in which the lifting apparatus 19 pivots in that case or the extent to which the angle deviates from the first threshold value is registered by the sensor 17. If now the operator pivots the lifting apparatus back to a value below the first threshold value by virtue of weight displacement that is at the same time

detected by the at least one sensor 17 and passed to the controlling unit 13. The controlling unit 13 thereupon again powers up both blocking valves 3 and 4 and the exchange of oil between chamber C1 and chamber C2 can again take place, as shown in Figure 2.

5 Figure 5 shows a powered blocking valve 4, in which case now the exchange from chamber C2 to chamber C1 can take place, but not in the reverse sequence. As already explained in relation to Figure 4 the operator of the lifting apparatus 19 can now level the lifting apparatus 19 back to a value below the first threshold value again by means of weight
10 displacement -- only this time in the opposite direction, as described in relation to Figure 4. Here too the operator does not have to shut down the crane or actuate an additional valve in order to produce a leveling effect.

Figure 6a shows a lifting apparatus 19, by way of example a work cage 12 on a holding apparatus 11 with a rotary mounting 14. The work
15 cage 12 is mounted rotatably on the rotary mounting 14. The holding apparatus 11 and the work cage 12 are additionally connected together by way of the hydraulic cylinder 1. In this case the cylinder casing can be connected to the work cage 12 and one of the cylinder rods 7, 8 can be connected to the holding apparatus 11. The hydraulic cylinder 1 is filled with
20 oil in both chambers C1 and C2, and both chambers C1, C2 are connected together with a compensating line 16. The oil 11 is now necessarily displaced in the movement of the work cage 12 from the chamber C1 into the chamber C2 or the chamber C2 into the chamber C1.

Figure 6b shows a lifting apparatus 19, by way of example a work
25 cage 12. Here the lifting apparatus 19 is not supported on the holding apparatus 11 directly by way of the hydraulic cylinder 1, but the damping and/or blocking action of the hydraulic cylinder 1 is passed indirectly by way of a toothed rack 21 to the lifting apparatus 19. A toothed rack 21 is fixed for that purpose to the hydraulic cylinder 1. That toothed rack 21 engages
30 into a gear on the rotary mounting 14. Movements at the work cage 12 are thus passed by way of the gear in the rotary mounting 14 to the toothed rack 21 and throttled or also blocked by the hydraulic cylinder 1.

CLAIMS:

1. A system comprising:

5 a lifting apparatus to be suspended from a holding apparatus, for gravitational levelling of the lifting apparatus by pivotal movement of the lifting apparatus relative to the holding apparatus,

a hydraulic cylinder to be mounted between the lifting apparatus and the holding apparatus, the hydraulic cylinder comprising first and second chambers connected together by a compensating line, and

10 a safety apparatus coupled to the hydraulic cylinder to monitor a pivotal angle of the lifting apparatus, and to limit the pivotal angle of the lifting apparatus deviating from a vertical straight line in two mutually opposite directions by blocking displacement of oil between the first and second chambers through the compensating line by the pivotal movement,

15 wherein swinging settlement of the lifting apparatus back in the direction of the vertical straight line by weight displacement in the lifting apparatus is damped by displacement of oil between the first and second chambers through the compensating line by a pivotal movement of the lifting apparatus back in the direction of the vertical straight line but otherwise remains unimpeded.

2. A system as set forth in claim 1, wherein the safety apparatus has at least one sensor, at least one controlling unit and at least one blocking apparatus.

20 3. A system as set forth in claim 2, wherein the at least one sensor is connected to the lifting apparatus.

25 4. A system as set forth in any one of claims 2 and 3, wherein the blocking apparatus is opened at a pivotal angle detected at the at least one sensor smaller than a predetermined first threshold value deviating from the vertical straight line in one of the two mutually opposite directions.

5. A system as set forth in any one of claims 2 through 4, wherein the blocking apparatus is closed at a pivotal angle detected at the at least one sensor greater than a

predetermined second threshold value deviating from the vertical straight line in one of the two mutually opposite directions.

5 6. A system as set forth in claim 5, wherein the lifting apparatus can be swingingly settled in the direction of the vertical straight line with the blocking apparatus blocked at both sides by way of a bridging apparatus.

10 7. A system as set forth in any one of claims 2 through 6, wherein at a pivotal angle detected at the at least one sensor between predeterminable first and second threshold values deviating from the vertical straight line a pivotal movement increasing the pivotal angle can be limited by a blocking apparatus and the pivotal movement back in the direction of the vertical straight line is damped by the displacement of oil between the first and second chambers through the compensating line but otherwise remains unimpeded.

