# United States Patent [19]

**Lochrie**

[11] **3,864,852**

[45] **Feb. 11, 1975**


[54] **HYDRAULIC OSCILLATOR FOR DIGGING BUCKET TEETH**


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[73] Assignee: **BTR Industries Limited,** London, England



[22] Filed: **Mar. 27, 1973**

[21] Appl. No.: **345,355**

[52] **U.S. Cl.** ..... **37/141 R,** 91/308, 91/318, 299/37, 299/79

[51] **Int. Cl.** ..... **E02f 3/40,** E02f 9/22, F01l 25/02

[58] **Field of Search** ..... 37/DIG. 18, 141 R, 142 R, 37/141 T, 142 A; 91/308, 318, 304; 137/624.14; 299/37, 79



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*Primary Examiner*—Clifford D. Crowder

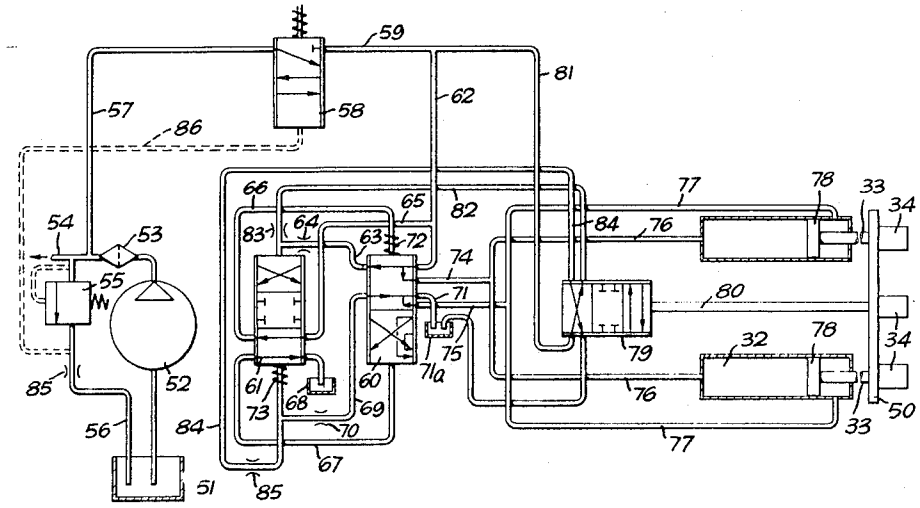
*Attorney, Agent, or Firm*—Watson, Cole, Grindle & Watson



[57] **ABSTRACT**

An excavating device of the type having an open digging bucket being steadily forced at its edge into the material to be excavated so as to fill the bucket, the edge itself being arranged for reciprocation or being provided with one or more cutting teeth which may be reciprocated by means of a hydraulic actuator, there being a valve arrangement for providing hydraulic fluid under pressure to the actuator so that the actuator reciprocates the teeth firstly in one direction and secondly in the opposite direction, the hydraulic actuator comprising a double acting piston and cylinder device wherein flow of fluid to one side of the piston is controlled by a first valve and flow of fluid to the other side of the piston is controlled by second valve, and wherein an arrangement is provided to oscillate the two valves between positions in which fluid flows to one side of the piston and then to the other side of the piston respectively, and further including an oscillator comprising an arrangement responsive to one condition of the first valve to change the condition of the second valve, and an arrangement provided responsive to the same condition of the second valve to change the condition of the first valve.


