(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 213 486 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
12.06.2002 Bulletin 2002/24

(51) Int Cl.[7]: **F15B 11/024**, B27L 7/00

(21) Application number: **01204395.6**

(22) Date of filing: **16.11.2001**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **05.12.2000 IT RE200125**

(71) Applicant: **Bell S.R.L.**
42100 Reggio Emilia (IT)

(72) Inventor: **Magnani, Elio**
42100 Reggio Emiila (IT)

(74) Representative: **Corradini, Corrado et al**
Studio Ing. C. CORRADINI & C. S.r.l.
4, Via Dante Alighieri
42100 Reggio Emilia (IT)

(54) Hydraulic unit with automatic regenerative system typically for log splitting machines operated by a single-acting cylinder-piston unit

(57) A hydraulic operating system for a tool, typically for a log splitting machine, comprising a single acting hydraulic cylinder-piston unit (9), a motor-driven pump (1) and a hydraulic distributor (5) arranged to selectively connect the piston chamber (90) of said cylinder-piston unit (9) to the pump delivery (4) or to discharge (15), in which the piston rod chamber (91) of the cylinder-piston unit (9) is connected to the piston chamber (90) by a conduit (13) comprising a unidirectional valve (130) which prevents oil transfer towards the piston rod chamber (91), and to the oil reservoir (3) by a discharge conduit (12) closed by a preset overpressure valve (120) sensitive to the pump delivery pressure and by a separate suction conduit (14) provided with a unidirectional valve (140) which prevents oil flow towards the reservoir (3).

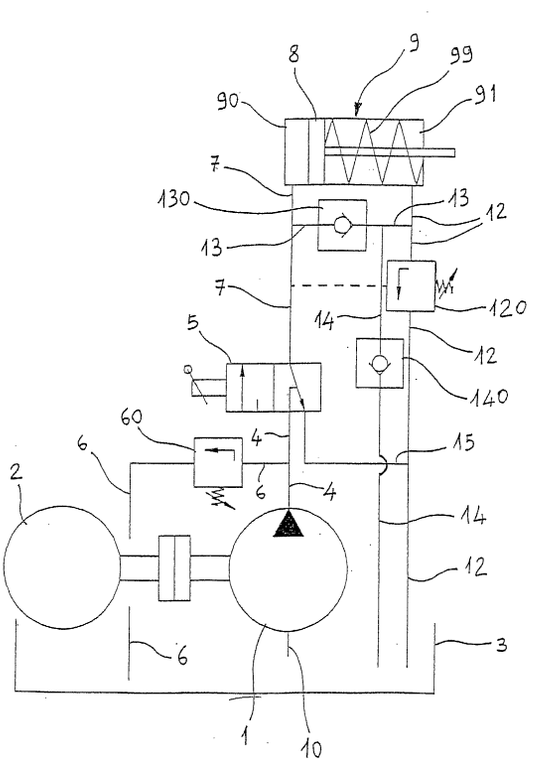

FIG.1

EP 1 213 486 A2

Description

[0001] This invention relates to a hydraulic service unit a typical, but not exclusive, application of which is in log splitting machines in which the log splitting action is provided by a single-acting cylinder-piston unit with spring return.

[0002] Such log splitting machines normally comprise a virtually horizontal operating seat in which the log to be split is positioned between two mutually movable members, known as the log pusher and the blade.

[0003] The log pusher is normally fixed, while the blade is operated by a hydraulic cylinder-piston unit, which can either be single or double acting and is connected to a motor-driven pump by way of a suitable interposed distributor.

[0004] In such log splitting machines, to increase productivity the respective cylinder-piston unit can be operated in two modes, usually known as normal and regenerative, to which two different lengthening speeds of the cylinder-piston unit correspond.

[0005] For correctly defining said operative modes, the basic characteristics of usual single and double acting cylinder-piston units can be summarized as follows.

[0006] A usual single acting cylinder-piston unit comprises an outer cylinder and a slidable inner piston which divides the volume of the cylinder into two parts usually known as the piston chamber and the piston rod chamber, this latter housing at least one elastic return means, typically a helical spring.