8. A system as set forth in any one of claims 2 through 7, wherein the at least one blocking apparatus co-operates with the hydraulic cylinder and comprises at least two blocking valves.

15 9. A system as set forth in claim 8, wherein the blocking valves are arranged in co-operable relationship with at least two non-return valves on the compensating line.

10. A system as set forth in any one of claims 2 through 9, wherein the at least one sensor ascertains the angle of the lifting apparatus and forwards a value of said angle to the at least one controlling unit.

20 11. A system as set forth in claim 10, wherein the predeterminable first and second threshold values can be stored in the at least one controlling unit.

25 12. A system as set forth in any one of claims 9 through 11, wherein the through-flow from the first chamber to the second chamber can be closed or enabled in the hydraulic cylinder by one of the blocking valves in co-operating relationship with a non-return valve and the through-flow from the second chamber to the first chamber by the other blocking valve in co-operating relationship with a non-return valve.

13. A system as set forth in any one of claims 10 through 12, wherein the blocking valves are actuable individually or simultaneously by the at least one controlling unit and thus

a respective individual one of the first and second chambers can be closed or enabled or said chambers can be simultaneously closed or enabled.

14. A system as set forth in any one of claims 1 through 13, wherein the lifting apparatus is in the form of a work cage.

5 15. A crane having a system as set forth in any one of claims 1 through 14.