**12 Claims, 6 Drawing Figures**



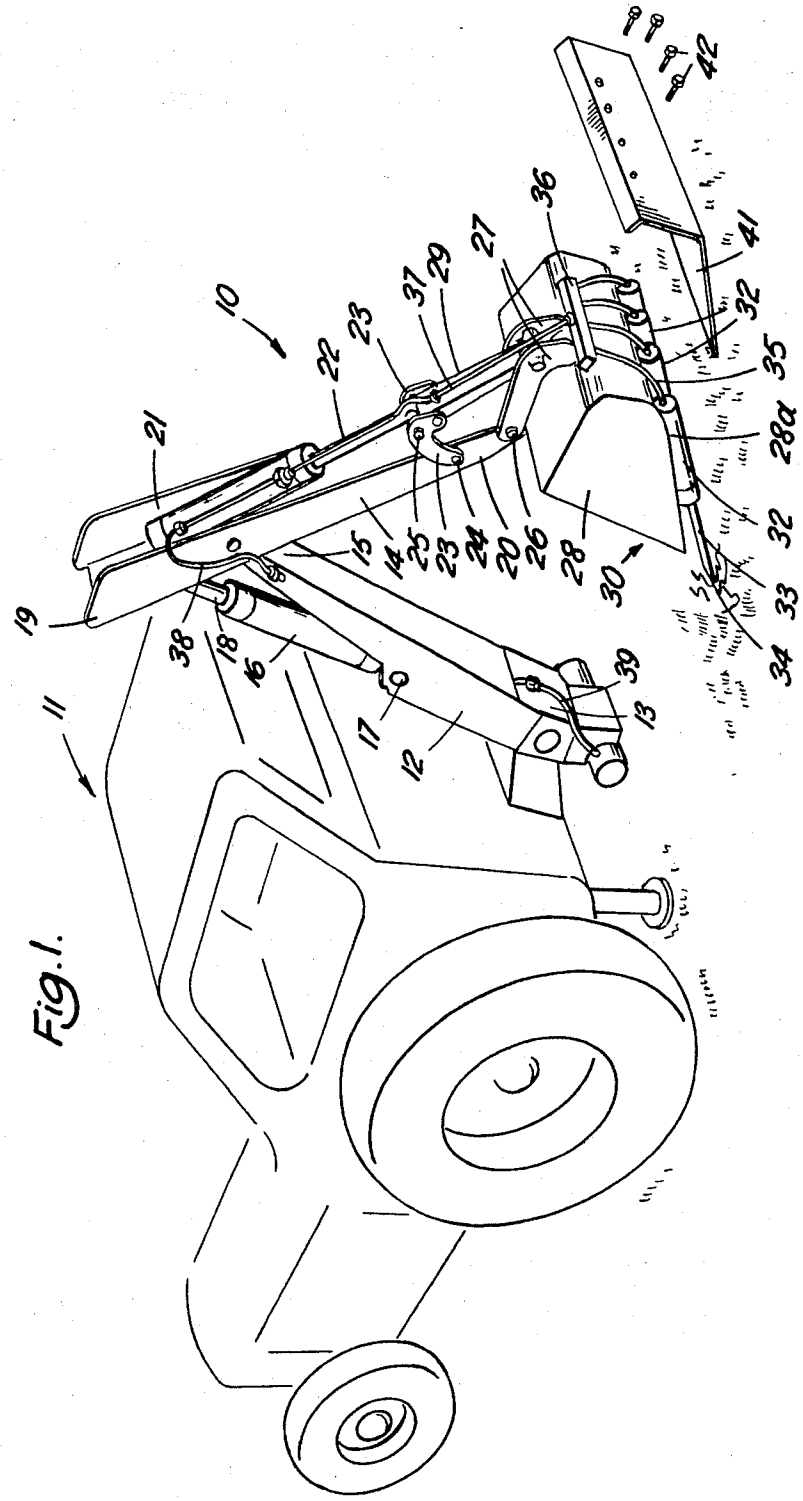
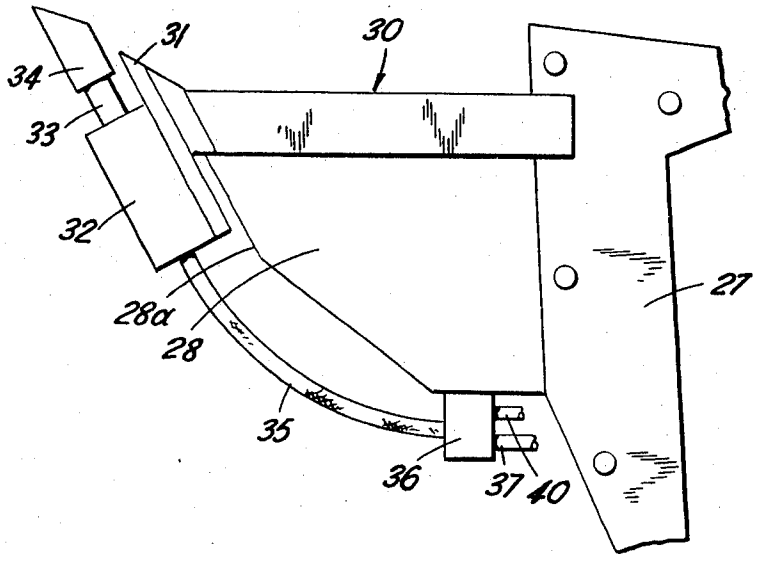

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Fig. 1.

Fig.2.



