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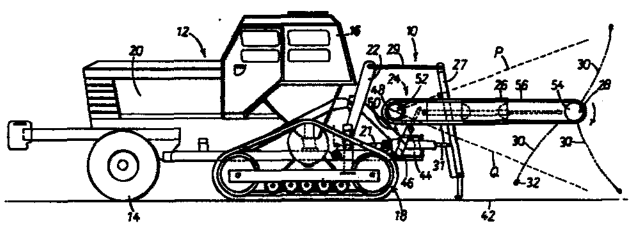
(54) Terrain clearance apparatus.

(57) Clearance apparatus comprising an elongate cylindrical motor-driven rotor carrying a plurality of chain flails (30) around its circumference. A plurality of pairs of lugs (32) are disposed on the cylindrical surface of the rotor, each of which provides a mounting point for pivotally connecting a respective chain flail to the rotor. The pairs of lugs are disposed in at least two separate spirals traversing the cylindrical surface of the rotor, the plurality of pairs of lugs in each spiral forming a plurality of parallel rows of pairs of lugs, with the pairs of lugs in adjacent rows in staggered relationship. The stagger between any two parallel rows is arranged to be at least as great as the width of the flails.

A means is provided for automatically adjusting the height of the rotor above the ground, and hence the depth of cut achieved by the flails, in dependence upon the drive load presented by the rotor to the motor which drives the rotor.



EP 0 189 255 A1

DESCRIPTION

"TERRAIN CLEARANCE APPARATUS".

The present invention relates to terrain clearance apparatus, sometimes referred to as flailing apparatus, and more particularly to such apparatus which comprises a rotor to which a plurality of flail members are attached.

A terrain clearance apparatus of this type was used in the second World War, notably on the Normandy beaches for clearing a path through a mine field. The latter apparatus comprised a cylinder of substantial diameter rotatably mounted in front of a tank or other motor driven vehicle, a plurality of chain flails being attached to the surface of the cylinder. In more recent years, a drive shaft of moderate diameter has replaced the large diameter cylinder and a tractor has replaced the tank.

The types of apparatus first used were simply mounted for rotation and were in contact with and were rolled over the terrain to be cleared. Later versions had separate drive means or were indirectly driven by the drive means of the vehicle to which they were attached.

The object of this kind of apparatus is to beat and clear the whole surface of the terrain over which the apparatus is passed. The World War II versions were found not to do this, largely because there were insufficient flails to accomplish this object. It was found, however, that merely increasing the number of flails did not solve the problem as the flails became tangled one with another and/or wrapped themselves round the rotor shaft. It was also found that wear on the pivotable connections of the flails to the cylinder was excessive and frequently resulted in flails breaking off from the cylinder.

It is one object of the present invention to provide a means of obviating these problems.

In accordance with the present invention, there is provided an elongate cylindrical, motor-driven rotor having a plurality of pairs of lugs disposed thereon, each of which provides a mounting point for pivotally connecting a respective chain flail to the rotor, said pairs of lugs being disposed in at least two separate spirals traversing the cylindrical surface of the rotor, the plurality of pairs of lugs in each spiral forming a plurality of parallel rows of pairs of lugs, with the pairs of lugs in adjacent rows in staggered relationship, the stagger between any two said parallel rows being equal at least to the width of the flails.

Preferably, ech flail comprises a length of chain whose one end is coupled to a metal bar which is pivotally mounted between a pair of upstanding lugs on the surface of the rotor such that the bar can effect pivotal movement only in a plane perpendicular to the rotational axis of the rotor, and there is provided a stop means on the rotor which serves to restrict the range of pivotal movement relative to the lugs available to the bar in a direction counter to the direction of rotor rotation.

The spirals are preferably disposed such that the starts of the spirals around the end circumference of the elongate cylindrical rotor are equi-distant from each other. Furthermore, the spacing of adjacent pairs of lugs on each of the spirals should preferably be the same.

Advantageously, the width of the flails is not less than 1.125 inches and the stagger is preferably such that it is not more than 10% greater than the width of the flails.