16. A vehicle having a crane as set forth in claim 15.

Fig. 1

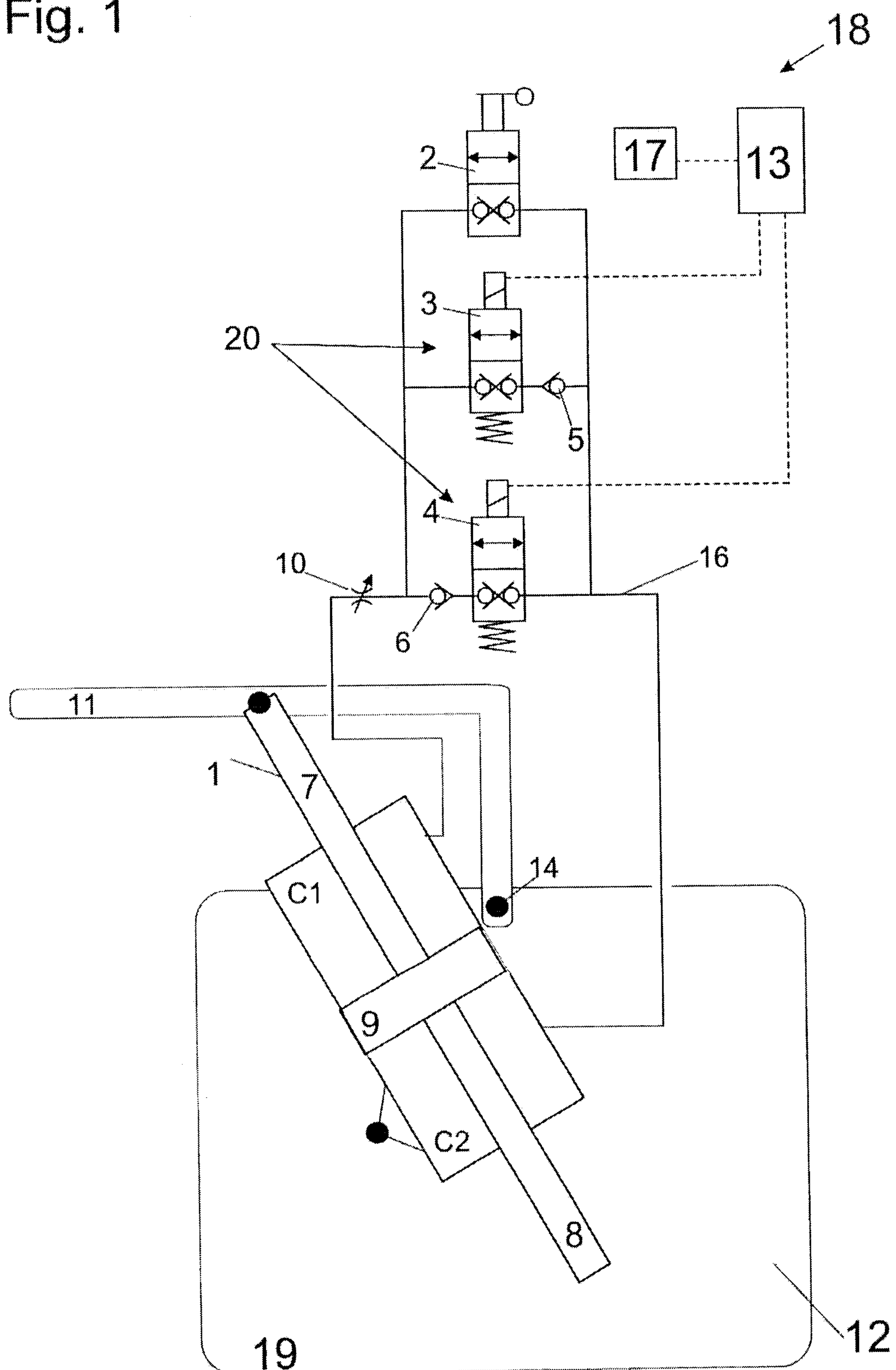


Fig. 2

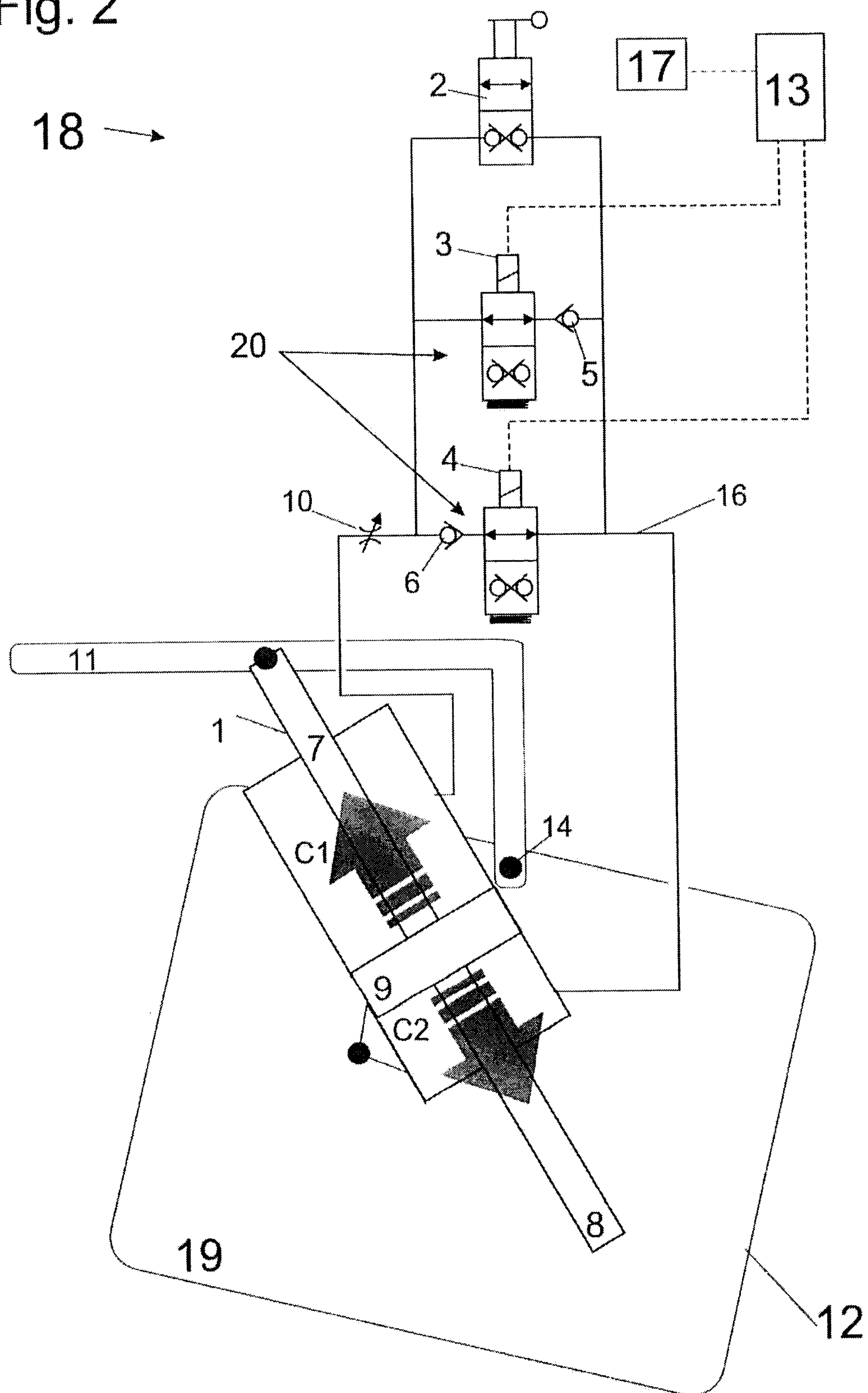


Fig. 3