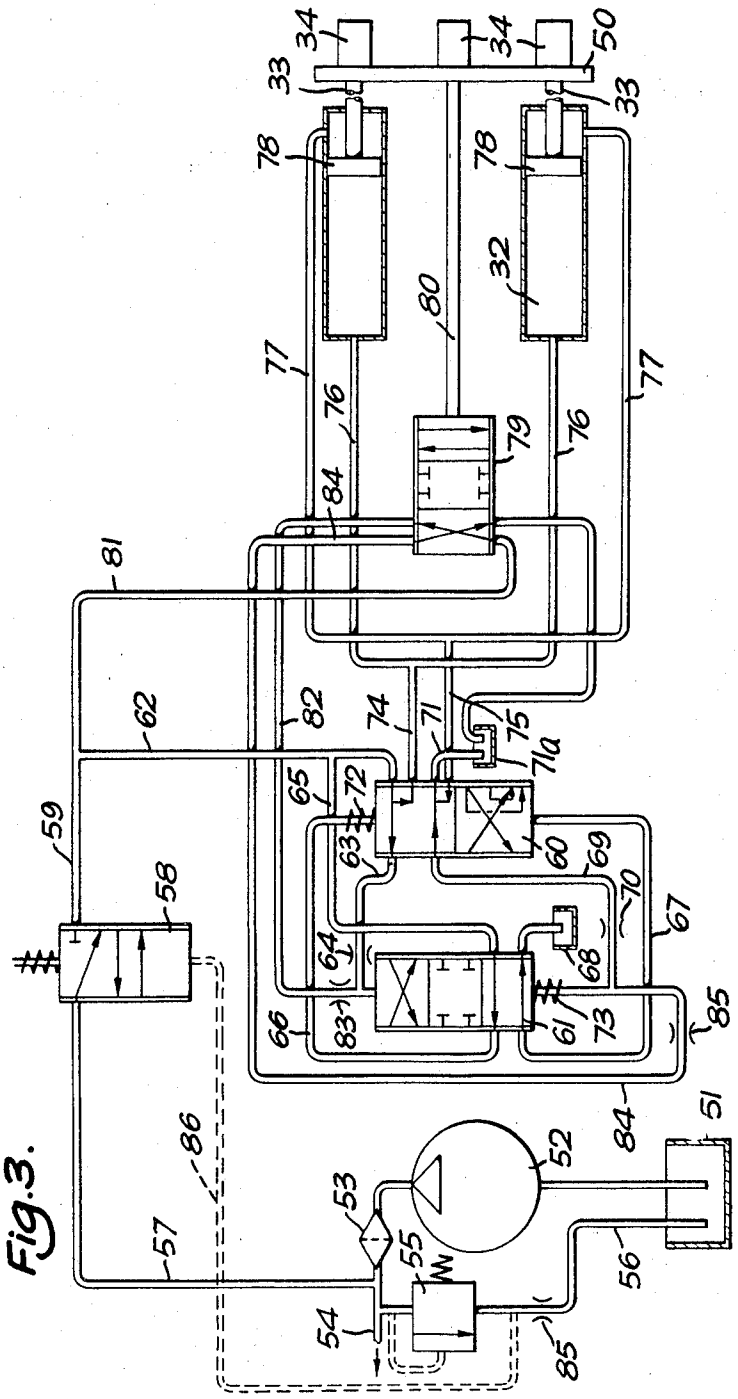

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Fig.3.

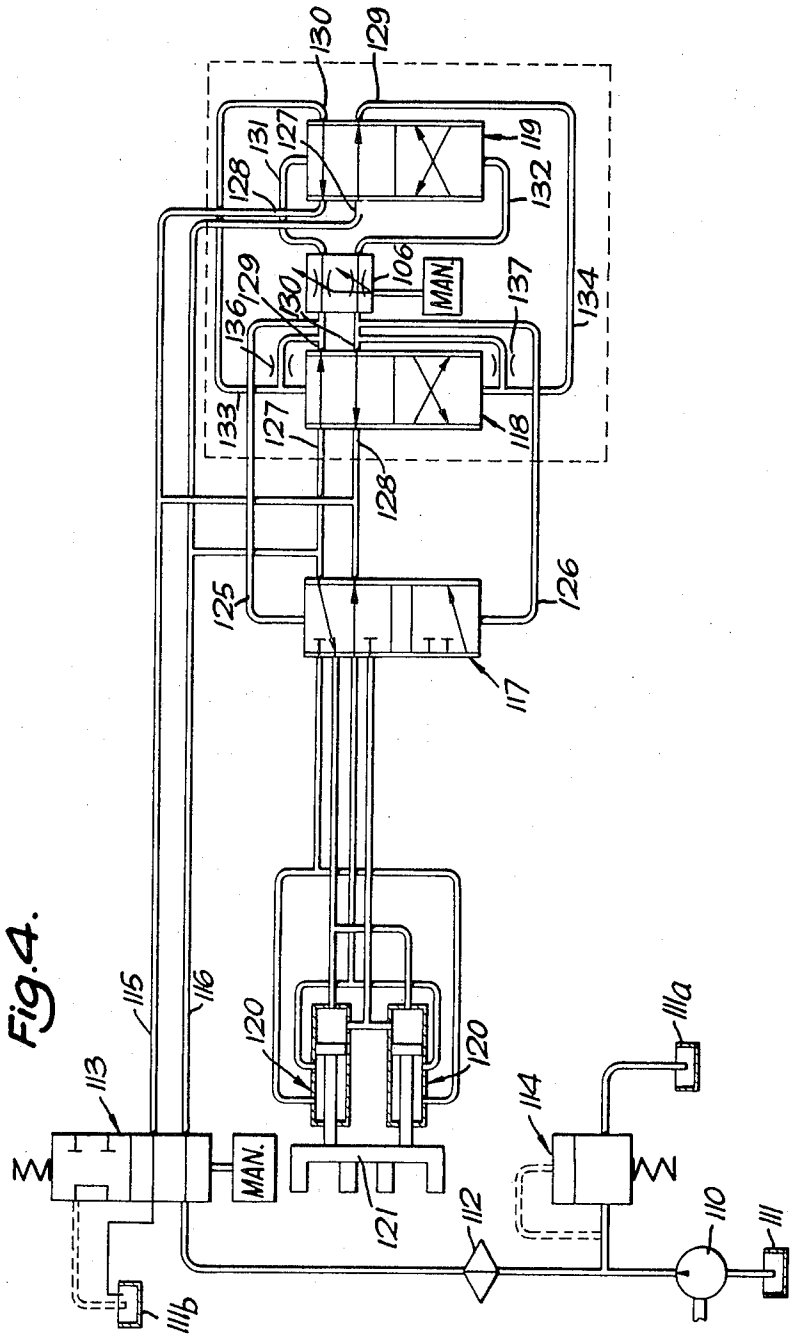

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Fig. 4.

Fig. 5.

