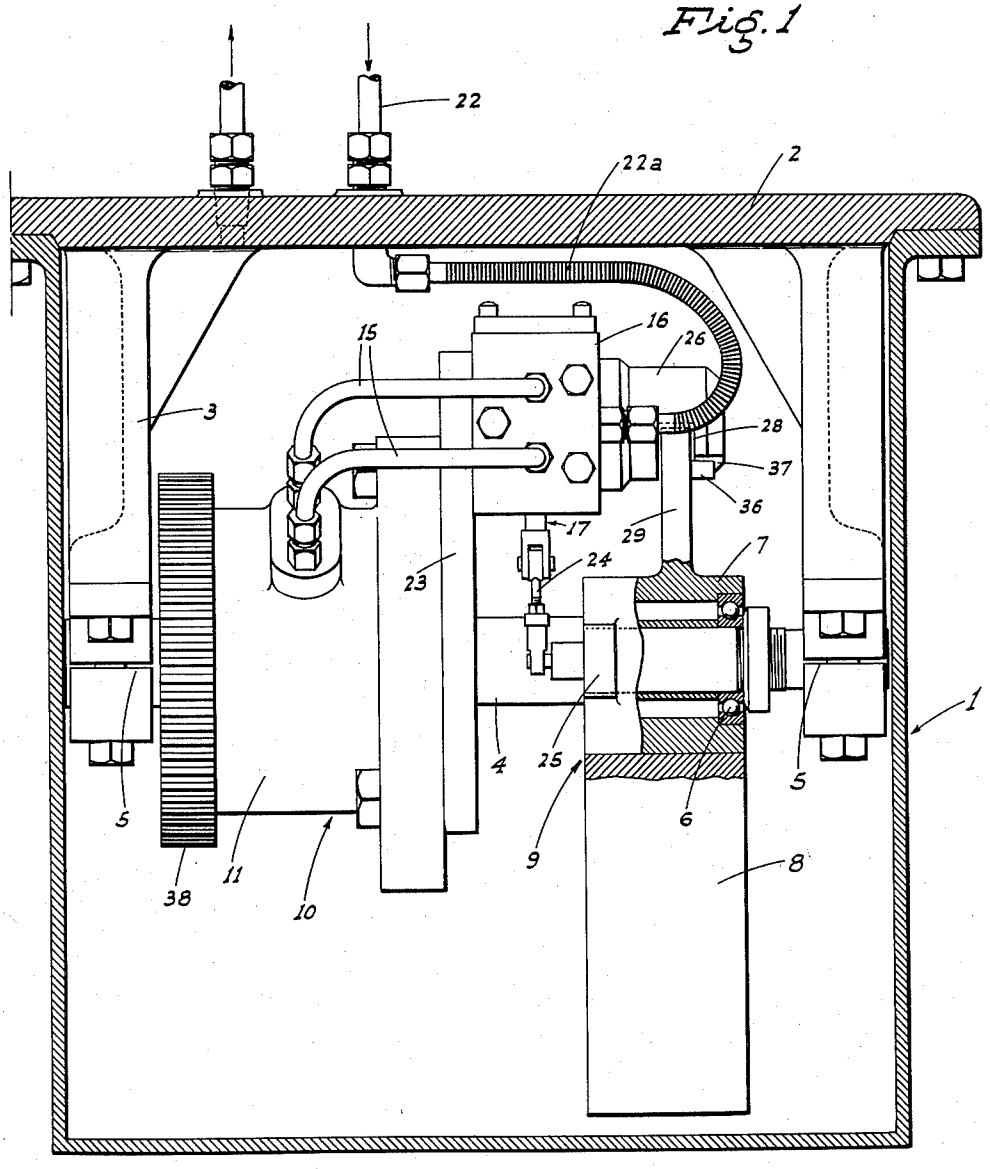
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PENDULUM-ACTUATED SERVO MECHANISM