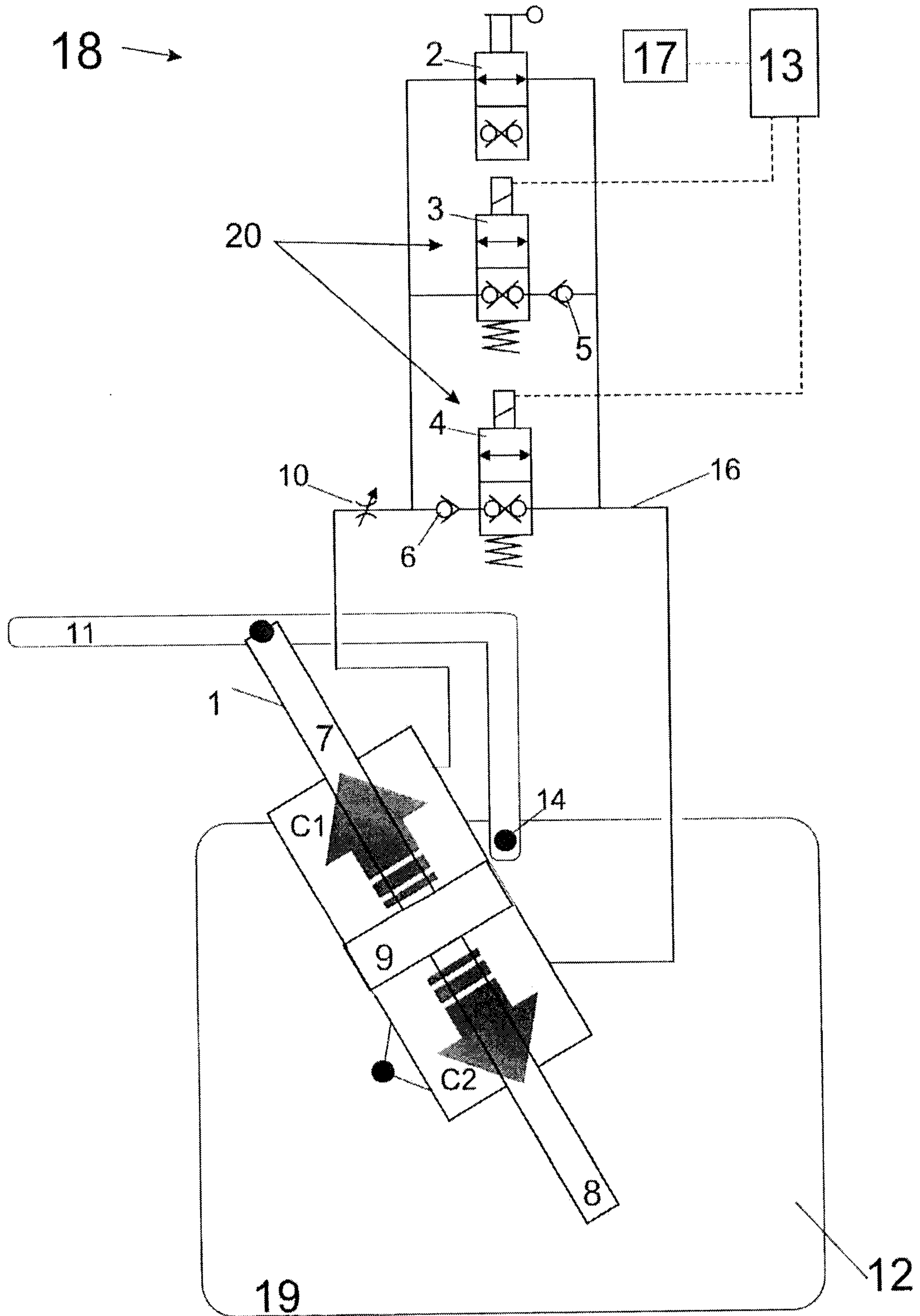
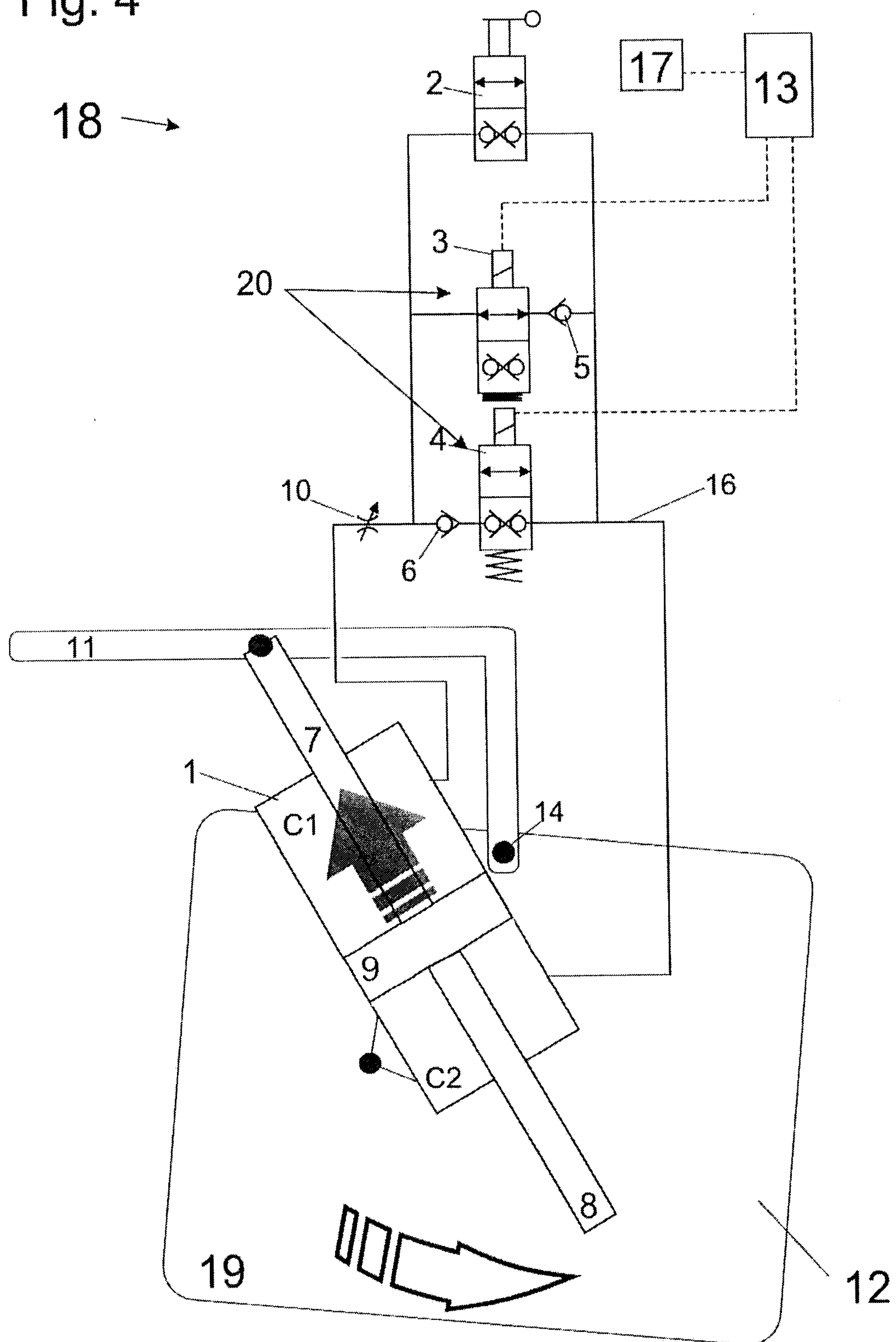