[0007] When operating in the normal operative mode a single acting cylinder-piston unit is elongated by feeding oil into the piston chamber, with consequent loading of the at least one spring, the same cylinder-piston unit being shortened by the thrust of the spring after connecting the piston rod chamber to discharge.

[0008] A usual double acting cylinder-piston unit comprises an outer cylinder and a slidable inner piston which divides the volume of the cylinder into two parts again known as the piston chamber and the piston rod chamber, these two chambers being both constantly filled with oil.

[0009] When operating in the normal operative mode a double acting cylinder-piston unit is elongated by feeding oil into the piston chamber and connecting the piston rod chamber to discharge, the same cylinder-piston unit being shortened by the reverse operation.

[0010] When a double acting cylinder-piston unit operates in said regenerative mode, during lengthening of the cylinder-piston unit the oil leaving the piston rod chamber is recovered and added to that directed to the piston chamber. This is achieved by connecting the pump delivery to both chambers of the cylinder-piston unit.

[0011] In this manner the outward speed of the piston increases, for equal oil pressure and throughput, relative to the speed which the same piston can achieve during operation in normal mode, said increase being directly proportional to the ratio of cylinder cross-section to piston rod cross-section.

[0012] If, for example, the cross-section through the piston rod is one half that through the cylinder, as is often the case in such log splitting machines, the outward speed of the piston when in regenerative mode is exactly twice its outward speed when in normal mode.

[0013] In the known art, and again with reference to double acting cylinder-piston units, switching between the regenerative and the normal mode can be done manually by operating the oil distribution valve positioned downstream of the pump, or automatically by providing a conduit which short-circuits the oil between the two chambers of the cylinder-piston unit by the controlled operation of a valve sensitive to the pressure in the piston chamber.

[0014] In both cases, on commencing a log splitting phase the service hydraulic unit of the log splitting machine is set in the regenerative mode, which in order to achieve maximum log splitting speed with minimum force is maintained if the log does not offer excessive resistance, i.e. such as to raise the pressure of the oil in the piston chamber above a predetermined value.

[0015] If instead the log offers particularly high resistance, measurable for example by a pressure transducer associated with the hydraulic circuit, and such that the pressure in the piston chamber exceeds said predetermined value, the machine is switched between the regenerative and the normal mode, in one of the aforesaid ways.

[0016] The detailed description of the relative hydraulic circuits and distribution valves is omitted, as these are wall known to an expert of the art.

[0017] The result of said automatic or manual switching is minimum lengthening speed with maximum available force.

[0018] The facility to operate both in regenerative mode and normal mode, typical of double acting cylinder-piston units, becomes extremely problematic in the case of single acting cylinder-piston units, because of the fact that in these latter the piston chamber does not contain oil.

[0019] In the aforedescribed log splitting machines the use of double acting hydraulic units involves costs incompatible with market requirements, hence in this sector it is preferred to use units with single acting cylinder-piston units and so renounce the advantages of the regenerative mode operating system.

[0020] Some circuit arrangements which enable single acting cylinder-piston units to operate in regenerative mode are known, but these are not utilized in practice for two reasons.

[0021] Firstly, these arrangements involve complicated hydraulic circuits, which are very similar to those typical of double acting cylinder-piston units because of the need to also ensure filling of the piston chamber of the cylinder-piston unit.

[0022] Secondly, said circuits do not allow automatic

switching between the regenerative and the normal operating mode.

[0023] Consequently in this sector there is a deeply felt need for machines, not exclusively for log splitting, operated by single acting cylinder-piston units which can operate in regenerative mode and in normal mode, with automatic switch-over.

[0024] The main object of the present invention is precisely to satisfy said requirement.

[0025] A further object is to satisfy said requirement within the context of a simple, rational, reliable, durable and low-cost construction comprising a relatively small number of component parts.

[0026] Said objects are attained by a hydraulic system presenting the characteristics indicated in the claims.

[0027] It is of the type essentially consisting of a hydraulic circuit comprising a motor-driven pump for supplying pressurized oil to a hydraulic distributor by means of which the lengthening and shortening strokes of the cylinder-piston unit can be selected.