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Fig. 1



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Fig. 2

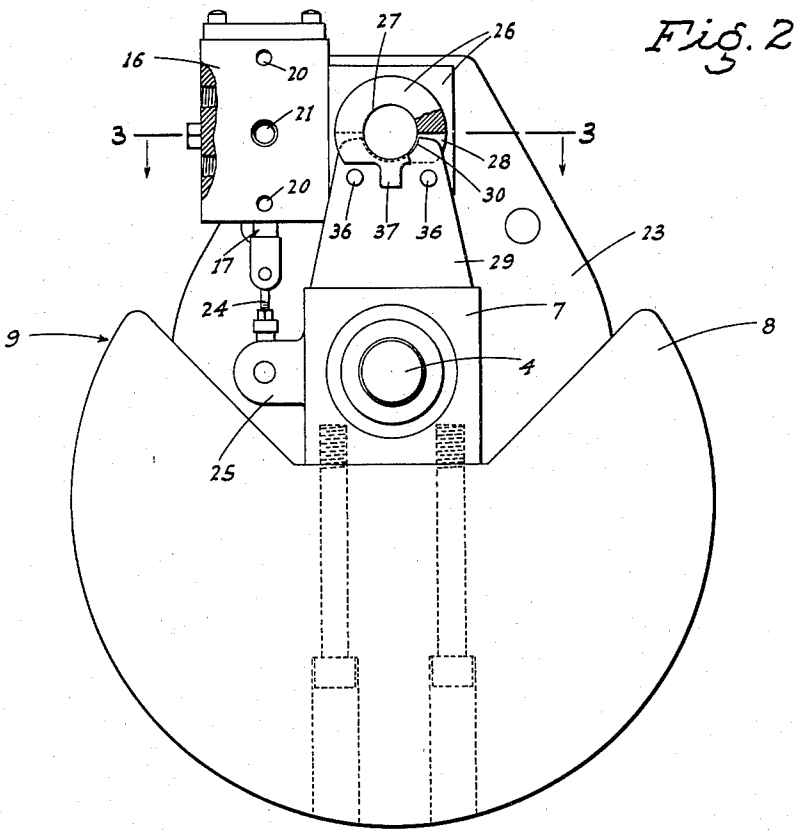
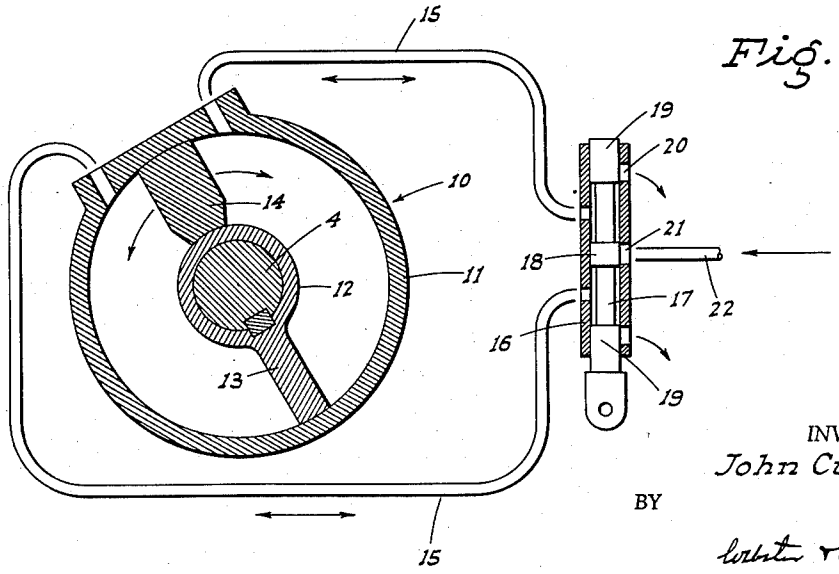