Fig. 4



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Fig. 5

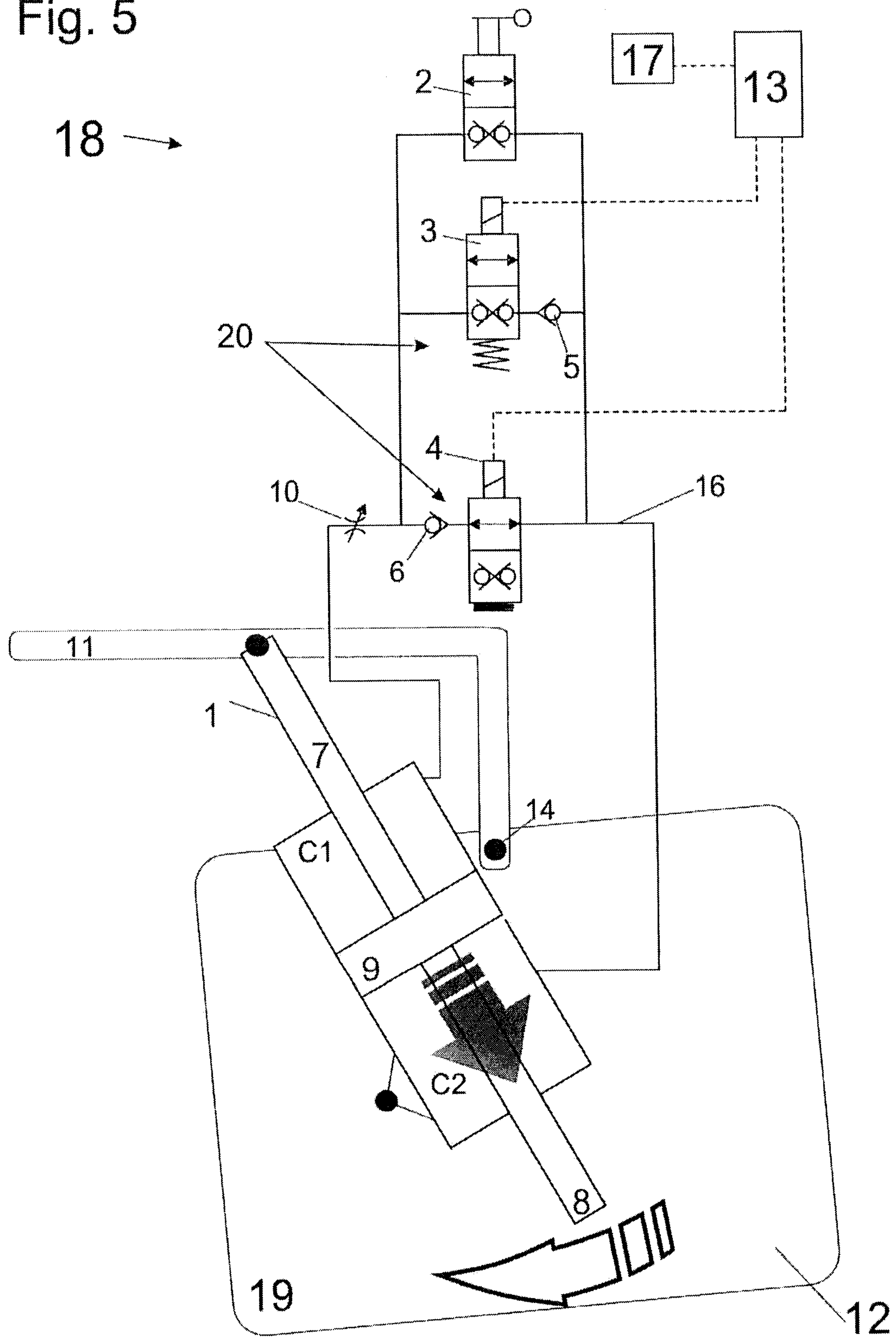