Preferably, each pair of lugs is provided with holes to receive the shank of a bolt, the shank then forming a pivot for the rigid metal bar coupled to the associated chain flail. This ensures that there is minimum wear on the lugs themselves and that wear is substantially confined to the shanks of the bolts and the metal bars forming, in effect, the first links of the chain flails.

The rotor is preferably supported between two arms which are pivotably mounted to a frame effectively to form a boom which can be raised or lowered, thereby to alter the height of the rotor above the ground. It has now been found that the beating effect of the flails depends in part on the terrain over which the rotor passes and in part on the height of the rotor above such terrain.

In order to provide a substantially constant flailing effect, the height above the ground of the rotor carrying the flails is arranged to be controlled automatically in dependence upon the power demand on the motor which is driving the rotor, i.e. upon the prevailing drive load presented to the motor by the rotor. For this purpose, the rotor is arranged to be positioned by an automatic control system so as to maintain the power demand on the motor constant, within predetermined operating limits.

The measurement of the power demand on the motor can be achieved in a number of ways.

For example, the power demand can be determined simply by measurement of the prevailing motor speed. Alternatively, where the drive for the rotor includes a hydraulic pump, the motor power demand can be determined by measurement of the hydraulic drive pressure at the motor.

It is preferred for a means of manually overriding the automatic control to be provided whereby manual control of the jib position, and hence of the height of the rotor above the ground, is available.

The invention is described further hereinafter, by way of example, with reference to the accompanying drawings, in which:

Fig.1 is a diagrammatic side elevation of one example of a terrain clearing apparatus embodying the present invention;

Fig.2 is a perspective detail view showing the preferred mechanism by which each flail is pivotally attached to the rotor by means of a respective pair of lugs;

Fig.3 is an end view of the rotor illustrating the preferred positions of the pairs of lugs thereon;

Fig.4 is a developed view showing the relative positions of the pairs of lugs on the surface of the rotor of Fig.3;

Fig.5 is a block circuit diagram of one example of a system for controlling the height of the rotor above the ground;

Fig.6 is a block circuit diagram of a second example of a system for controlling the height of the rotor above the ground; and

Fig.7 is a block circuit diagram of one means of achieving rotor speed control.

In Fig.1, the illustrated terrain clearing apparatus 10 is shown mounted on the back of a vehicle 12 having front wheels 14, a control cab 16 and rear continuous tracks 18. The vehicle 12 has a main engine 20 which, as well as driving the tracks 18, rotates a conventional power take-off shaft 21. The apparatus 10 includes a main frame 22 which is adapted to be detachably mounted onto the frame of the vehicle

12 so as to be rigidly attached thereto. Pivotably mounted on the main frame 22 is a sub-assembly 24 which includes a pair of parallel boom arms 26 disposed on the two sides of the apparatus respectively and extending rearwardly of the main frame 22 in the manner of a jib. Rotably mounted between the distal ends of the arms 26 is a transversely extending, cylindrical rotor 28, whose peripheral surface carries a plurality of flails 30. Each flail 30 comprises a plurality of chain links 30a (see Fig.2) whose free end can carry a suitable tool 32 to assist the flailing action of the chain.

Mounted at a position between the boom arms 26 and between the rotor 28 and the pivotal axis 48 of the boom arms 26 is a metal blast plate 27 which is coupled to the frame 22 at its upper end, by pivotable links 29 and at its lower end by links 31. The links 31 preferably include Aeon rubber portions (not visible in Fig.1) to assist in absorbing explosive impacts experienced by the blast plate 27.

As shown in Figure 2, in a preferred arrangement, each chain flail 30 is attached to the rotor 28 by means of a respective pair of upstanding lugs 32a,32b welded to the rotor surface. The last link at the inner end of each chain 30 is loosely coupled to one end of a respective, parallel-sided metal bar 34 by way of an aperture 36 in that bar. The other end of the bar 34 is pivotally mounted between the associated pair of lugs 32a,32b by means of a bolt 38 which extends through aligned apertures in the lugs 32a,32b and loosely through a further aperture (not visible in Fig.2) in the bar 34. The pairs of lugs 32a, 32b are all positioned on the rotor such that the bars 34 can only effect a pivotal movement on the bolts 38 in respective planes lying perpendicular to the rotational axis of the rotor 28.