Fig. 5



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Fig. 3

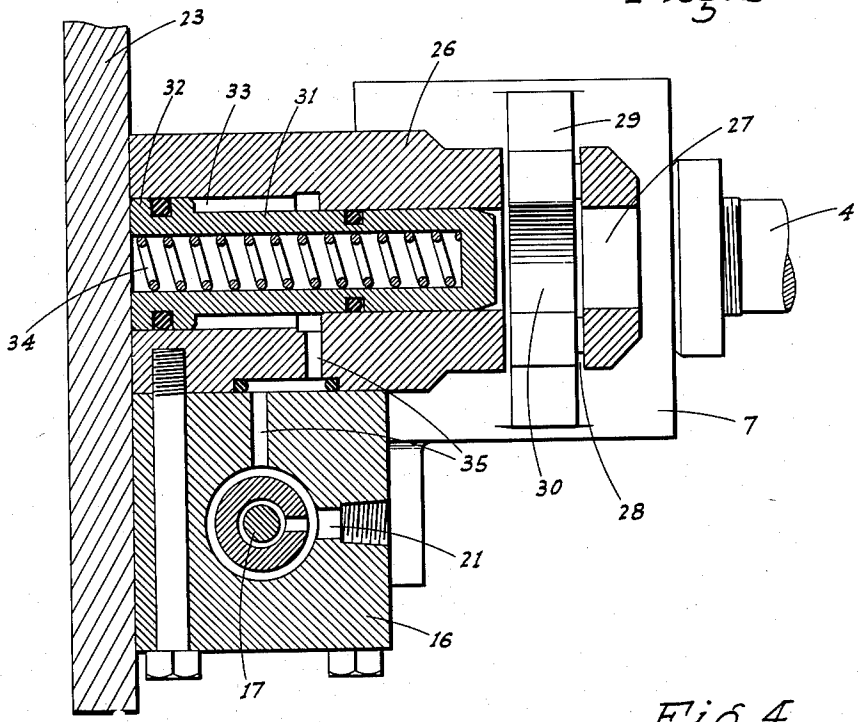
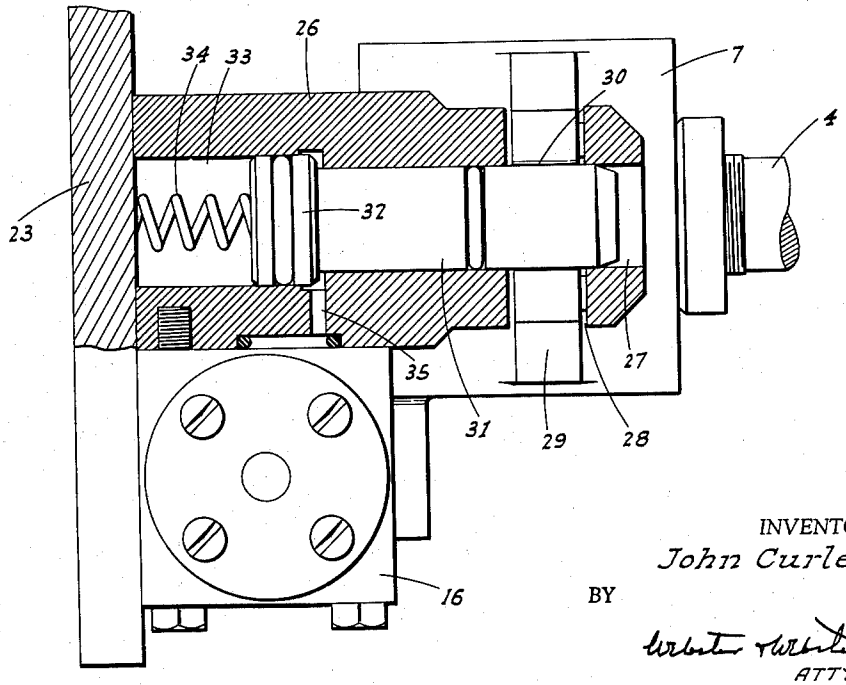


Fig. 4



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2,971,499

PENDULUM-ACTUATED SERVO MECHANISM

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Filed June 8, 1959, Ser. No. 818,923

3 Claims. (Cl. 121—41)

This invention relates to a pendulum-actuated mechanism particularly designed for controlling the operation of a tractor-mounted bulldozer, grader blade, or other implement, and in the main represents improvements over the pendulum actuated unit for the purpose shown in U.S. Patent No. 2,778,130, dated January 22, 1957.

In this previous patent swinging of the pendulum directly actuated the main valve in the hydraulic line leading to the rams or other power units which operated the bulldozer. This was found to be objectionable in that a smooth action could not be effectively obtained, and the resultant ram movements were jerky.

The major object of the present invention is to eliminate the objectionable features of the previous unit by the provision of a pendulum operated mechanism so arranged that a fast acting high-response pendulum, which follows the rapid movements of the tractor, actuates a sensitive low-pressure valve in the hydraulic line. This controls the operation of a servo unit which in turn operates the main high-pressure valve in the line leading to the rams.

A further object of the invention is to provide automatically functioning means to prevent swinging of the pendulum when the hydraulic pressure fails for any reason.

Another object of the invention is to provide a practical, reliable, and durable pendulum actuated servo mechanism, and one which will be exceedingly effective for the purpose for which it is designed.

These objects are accomplished by means of such structure and relative arrangement of parts as will fully appear by a perusal of the following specification and claims.

In the drawings:

Fig. 1 is an end elevation of the main unit of the control system or mechanism, partly broken away and in section, and the enclosing housing being in section.

Fig. 2 is a side elevation of the unit, partly broken away and in section, and removed from the housing.

Fig. 3 is a fragmentary enlarged sectional plan on line 3—3 of Fig. 2, and showing the pendulum locking pin in its normal retracted position.

Fig. 4 is a generally similar view of the locking pin as advanced to a locking position.

Fig. 5 is a somewhat diagrammatic view of the hydraulic rotary actuator and the control valve therefor.