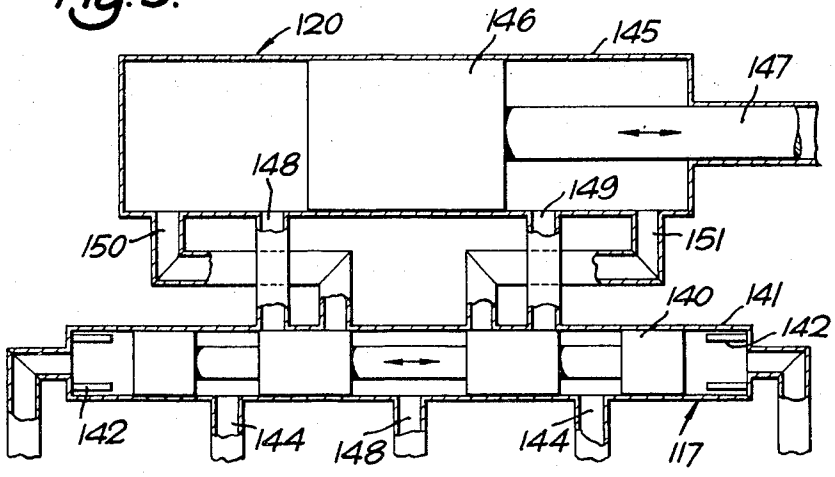
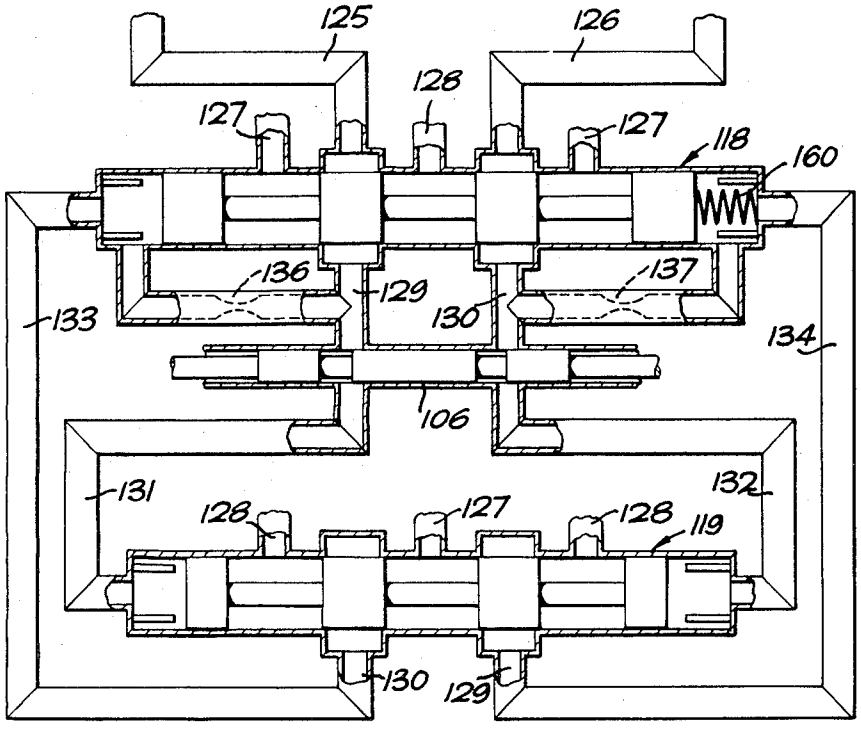

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Fig. 6.


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# HYDRAULIC OSCILLATOR FOR DIGGING BUCKET TEETH

This invention relates to excavating devices having buckets for use therewith.

Excavating devices are known in which buckets are provided with teeth and means is provided to move the teeth or allow the teeth to move relative to the bucket. This has usually been accomplished by mechanical means although proposals have been made which involve hydraulic means. For example in British Specification No. 1,134,089 an arrangement is shown in FIGS. 22 to 24 in which a hydraulic pump supplies fluid both to drive a rotary valve and to supply fluid to a plurality of rams through fluid lines controlled by the valve. This arrangement has many disadvantages which include a lack of control over the movement of the teeth, as the frequency and amplitude of the vibrations cannot be accurately varied or controlled.

The invention provides an excavating device of the kind having a digging bucket provided with a mouth and having an edge on at least one side of the mouth, and means for applying a steady force to the bucket to force the edge into the material to be excavated so as to fill the bucket, in which excavating device the edge is itself arranged for reciprocation or is provided with one or more cutting teeth which may be reciprocated, the edge or each tooth being connected to a hydraulic actuator. A valve means is arranged to provide hydraulic fluid under pressure to the actuator so that the actuator reciprocates the teeth firstly in one direction and secondly in the opposite direction. The hydraulic actuator comprises a double acting piston and cylinder device, wherein flow of fluid to one side of the piston is controlled by first valve means and flow of fluid to the other side of the piston is controlled by second valve means. Means is provided to oscillate the two valve means between positions in which fluid flows to one side of the piston and then to the other side of the piston respectively, such oscillating means comprising means responsive to one condition of the first valve means to change the condition of the second valve means and means responsive to the same condition of the second valve means to change the condition of the first valve means.

A specific example of an excavating device according to the invention and a modification thereto will now be described with reference to the accompanying drawings in which:

FIG. **1** is a part exploded perspective view of an excavating device;

FIG. **2** is a side view of the bucket provided for the excavating device of FIG. **1**;

FIG. **3** is a hydraulic circuit diagram for use with the excavating device of FIGS. **1** and **2**;

FIG. **4** is a circuit diagram of a modified hydraulic oscillator system;

FIG. **5** is a schematic drawing of the hydraulic actuator and main valve of the system of FIG. **4**; and

FIG. **6** is a schematic drawing of the oscillator of the system of FIG. **4**.

FIG. **1** shows an excavating device shown generally at **10** which comprises a tractor **11** to which is pivotally mounted an arm **12** which may be swivelled about a vertical axis (not shown) adjacent the end **13** of the arm by swivelling means (not shown), and about a horizontal axis (not shown) also adjacent the end **13** of the arm **12** by further swivelling means.