[0028] This latter comprises a piston chamber and a piston rod chamber which are both filled with oil, and a transfer path through which, during lengthening of the cylinder-piston unit, the oil present in the piston rod chamber can either flow into the piston chamber or be discharged into the pump reservoir, depending on the state of a preset pressure-sensitive valve present in the piston chamber.

[0029] The piston rod chamber is directly connected to the reservoir by an independent conduit provided with a directional valve which prevents the oil discharging into the reservoir but enables it to rise from the reservoir to the piston rod chamber.

[0030] According to the teachings of the invention, a transfer conduit is provided which bypasses the distributor and is intercepted by a first unidirectional valve which prevents transfer of oil from the piston chamber to the piston rod chamber but not vice versa.

[0031] Upstream of the first directional valve there is a suction conduit which dips into the oil reservoir and is intercepted by a second directional valve which enables the oil to pass only towards the piston rod chamber.

[0032] Between the suction conduit and the piston rod chamber there branches the discharge conduit of the piston rod chamber, which is intercepted by the preset overpressure valve sensitive to the pressure in the piston chamber.

[0033] By virtue of the aforedescribed solution, and as will be apparent hereinafter, during lengthening of the cylinder-piston unit the oil leaving the piston rod chamber enters the piston chamber when the pressure in this latter is less than the preset pressure of the overpressure valve, and discharges to the reservoir when said pressure exceeds said preset value. Hence all the objects of the invention are attained in that on the one hand the switching between the regenerative and normal operating modes is automatic, and on the other hand the hydraulic unit is simple overall and of low cost, inter alia because its activation and deactivation can be achieved by a distributor with only two operative positions.

[0034] The characteristics and constructional and functional merits of the invention will be apparent from the ensuing detailed description given with reference to the single accompanying figure which shows by way of example a hydraulic scheme according to the invention.

[0035] It comprises a hydraulic pump 1 driven by a motor unit 2 and presenting a suction conduit 10 which dips into an oil-containing reservoir 3, and a delivery conduit 4 connected to a hydraulic distributor 5 of sliding type.

[0036] The distributor comprises a first position in which the pump is connected directly to the piston chamber of the cylinder-piston unit, and a second position in which the pump and piston chamber of the cylinder-piston unit are both connected to discharge.

[0037] From the delivery conduit 4 there branches a recirculation conduit 6 which leads to the reservoir 3 and is intercepted by a maximum pressure valve 60.

[0038] The distributor 5 presents an extremely simple constructional form in that it comprises only two operative positions, to be selected by the user, for example in operating a log splitting machine.

[0039] The position illustrated corresponds to the passive or return stroke of the log splitting blade, the other position corresponding to the active or outward stroke of the blade.

[0040] The single acting cylinder-piston unit 9 associated with the blade presents a first chamber 90 between the piston 8 and the cylinder rear end, hereinafter known as the piston chamber, and a second chamber 91 between the piston 8 and the cylinder front end, hereinafter known as the piston rod chamber, in which a compression spring 99 is housed for the return of the piston.

[0041] Both said chambers 90, 91 are constantly filled with oil.

[0042] The piston chamber 90 is connected to the casing of the distributor 5 by the conduit 7, whereas the piston rod chamber 91 is connected to the reservoir 3 by the conduit indicated by 12.

[0043] The conduit 12 is intercepted by an overpressure valve 120 of presetting type as shown, which is operationally connected to the conduit 7 as shown in the figure by a dashed line, and is sensitive to the pressure in the conduit 7.

[0044] A transfer conduit 13 connects the conduit 12 upstream of the valve 120 to the conduit 7.

[0045] The transfer conduit 113 could evidently be directly connected to the chambers 90 and 91 of the cylinder-piston unit 9.

[0046] The transfer conduit 13 is intercepted by a unidirectional valve 130, which in the illustrated example is a non-return valve of ball type, and when in its closed position prevents passage of oil from the conduit 7 to the conduit 12.