As shown in Figs. 2 and 3, the lugs 32a,32b in each pair are joined together at one side thereof by a plate 40 which is dimensional and positioned so as to restrict the extent to which the respective metal bar 34 can pivot relative to those lugs in the direction A indicated in phantom lines in Fig.3. This is achieved by engagement of the side of the bar 34 with the edge 40a of the plate 40. The pivotal movement in the opposite direction can, if desired, also be restricted by engagement of the edge 34a of the bar 34 with the plate 40.

The use of the metal bars 34 to couple the chains to the rotor ensures that there is minimum wear on the lugs and on the links 30a and that wear is confined substantially to the shanks of the bolts 38. Limiting the pivotal movement of the bars 34 to planes perpendicular to the rotational axis of the rotor assists in preventing tangling of the chain flails in use.

Referring now to Figures 3, 4 and 4a, there is shown a preferred arrangement of the pairs of lugs 32a,32b around the circumference of the rotor 28. This particular embodiment employs seventy-two pairs of lugs which, for the purposes of explanation, have been marked 1-72 in the developed view of Fig.4. The seventy-two pairs of lugs are arranged in a plurality of separate spirals around and along the circumference of the rotor 28. As indicated in Fig.4a, the pairs of lugs lie on three separate spirals or helices marked 1, 2 and 3. Helix 1 consists of the pairs of lugs marked 1,4,7,10,13,16,19,22,25,28,31,34,37,40,43,46, 49,52,55,58,61,64,67 and 70. Helix 2 consists of the pairs of lugs marked 3,6,9,12,15,18,21,24,27,30,33,36, 39,42,45,48,51,54,57,60,63,66,69 and 72. Helix 3 consists of the pairs of lugs marked 2,5,8,11,14,17, 20,23,26,29,32,35,38,41,44,47,50,53,56,59,62,65,68 and 71. It will be noted that the pairs of lugs in Helix 1 form four straight rows all of which lie parallel to the rotational axis of the rotor. (These rows are formed respectively by the pairs of lugs 7,19,31,43,55 and 67; 4,16,28,40,52 and 64; 1,13,25,37,49 and 61; and 10,22,34,46,58 and 70). Similarly the pairs of lugs in Helix 2 form four straight rows all of which again lie parallel to the rotor axis. (These rows are formed respectively by the pairs of lugs 9,21,33,45, 57 and 69; 6,18,30,42,54 and 66; 3,15,27,39,51,63; and 12,24,36,48,60 and 72). Again, the pairs of lugs in Helix 3 forms another four straight rows lying parallel to the rotor axis. (These rows are formed respectively by the pairs of lugs 2,14,26,38,50 and 62; 11,23,35,47,59 and 71; 8,20,32,44,56,68; and 5,17,29,41,53 and 65). The rotor thus carries twelve parallel rows of pairs of lugs (see Fig.3), each row containing six pairs of lugs. It will be noted also that the pairs of lugs in adjacent rows on the rotor are mutually displaced or staggered in the axial direction.

It will be noted that the illustrated arrangement of the pairs of lugs on the rotor can also be considered to comprise just two separate spirals, the odd-numbered pairs of lugs being in one spiral and the even-numbered pairs of lugs being in the other spiral. It will be noted that the pairs of lugs in the first spiral form six straight rows, all of which lie parallel to the rotational axis of the rotor. (These rows are formed respectively by the pairs of lugs 2,14,16,38,50,62; 4,16,28,40,52,64; 6,18,30,42,54,66; 8,20,32,44,56,68; 10,22,34,46,58,70; and 12,24,36,48,60,72). It will also be noted that the pairs of lugs in the second spiral form another six straight rows all of which lie parallel to the rotational axis of the rotor. (These rows are formed respectively by the pairs of lugs 7,19,31,43,55,67; 9,21,33,45,57,69; 11,23,35,47,59,71; 1,13,25,37,49, 61; 3,15,27,39,51,63; and 5,17,29,41,53,65). As before, therefore, the rotor still carries twelve parallel rows of pairs of lugs (see also the end view of Fig.3), each row containing six pairs of lugs. It will be noted also that the pairs of lugs in adjacent rows on the rotor are again mutually displaced or staggered in the axial direction. The stagger between any two rows on the rotor should not be less than the width X of the flails (see Fig.2).