A further arm **14** is pivotally mounted at a point remote from its ends to the end **15** of the arm **12.** A double acting hydraulic ram **16** is pivotally mounted at **17** part way along the arm **12,** and the piston rod **18** of the ram **16** is pivotally mounted to the further arm **14** adjacent the end **19.** Contraction of the ram **16** thus raises the end **20** of the further arm **14.**

A further double acting hydraulic ram **21** is pivotally mounted to the further arm **14** adjacent the end **19,** the piston rod **22** of which is pivotally attached at **25** to two levers **23,** which levers are pivotally mounted at **24** to the further arm **14.**

A pin **26** extends through the end **20** of the further arm **14.** Two plates **27** are attached to an excavating bucket **28** and are pivotally mounted on the pin **26.** A strut **29** is pivotally mounted on both the plates **27** and the levers **23** so that movement of the piston rod **22** of the ram **21** causes rotation of the bucket **28** about the pin **26.**

Attached to the underside **28***a* of the bucket **28** and adjacent the edge **31** of the mouth **30** are four double acting rams **32,** so arranged that their piston rods **33** extend in the direction in which the bucket mouth **30** faces. The piston rods **33** each carry at the end remote from the respective ram a tooth or chisel **34** which terminates in a wedge shape.

Hydraulic fluid is supplied to the rams **32** through the lines **35** from a valve block **36.** The valve block **36** comprises two spool valves interconnected as described below so that alternating pulses in fluid pressure are supplied to the rams **32** from a substantially constant pressure source supplied to the valve block through the flexible line **37, 38, 39.** The line **39** is connected through a hydraulic control valve (not shown) to the hydraulic system of the tractor **11,** as described below. A further line **40** (not shown in FIG. **1**) is connected to the valve block and communicates with the hydraulic fluid sump on the tractor.

A cover plate **41** is provided which is securable by means of bolts **42** to the underside **28***a* of the bucket **28** so that the rams **32,** lines **35** and valve block **36** are protected from the material being excavated.

During use of the above described apparatus, the teeth **34** are reciprocated by the rams **32** receiving pressure pulses from the valve block **36.** The rams **16** and **21** are actuated to urge the bucket into the material to be excavated (such as soil, sand, clay) and the teeth **34** are reciprocated in the direction in which the mouth faces, i.e. into and out of the material.

In another form of bucket (not shown) three teeth are provided, which are rigidly connected together. Two double acting rams **32** are provided, the piston rods **33** of which are drivably connected to the three teeth. It will be appreciated that as many rams as may be required may be provided, and there may be one tooth per ram, or more teeth or less. The teeth may be mechanically connected together.

Referring now to FIG. **3,** the hydraulic circuit is shown for an arrangement of the excavating device as just described above having two rams **32,** the piston rods **33** of which are attached to a bar **50** on to which bar **50** three teeth **34** are mounted.

The hydraulic system of an excavator such as the above described tractor comprises a sump **51** for hydraulic fluid, a pump **52** which pumps fluid through a

filter 53 and through line 54 to valves for controlling the various hydraulic motors, such as rams 16 and 21 (FIG. 1). A relief valve 55 is connected to the delivery side of the filter 53 and exhausts to the sump through line 56.

In order to fit the above described bucket to the tractor 11, a further line 57 is connected to the delivery side of the filter 53 and carries fluid to a control valve 58, which is spring loaded to the "off" or "closed" position. Manually operable means (not shown) may be provided to open the valve 58.

Valve 58, when open, supplies fluid through line 59, (which corresponds to lines 37, 38 and 39 in FIG. 1), and 62 to the spool valve 60, which, together with spool valve 61, comprise the valve block 36 (FIGS. 1 and 2).

Valves 60 and 61 are so connected together as to form an oscillating system or a hydraulic oscillating means when fluid is supplied under pressure to line 62. Considersing the valves in the position as shown, fluid is passed through valve 60 from line 62, along line 63 which is provided with a throttle 64, and into valve 61 so that the spool of valve 61 is driven through the central position toward the third position shown in the uppermost part of valve 61. During the movement of the spool of valve 61, fluid is exhausted from the valve through line 69, valve 60 and line 71 to the sump 71*a*.

In the position shown fluid pressure is exerted on the spool of valve 60 through line 65, valve 61 and line 66, to maintain it in the position shown.

When sufficient fluid has entered valve 61 from line 63 so that valve 61 is in the third position, fluid from line 65 flows through line 67 to move the spool of valve 60 to bring into operation the second position of the valve shown in the lower part of valve 60. As the spool moves, the fluid is exhausted from the valve 60 through line 66, valve 61 and so to the sump 68.

Fluid from line 62 now flows through valve 60 along the line 69, which is provided with a throttle 70 and into valve 61 so that the spool of valve 61 is returned through the central position to the first position. During the movement fluid is exhausted from the valve 61 through line 63, valve 60 and line 71 to the sump 71*a*.

When the valve 61 has returned to the first position, fluid from line 65 once more flows through the valve 61 and line 66 to drive the spool of valve 60 back to its first position, while exhausting fluid from valve 60 through line 67 to sump 68.

Thus it will be appreciated that valves 60 and 61 will oscillate between the first and second, and first and third positions respectively. It will also be appreciated that if the throttles 64 and 70 are made more restrictive to the flow of fluid through lines 63 and 69 respectively, the time for the spool of valve 61 to move from the first position to the third position or from the third position to the first position will be greater and consequently the frequency of oscillation of the system will be smaller. Similarly, if the throttles are made less restrictive, the frequency will be greater.

The valves 60 and 61 are provided with springs 72 and 73 to bias the spools to one side of the respective valve, so that the spools are in correct relationship for oscillations to start when valve 58 is opened.

The valve 60 is ported so that in addition to the fluid paths described above, fluid supplied through the line 62 may also leave the valve through line 74 or 75 depending on whether the valve is in the first or second position respectively. In addition, when line 62 is connected to line 74, line 75 is connected to line 71 which drains to the sump 71*a* and when line 62 is connected to line 75, line 74 is connected to line 71.