[0047] An oil suction conduit 14 is also provided, which connects that branch of the conduit 13 upstream

of the valve 130 to the reservoir 3 and is intercepted by a non-return valve 140, which in the illustrated example is a ball valve preventing flow of oil towards the reservoir.

[0048] Finally, a discharge conduit 15 branches from the casing of the distributor 5 and is connected at its other end into the conduit 12 upstream of the respective overpressure valve 120.

[0049] The discharge conduit 15 could evidently be directly connected to the reservoir 3.

[0050] The described unit operates in the following manner.

[0051] When the distributor 5 is in its first operative position shown in the figure, with the pump 1 operating and the piston 8 completely retracted, the valves 120, 130 and 140 are closed and the pumped oil returns to the reservoir 3 through the conduit 15 connected into the conduit 12.

[0052] When the operator switches the distributor 5 to its second position (not shown), the pumped oil enters the piston chamber 90 through the conduit 7, the valves 120 and 140 remain closed, the valve 130 is opened by the pressurized oil flowing from the piston rod chamber 91 and entering the piston chamber 90, and the blade of the log splitting machine advances at maximum speed to act on the log with minimum force.

[0053] If the log splitting blade encounters a resistance such that along the conduit 7 the oil exceeds the preset pressure of the overpressure valve 120, the hydraulic unit automatically switches from regenerative mode to normal mode, by which the log splitting blade advances at minimum speed to act on the log with maximum force.

[0054] Specifically, on attaining said preset pressure the valve 140 remains closed, whereas the valve 120 opens with simultaneous closure of the valve 130, with the result that only the pumped oil enters the piston chamber 90, whereas the oil leaving the piston rod chamber 91 is discharged to the reservoir 3 through the valve 120.

[0055] As soon as the resistance which caused said switching disappears, the valve 120 recloses and the valve 130 automatically returns to the previously occupied position, the system then returning to its regenerative configuration.

[0056] When the log splitting blade has reached the end of its advancement travel, if the distributor 5 is not switched to its first operative position the pumped oil returns to the reservoir through the recirculation conduit 6.

[0057] On resetting the distributor 5 to the same configuration as Figure 1, with the pump 1 in operation, the piston 8 retracts by the effect of the thrust of the spring 99, the oil leaving the piston chamber 90 discharges to the reservoir 3 together with the pumped oil, the valves 120 and 130 remain closed, and the valve 140 opens by the effect of the vacuum created in the piston rod chamber 91 by the piston 8 during its retraction, with the result that said piston rod chamber 91 completely fills with oil, ready to operate the cylinder-piston unit 9 in the regenerative mode.

[0058] Both the regenerative and normal modes of operation are determined by the second operative position of the distributor 5, in which it connects together the two conduits 4 and 7, and closes the discharge conduit 15. The merits and advantages of the invention are apparent from the aforegoing and from an examination of the accompanying figure.

Claims

1. A hydraulic operating system for a tool, typically for a log splitting machine, comprising a single acting hydraulic cylinder-piston unit, a motor-driven pump and a hydraulic distributor arranged to selectively connect the piston chamber of said cylinder-piston unit to the pump delivery or to discharge, **characterised in that** the piston rod chamber of the cylinder-piston unit is connected to the piston chamber by a conduit comprising a unidirectional valve which prevents oil transfer towards the piston rod chamber, and to the oil reservoir by a discharge conduit closed by a preset overpressure valve sensitive to the pump delivery pressure and by a separate suction conduit provided with a unidirectional valve which prevents oil flow towards the reservoir.

2. A system as claimed in claim 1, **characterised in that** said unidirectional valves are ball valves.

3. A system as claimed in claim 1, **characterised in that** said hydraulic distributor is a distributor with two operative positions corresponding to shortening and lengthening of the cylinder-piston unit respectively, in the first of which it connects both said pump delivery and said piston chamber to the reservoir, and in the other of which it connects the pump to the piston chamber.

4. A system as claimed in claim 3, **characterised in that** said distributor is a sliding distributor.

5. A log splitting machine operated by a single acting cylinder-piston unit with its return controlled by an elastic means such as a spring, **characterised by** being associated with a hydraulic system in accordance with claims 1 to 4.