Fig. 6a

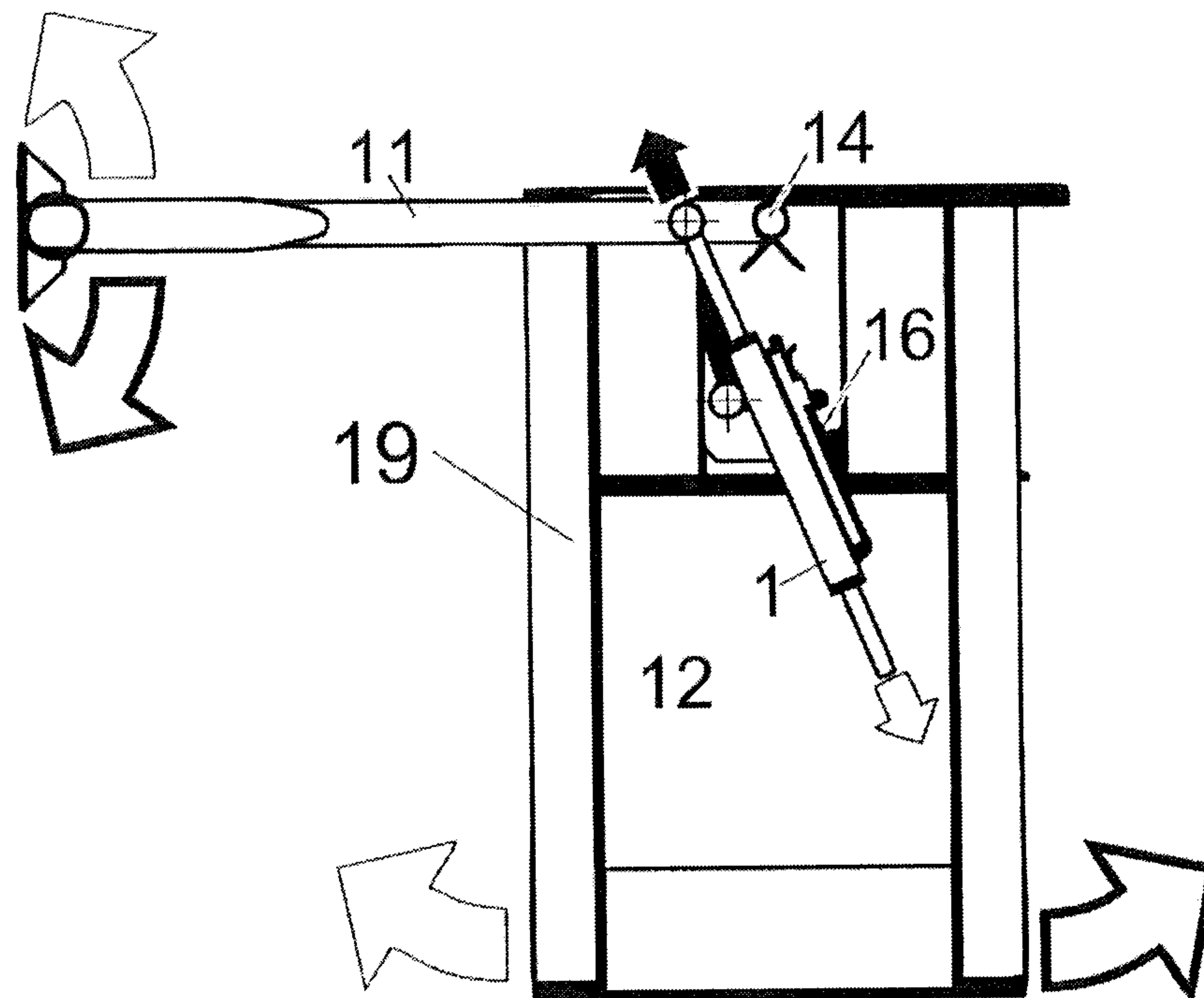
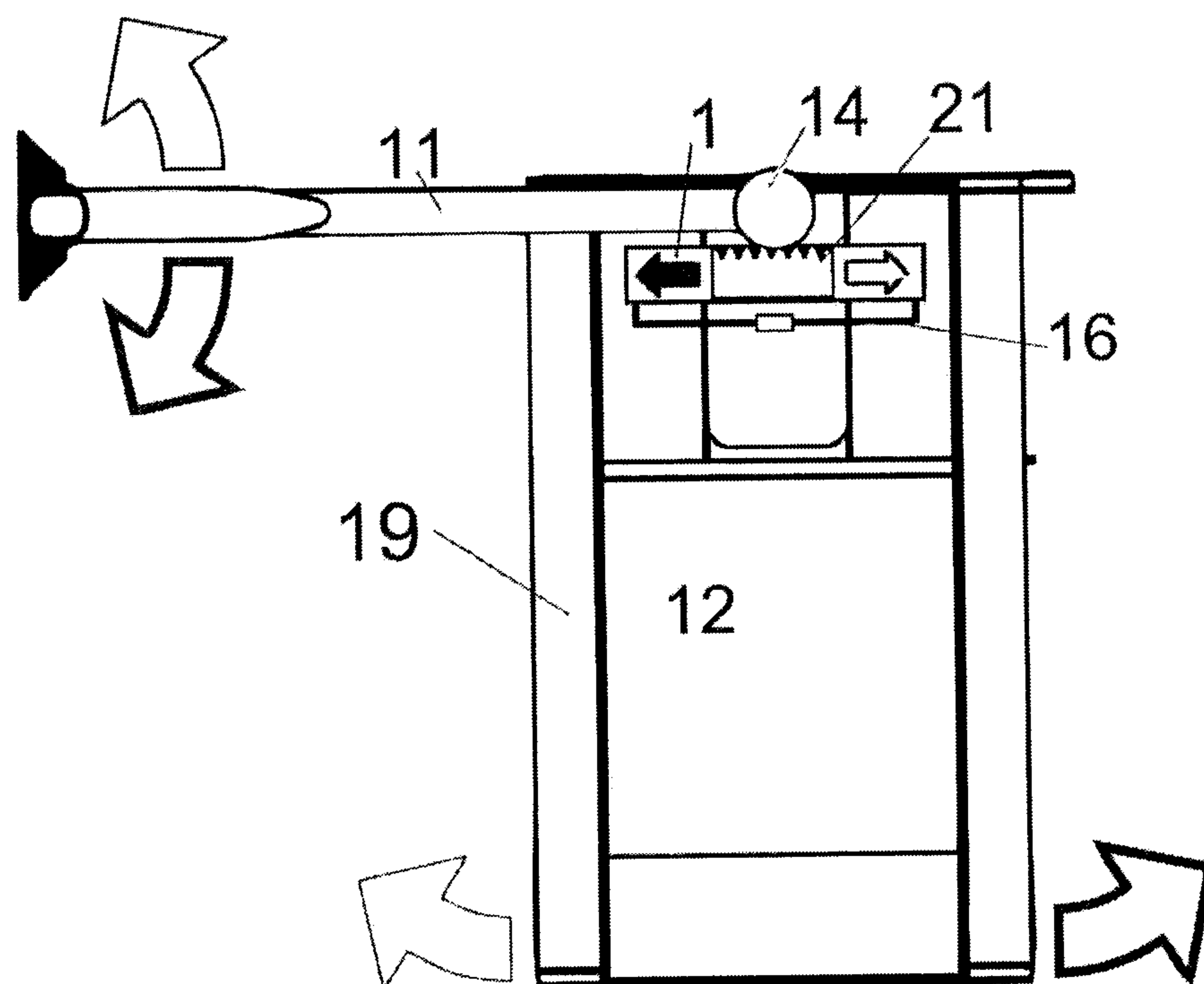