Lines 74 and 75 are connected to the rams 32 through lines 76, 77 respectively so that fluid pressure in line 74 drives the pistons 78 and hence the piston rods 33 to the right as viewed in FIG. 3 while fluid is exhausted from the rams 32, and fluid pressure in line 75 drives the pistons 78 to the left as viewed in FIG. 3 while fluid is exhausted through lines 74.

Thus when the valve 60 oscillates as described above, the piston rods 33 of the rams 32 perform a reciprocatory motion, and vibrate the teeth 34.

A further spool valve 79 is arranged between the rams 32 and the spool of the valve 79 is connected mechanically by the link 80 to the bar 50. The position of the spool of the valve 79 in the valve housing is thus dependent on the position of the pistons 78 and the rams 32. Fluid is supplied to the valve 79 through line 81 which is connected to line 59.

If the pistons 78 reciprocate with a small amplitude about the centre of the total stroke of rams 32, the spool of valve 79 will also be reciprocated in the centre portion of its movement, and the fluid line 81 will terminate in the valve.

If the pistons 78 are in the position shown (as may be caused by drift, or by little resistance offered to movement of the teeth) the valve will pass fluid from line 81 to line 82, which is fitted with a throttle 83, and supply fluid to the valve 61 so that the movement of the spool of valve 61 is modified. Furthermore, line 84, which is also connected to the valve 61 through throttle 85 is drained to the sump 71*a* through lines 69 and 71. With the valve 79 working between the positions shown and the central position, it will be appreciated that the valve 61 will move from the position shown (first position) to the third position in a shorter time than from the third position to the first position. Similarly, if (as may be caused through drift or by a large resistance offered to the movement of the teeth) the valve 79 works between the central and right hand positions, valve 61 will move from the position shown to the third position in a greater time than from the third position to the first position.

If the throttles 83, 85 are made more restrictive, the effect of valve 79 on the movement of valve 61 is less and hence the amplitude of the stroke of pistons 78 will be greater. Similarly, if the throttles 83, 85 are made less restrictive, the amplitude of the stroke of pistons 78 will be smaller.

In a modification of the circuit as above described, the return line 56 from the relief valve is fitted with a throttle 87. A line 86 (shown by a broken line) connects a drain side of the relief valve to the control valve 58 which is modified so that its opening is progressive and dependent upon the pressure in line 86.

During use of the excavator, if the pressure in the ram driving the bucket 28 (such as ram 21 in FIG. 1) exceeds a predetermined value through the bucket striking material offering high resistance to movement of the bucket the relief valve 55 will operate to permit fluid to drain to the sump 51. A fluid pressure will thus appear in line 86 which will increase the opening of valve 58 and increase the fluid flow to valve block 36, which will increase the power input to the rams 32, to utilise at least part of the power which would have been wasted through the relief valve, to drive the rams 32.

Relief valve **51** may be referred to as a further valve means.

After the bucket has been filled emptying thereof may be assisted by maintaining the vibration of the teeth.

In the circuit shown in FIG. **3**, sumps **68** and **71***a* are shown remote from sump **51**, but in practice the sumps **68** and **71***a* are common with sump **51**.

It will of course be appreciated that the two rams **32** with three teeth **34** shown in FIG. **3** may be replaced by the four rams **32** and teeth shown in FIG. **1**.

The symbols used in FIG. **3** are in accordance with those shown in British Standards Institute publication B.S. 2917,1969. 2917, 1969.

Referring now to FIGS. **4** to **6** the modified hydraulic system comprises a pump **110**, which draws hydraulic fluid from a reservoir **111** and supplies the fluid through a filter **112** to an on/off valve **113**. A pressure release valve **114** is arranged to return fluid to the reservoir (shown as a separate reservoir **111***a*) if the pressure between the pump **110** and filter **112** rises above a predetermined limit. The on/off valve **113** also acts as a second on/off valve for a conduit **115** which is a return conduit for fluid to the reservoir (shown as a separate reservoir **111***b*). When the valve **113** is in the on condition, the conduit **115** is connected to the sump **111***b*, and pressurised fluid is supplied from the filter **112** through the valve **113** to a conduit **116**. The conduits **115** and **116** are each connected to a main valve **117**, comprising part of a first valve means a first change-over valve **118**, and a sceond change-over valve **119**.

The amin valve **117** serves to supply pressurised fluid to, and drain fluid from, a pair of hydraulic actuators **120**. The hydraulic actuators each comprise a piston and cylinder device, the pistons being connected to a row of teeth **121** so that the teeth are reciprocated as the pistons move backwards and forwards in the cylinders. The teeth **121** correspond to the teeth **34** of the previous embodiment.

The main valve **117** has two conditions of operation, the first condition being as shown in FIG. **4** and in which pressurised fluid is supplied to the actuators to cause the pistons to move to the left (in the configuration shown in the drawing), and the second condition being as shown in the lower half of the valve **117**, and in which the pistons of the actuator are moved to the right. When the pistons of the actuators are being moved, fluid is drained from the unpressurised side of the pistons and returned to the sump through the valve **117** and the conduit **115**.

The main valve **117** is a spool valve, there being conduits **125** and **126** connected to the two ends respectively of the spool such that when pressurised fluid is supplied through conduit **126** and conduit **125** connected to the sump the spool is moved to its first condition, and when pressurised fluid is supplied to the conduit **125**, conduit **126** being connected to the sump, the spool is moved to its second condition. The valves **118** and **119** are connected in such a way that an hydraulic oscillator means is provided which connects alternately conduit **125** and conduit **126** to the conduit **116** containing pressurised fluid, the conduit **125** or **126** not being so connected then being connected to drain into the conduit **115**.