Referring now more particularly to the drawings, and to the characters of reference marked thereon, the main unit of the mechanism is shown in Fig. 1, and comprises an oil-tight housing 1 having a heavy cover or top plate 2 from which a pair of spaced alined brackets 3 depend; a horizontal shaft 4 extending between and being clamped, as at 5, in said brackets.

Turnably mounted on the shaft by means of anti-friction bearings 6 is a block 7 to which is secured a depending weight 8 of suitable configuration; the block and weight together forming a pendulum, indicated generally at 9, which is located on the shaft near one of the brackets 3. Since the housing 1 is kept full of oil, the pendulum 9 is submerged in such oil and its movement is dampened and stabilized.

Mounted in connection with shaft 4 between the pendulum 9 and the other bracket 3 is a servo unit which comprises a hydraulic rotary actuator of conventional or standard form and indicated generally at 10.

This actuator, of which the shaft 4 forms a part, comprises an oil-tight housing 11 concentric with and turnable on the shaft, a hub 12 on the shaft within the housing, a vane 13 extending radially from the hub and engaging the interior wall surfaces of the housing, and a radial vane 14 fixed with the housing and engaging the hub, as shown in Fig. 5. The interior of the housing is thus divided into two separated and opposed chambers; hydraulic fluid being fed into and from the chambers by conduits 15 connected to the housing on opposite sides of vane 14.

These conduits extend to the body 16 of a piston-type valve 17 which includes a central land 18 and end lands 19; the conduits 15 being connected to the body between the central and end lands. Discharge ports 20 from the body 16 empty into the housing 1 and are normally covered by the end lands 19, while an intake port 21 in body 16, to which a feed conduit 22 is connected, is normally covered by the central land 18. This valve is of the closed-center type, constructed so as to be very sensitive in operation.

The valve body 16 is disposed in a plane between the actuator 10 and the pendulum 9, and is fixed with the actuator housing 11 by means of a plate 23 bolted to the adjacent end of the housing 11 and to which the body 16 is secured so as to be above and laterally out from the block 7 of the pendulum 9, as shown in Fig. 2.

The valve 17 is connected to the pendulum 9 so as to be actuated by relative swinging movement thereof by means of a link 24 pivotally connected to and depending between the lower end of valve 17, and a short arm 25 rigid with and projecting laterally from the pendulum block 7 radially of shaft 4.

It will therefore be seen that with such swinging of the pendulum 9, fluid under pressure will be fed from conduit 22 through either one or the other of conduits 15 into the actuator 10 to impart rotation to the actuator housing 11 in one direction or the other. The conduits 15 are arranged in their relation to the actuator and valve so that housing 11 will turn in the same direction as the pendulum. The result achieved by such rotation will be set forth later.

In order to prevent swinging of the pendulum and possible excessive movement of the sensitive valve 17 when there is no hydraulic pressure in the conduit 22, the following automatically functioning device is provided, as shown particularly in Figs. 3 and 4.

This device comprises a body 26 secured to body 16 on one side thereof and directly above shaft 4, as shown in Fig. 2. This body is provided with a longitudinal bore 27 parallel to shaft 4; the bore being intersected above block 7 by a notch 28 open to the bottom and sides of the block 26. A relatively heavy boss 29 upstands from block 7 and projects into the notch 28; the upper face of the boss being formed with a cradle 30 which normally alines with the lower portion of bore 27.

A locking pin or plunger 31 is slidable in the bore 27, and on its end furthest from notch 28 is provided with an enlarged head 32 slidable in a correspondingly enlarged bore 33, which forms a cylinder for the head. The length of the plunger is such that when retracted relative to the notch 28 and the head 32 is abutting against the plate 23, the other end of the plunger 31 is clear of the notch, as shown in Fig. 3.

The plunger 31 is hollow, being open to its head end

only, and a compression spring **34** within the plunger, and engaging at one end against plate **23**, tends to advance said plunger so that it will cross the notch **28** and engage the cradle **30**, as shown in Fig. 4; thus preventing swinging of the pendulum **9**.

The pressure port **21** for valve **17** also connects with bore **33** by means of suitable passageways **35** therebetween; the normal pressure in conduit **22** and port **21** being greater than the resisting strength of the spring **34**. Therefore, as long as there is normal working pressure in the hydraulic system of the mechanism, such pressure will act against the head **32** and force the plunger **9** to—and hold the same in—a retracted position, as shown in Fig. 3, so that the pendulum—of which the cradled boss is a part—is free to swing.