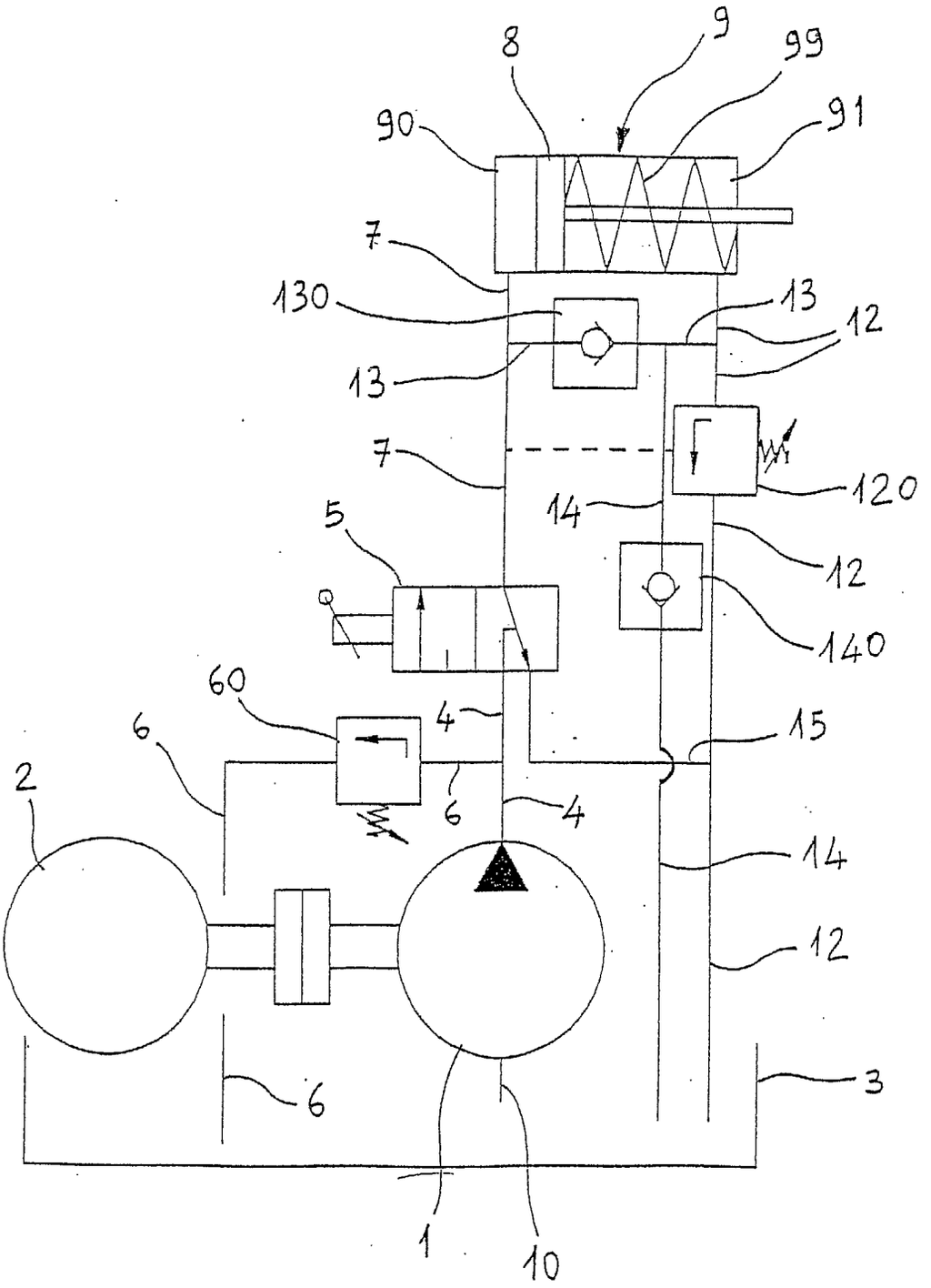

FIG.1