Each valve **118** and **119** comprises a two-position changeover valve having an inlet port and an outlet port, and two further ports, indicated by reference numerals **127** and **128**, and **129** and **130** respectively. For each valve, the inlet port **127** is connected permanently to the conduit **116**, and the outlet port **128** is connected permanently to the conduit **115**. In the first condition of operation of the valve, the further port **129** is connected to the inlet port **127**, and the further port **130** is connected to the outlet port **128**. In the second condition of operation the further port **129** is connected to the outlet port **128**, and the further port **130** is connected to the inlet port **127**. The further ports **129** and **130** of the first valve **118** are connected respectively to the conduits **125** and **126** so that the spool of the main valve **117** is moved in dependence upon the condition of the valve **118**. The further ports **129** and **130** are additionally connected to conduits **131** and **132** which supply fluid to the ends of the spool of valve **119**, so that the spool of the valve **119** is moved in dependence upon the condition of operation of valve **118**. Furthermore, the further ports **129** and **130** of the second valve **119** are connected to further conduits **133** and **134** respectively, which conduits are arranged to supply fluid to the ends of the spool of valve **118**, so that the spool of valve **118** is moved in dependence upon the condition of operation of valve **119**.

It will be appreciated that the above described connections of the valve **118** and **119**, also respectively referred to as second and third valve means, provide a hydraulic oscillator means. When pressurised fluid is supplied to the oscillator, and the valves are in their first conditions of operation as shown in the drawing, the spool of valve **119** is held by pressure in conduit **131**, in its first position. However, fluid pressure acting in conduit **134** moves the spool of valve **118** to its second condition, whereafter fluid pressure appears in conduit **132** thereby moving valve **119** to its second condition of operation. These pressures may be looked upon as fluid actuated means. Both valves are then in their second condition of operation, and fluid pressure appears in conduit **133** thereby moving the spool of valve **118** back to its first condition of operation. The valve **118** then allows pressurised fluid to flow in the conduit **131**, thus moving the spool of valve **119** back to its first position. Such pressures for the return are referred to as change means.

The conduits **131** and **132** are connected to the further ports **129** and **130** respectively by means of a frequency valve **106**, which comprises a pair of adjustable restrictions, whereby the time taken for sufficient fluid to flow to move the spool of valve **119** from one position to another position may be adjusted. In the embodiment shown, the two restrictions are manually adjustable simultaneously.

The further port **129** of the valve **118** is connected to the conduit **133** through a further restriction **136**, and the further port **130** of valve **118** is connected to the conduit **134** through a further restriction **137**.

FIG. **5** shows diagrammatically a specific embodiment of spool valve employed as the main valve **117**, in combination with an actuator **120**. The valve **117** has a spool **140** reciprocable in a ported chamber **141**, the ends of the chamber having ports through which fluid pressure may be applied to the ends of the spool to move it between extreme end positions, the movement of the spool being limited by stops **142**. The embodiment of the valve shown has one inlet port **143** and two outlet ports **144**, the inlet port **143** being for connec-

tion to the conduit **116**, and the two outlet ports **144** being for connection to the conduit **115**. Inlet port **143** therefore serves as a means for returning spool **140** to its initial condition between fluid pulses provided by the oscillator means. The actuator **120** comprises a cylinder **145** and a co-operating piston **146**, having a piston rod **147**, arranged for reciprocation within the cylinder **145**. Two outlet ports **148** and **149** are arranged one either side of the piston, and two inlet ports **150** and **151** are arranged nearer the ends respectively of the cylinder **145** than the outlet ports **148** and **149**.

In use, the piston **146** of the actuator will tend to oscillate about its mid position. But if the piston tends to creep towards one end of the cylinder **145**, such as may occur through leakage or unbalanced axial loading, the piston will partially cover one of the outlet ports **148** or **149**. For example, if the piston **146** is drifting towards the left in FIG. **5**, the piston will reach the position where the outlet port **148** is restricted. The cross-sectional area of the port is therefore reduced and hence its flow resistance is increased. This reduces the flow rate of the hydraulic fluid passing through the port **148** during the half cycle of oscillation while the piston **146** is moving to the left. The velocity of the piston is reduced correspondingly during this half cycle. During the other half cycle while the actuator piston is moving to the right the hydraulic fluid flow enters the cylinder **145** through the inlet **150** and leaves through the outlet port **149**, which latter port is not covered by the piston and hence the piston velocity is not reduced during this half cycle. Consequently, the mean velocity of the piston to the left is reduced, and when an equilibrium position is reached in which the restriction of the outlet port **148** by the piston **146** reduces the piston movement during the half cycle for leftward movement to a value equal to the piston movement to the right during the other half cycle, the drift of the piston will cease.

FIG. **6** is a schematic view of an actual embodiment of first valve **118**, second valve **119**, and frequency valve **106**, the parts of the valves and conduits corresponding to those shown in FIG. **4** being given similar reference numerals. It will be noticed that the valves **118** and **119** are similar in construction, the valve **118** having two inlet ports **127** and one outlet port **128**, and two further ports **129** and **130** for supplying fluid to the conduits **125** and **126** for the main valve.

The valve **119** has one inlet port **127**, and two outlet ports **128**, and only two further ports **129** and **130**. The frequency valve **106** is a simple spool type restricting valve having means to move the spool to increase or decrease the restriction in conduits **131** and **132**. The valve **118** is provided with a helical spring **160** which biases the spool to the left, to prevent the valve spool remaining in the position shown in which starting of the oscillator would not occur automatically when pressurised fluid is supplied along conduit **116**.