In addition to this automatic lock, a manual lock may be employed, such as shown in said Patent No. 2,778,130.

In order to limit the extent or degree of swinging movement of the pendulum from a normal centralized position, when the locking pin is retracted, the boss **29** is provided with a pair of transversely spaced stops **36** projecting from the face thereof adjacent but below the notch **28**. A stop lug or finger **37** depends from the outer end of body **26** in the path of lateral movement of the stops **36**.

To enable the actuator to serve the purpose for which it is particularly intended in the present system, the rotary actuator housing **11** is provided with a spur gear **38** secured to one end of the housing and concentric therewith. By means of this or a similar gear, mechanical connection may be readily made with a large valve to actuate the same, as shown in the copending application of John Curlett and Raymond A. Gurries on a Hydraulic Power Unit Control System, Serial No. 826,681, filed July 13, 1959, now Patent No. 2,952,245.

The housing **1** is mounted on the tractor to which the tool or implement to be controlled is also mounted, and is set so that the shaft **4**, which forms the axis or fulcrum of the pendulum, is disposed so as to extend lengthwise or transversely of the tractor, depending on whether the implement is to be controlled or adjusted by longitudinal or lateral tilting respectively of the tractor and implement.

In operation, it is actually the housing **1** and parts therein which tilt, while the pendulum **9** remains stationary, and the swinging thereof is a relative matter. If, for instance, the pendulum relatively swings to the right, the valve **17** is operated to feed fluid to the rotary actuator **10** to rotate the housing **11** of the actuator in the same direction as the pendulum **9**.

Since the body **16** of the pendulum is fixed with the housing **11**, said body follows the pendulum movement to then shut the valve **17** and maintain said valve and the connecting link **24** in substantially straight and hence nonbinding alinement. Thus, the housing **11** follows the movements of the pendulum, and delivers a large torque to operate a main high-pressure valve, through the necessary gear and link connections with said housing, exactly as though the pendulum operated such valve directly.

The low-pressure feed conduit **22** leads and is connected to the cover plate **2** of the stationary housing **1**, while the valve housing **16**, to which said conduit feeds, is movable within the housing **1**. The length of conduit which connects the conduit **22** at the cover plate **2** and the intake port **21** of housing **16** is in the form of a length of flexible hose **22***a* of sufficient extent to allow of the necessary movement of the housing **16** relative to the housing **1**.

From the foregoing description it will be readily seen that there has been produced such a device as will substantially fulfill the objects of the invention, as set forth herein.

While this specification sets forth in detail the present and preferred construction of the device, still in practice such deviations from such detail may be resorted to as do not form a departure from the spirit of the invention, as defined by the appended claims.

Having thus described the invention, the following is claimed as new and useful, and upon which Letters Patent are desired:

1. A pendulum-controlled hydraulic servo mechanism comprising a horizontal shaft, means mounting the shaft in a fixed position, a pendulum turnable on the shaft, a hydraulic rotary actuator of which the shaft forms a part and including a mechanism actuating housing turnable on the shaft beyond the pendulum, a valve body fixed with the housing, a normally closed valve slidable in the body in laterally offset relation to the shaft, a feed conduit leading to the body, another conduit extending between the body and actuator, and connecting means between the valve and pendulum to open the valve upon swinging of the pendulum from a normal neutral position so as to impart rotation to the housing; the valve being arranged so that upon such rotation of the housing and valve body about the shaft as an axis, the valve will be reclosed.

2. A mechanism, as in claim 1, with an enclosed housing in which the valve body, the rotary actuator and the pendulum are movably mounted; the feed conduit comprising a portion outside said enclosed housing and connected thereto at a point adjacent the valve, and a flexible portion inside the housing leading to the valve body from a connection with the first named portion at the housing; the flexible portion being arranged to allow of a predetermined amount of movement of the valve body within and relative to the enclosed housing.

3. A pendulum-controlled hydraulic valve operating mechanism comprising a pendulum, a normally closed valve mounted adjacent the pendulum and having a fluid pressure conduit connected thereto, means between the pendulum and valve to open the latter upon relative swinging of the pendulum from a normal position, and means to lock the pendulum against swinging movement upon the absence of pressure in the conduit; such means comprising a fixed body extending lengthwise of the axis of the pendulum and offset therefrom, a boss rigid with the pendulum and projecting radially of the axis thereof the boss having a notch intermediate its end and facing the pendulum axis and into which the boss normally projects, and a slidable spring-advanced and pressure retracted locking pin mounted in the body to extend across and beyond the notch when advanced, the boss having a cradle then engaging about the portion of the pin exposed in the notch.

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