Fig. 6b



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Fig. 7

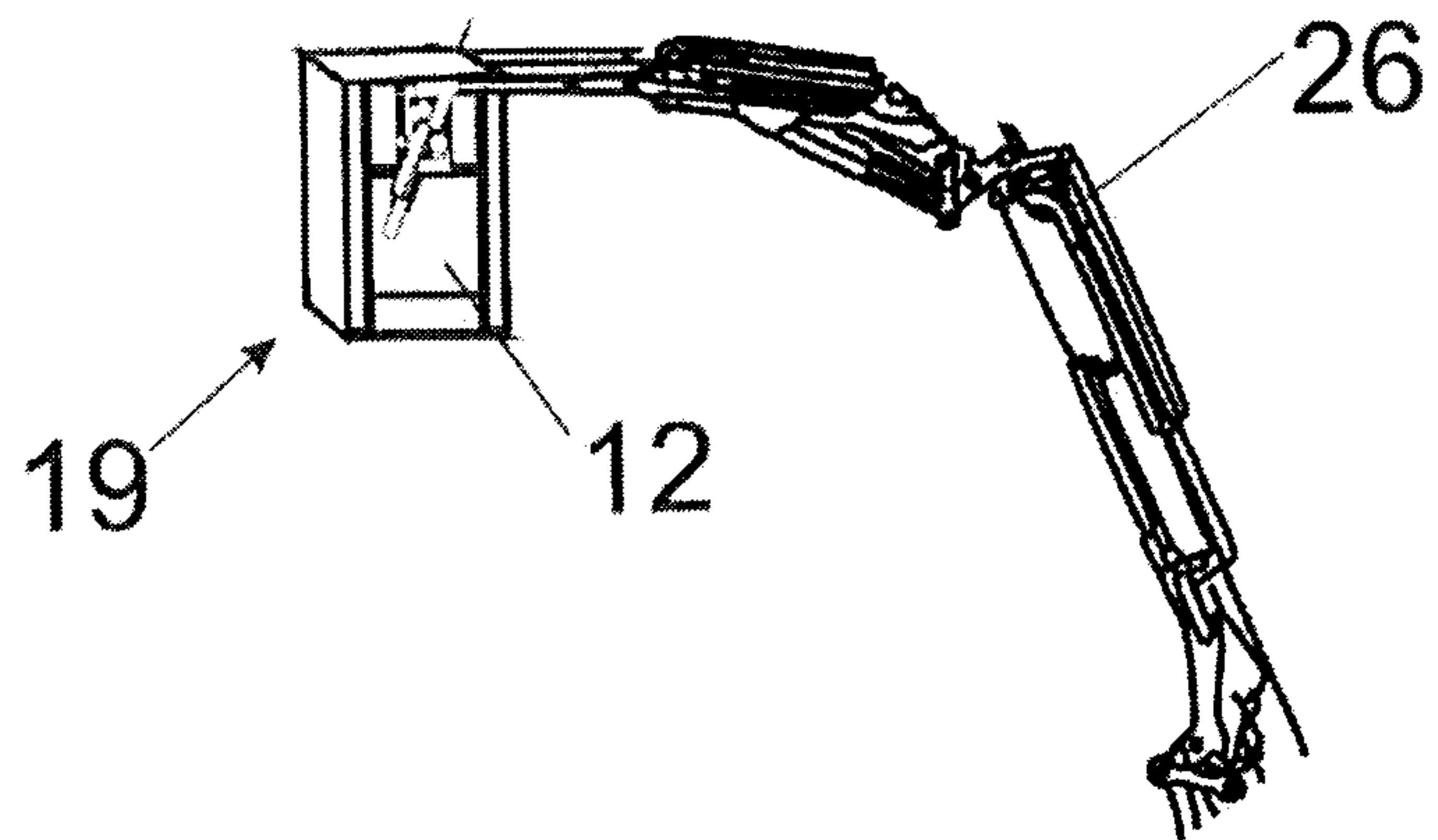


Fig. 8