I claim:

**1.** An excavating device having a digging bucket provided with a mouth and having reciprocable cutting means mounted on at least one side of the mouth, comprising means for applying a steady force to the bucket to force it into material to be excavated to fill the bucket, a double acting piston and cylinder device for reciprocating the cutting means, the cylinder having outlet ports at only two spaced apart locations along the cylinder one on either side of the piston and two inlet ports nearer the ends of the cylinder respectively than the outlet ports, first valve means for controlling fluid flow to the cylinder, said valve means reciprocating the piston under normal working conditions in the region between the two outlet ports as said valve means are movable between a first condition in which one of said inlet ports and one of said outlet ports on the opposite side of the piston are open and the other of said inlet and outlet ports are closed, and a second condition in which said other inlet port and said other outlet port are open and said one inlet port and said one outlet port are closed, whereby when the piston drifts in either axial direction from said region the piston at least partly covers said one or said other of the outlet ports so that the fluid flow out of that outlet port is throttled thereby increasing the pressure of fluid in the cylinder on the same side of the piston as that outlet port to resist further movement of the piston in the same direction, and hydraulic oscillator means separate from said piston and cylinder device is provided for oscillating said first valve means between its first and second conditions.

**2.** An excavating device as claimed in claim **1** wherein said first valve means comprises a spool valve and wherein said oscillator means provides a pulsating flow of fluid to one end of said spool valve for changing the condition of said valve means, and means being provided for returning said valve means to the initial condition between the fluid pulses.

**3.** An excavating device as claimed in claim **2** wherein said oscillator means also provides a pulsating flow of fluid to the other end of the spool valve alternating with the pulsating flow of fluid to the one end of the spool valve to return the spool valve to its initial condiditon.

**4.** An excavating device as claimed in claim **3** wherein said oscillator means comprises second valve means movable between two conditions in which fluid pressure is supplied to opposite ends, respectively of said first valve means, and means being provided for oscillating the second valve means between its two conditions including third valve means movable between two conditions, said second and third valve means being changed from one condition to the other condition by fluid actuated means, said third valve means being connected in said one condition to supply fluid to change the condition of said second valve means from said one to said other condition, said second valve means being connected in said other condition to supply fluid to change the condition of said third valve means from said one to said other condition, and means being provided to change said second and third valve means from their other conditions to their one condition whereby in use said second and third valve means oscillate in sequence between their two conditions of operation.

**5.** An excavating device as claimed in claim **4** wherein each of said second and third valve means has an inlet port, an outlet port and a further port which further port, in one condition of operation of each said second and third valve means, is connected to the inlet port of its respective valve means, and in the other condition of operation of each said second and third valve means is connected to the outlet port of its respective valve means, the further port of one of said second and third valve means being connected to supply fluid for changing the condition of another of said second and third valve means from said one to said other condition,

and the further port of said another valve means being connected to supply fluid for changing the condition of said one valve means from said one to said other condition, the arrangement being such that when the inlet ports of both said one and said another valve means are connected to a substantially constant pressure source, and the outlet ports thereof are connected to drains, said one and said another valve means oscillate in sequence between their two conditions of operation.

**6.** An excavating device as claimed in claim **5** wherein the means to change each of said second and third valve means between its other condition of operation and its one condition is fluid actuated, and that each said valve means is provided with a second further port which, in said one condition of each said valve means is connected to the outlet of its respective valve means, and in said other condition of operation is connected to the inlet of its respective valve means, the second further port of said second valve means being connected to supply fluid to change said third valve means from said other to said one condition, and said second further port of said third valve means being connected to supply fluid to change the condition of said second valve means from said other condition to said one condition.

**7.** An excavating device as claimed in claim **6** wherein said second and third valve means comprise spool valves, the fluid actuated means for changing the condition of the valves comprising fluid inlets to the ends of the spool whereby the spool is moved axially between its two conditions.

**8.** An excavating device as claimed in claim **5** wherein restrictions are provided in conduits connecting said further ports to the fluid actuated means.

**9.** An excavating device as claimed in claim **8** wherein said restrictions are variable whereby the frequency of oscillations may be varied.

**10.** An excavating device having a digging bucket provided with a mouth and having reciprocable cutting means mounted on at least one side of the mouth, comprising means for applying a steady force to the bucket to force it into material to be excavated to fill the bucket, a double acting piston and cylinder device for reciprocating the cutting means, first valve means for controlling fluid flow to the cylinder which are movable between two conditions in which fluid is supplied to opposite sides of the piston respectively to reciprocate the cutting means, second valve means movable between two conditions, each said valve means having fluid actuated means to change the valve from one condition to the other condition and vice versa, said first valve means being connected to fluid actuated means of said second valve means, and said second valve means being connected to fluid actuated means of said first valve means, the arrangement being such that movement of each said valve means from one condition to the other changes the direction in which it acts on the fluid actuated means of the other of said valve means whereby, in use, said valve means each oscillate in sequence between their conditions of operation, and further valve means operable if the reciprocating cutting means oscillate in excess of a predetermined amount in either direction to apply fluid pressure to the fluid actuated means for one of said first and second valve means in a sense to correct the oscillating position of the cutting means.

**11.** An excavating device as claimed in claim **10** wherein means are provided to bias each of said first and second valve means to one of its conditions of operation in the absence of fluid pressure to the fluid actuated means for its respective valve means.

**12.** An excavating device as claimed in claim **10** wherein said first and second valve means are spool valves, and said fluid actuated means for said valve means comprise fluid inlets leading to the ends of the spools whereby the spool is moved axially between its conditions.

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