By virtue of the aforegoing arrangement of the fixing locations for the chain flails, the tendency of the flails to become tangled is reduced to a minimum and the ground area subjected to impact by the flails is maximised. Furthermore, the rotor so formed is dynamically balanced resulting in minimum horse power to drive it.

The total number of pairs of lugs clearly depends on the length of any particular rotor 28. In other embodiments, a greater number of spirals may be provided.

In order to provide a substantially constant flailing effect, the height above the ground 42 (Fig.1) of the rotor 28 (and hence the depth of cut of the flails in the ground) is arranged to be controlled automatically in dependence upon the power demand on the motor which drives the rotor 28.

In the embodiment of Fig.1, the apparatus 10 includes a mechanical gear box 44 which is driven by the power take-off shaft rotated by the engine 20 of the vehicle 12. The engine 20 might be a diesel or petrol engine. The gearbox drives two belts 50 (only one visible in Figure 1), each of which in turn drives a pulley wheel 52 on a respective end of a shaft (not visible) rotating on the axis 48. The pulley wheels 52 in turn drive pulley wheels 54 at the two ends of the rotor 28 via respective drive belts 56. The shaft connected to the pulleys 52 can, if desired, contain a means of balancing the drive forces on the two belts 56 to ensure a reliable drive for the rotor.

Thus, in the arrangement of Figure 1, the rotor is driven from the main engine of the vehicle 12 by way of the power take-off 21 and the gearbox 44. In other embodiments, the rotor 28 can be driven hydraulically by use of suitable hydraulic motors. As indicated diagrammatically in Fig.1a, such hydraulic motors 60 can be positioned so as to directly drive the two pulleys 52, respectively. Power for such hydraulic motors can be derived from a conventioanl hydraulic power take-off on the vehicle 12.

The vehicle 12 also includes a conventional hydraulic pump (not shown) providing a source of hydraulic pressure. The boom arms 26 can be raised together by means of two hydraulic rams 46, positioned respectively between the two arms 26 and the fixed main frame 22. The operated position of the rams 46 determines the angle of the arms about an axis 48 fixed relative to the frame 22, the possible range of movement in this embodiment being indicated by the angle between the dotted lines P and Q. Advantageously, the rams 46 are single acting devices, there being provided additional damping rams (not visible in Fig.1) which control the rate of descent of the boom arms 26 when the height of the rotor is being reduced. Alternatively, the rams 46 can be double-acting to themselves enabling damped lowering of the boom arms to be achieved.

A number of possible ways of achieving automatic control of the height of the rotor 28 (and therefore the depth of cut) will now be described with reference to Figures 5 and 6.

Referring first to Figure 5, the basis of the automatic control is to adjust the angular position of the jib formed by the boom arms 26 (and hence the height of the rotor 28) so as to maintain the power demand on the driving engine, i.e., the effort required to rotate the rotor, at a constant level within specified limits.

If the apparatus 10 is of the type shown in Figure 1, wherein the rotor is driven by the main engine of the vehicle 12, then a measure of the power demand on the engine can be obtained simply by measuring the engine speed. Because a high proportion of the engine power is being used to drive the rotor compared to the power used to achieve the actual displacement of the vehicle itself, changes in vehicle engine speed are found to provide a useful indication of the prevailing effort required to drive the rotor.

One method of measuring the engine speed is to use an impulse proximity sensor 62 (see Fig.5) positioned close to the starter ring of the flywheel of the engine. This impulse output is converted in a frequency/voltage circuit 64 to an analogue voltage level directly proportional to the input frequency. This analogue output is compared in a comparator 66 with two adjustable preset reference levels. The difference between the two levels provides a null-band between overspeed and underspeed error in which no corrective action is taken. If either of these two limits is exceeded, the appropriate comparator output will slew to provide corrective action. To avoid hunting and excessive overshoot, the comparator outputs are enabled at 68 by a free-running asymmetrical oscillator 70 in which the pulse repetition frequency and mark/space ratio are individually tunable for optimum performance.

The two enabled comparator status outputs drive electrical relays 72,74, which energise respective solenoids 76 of a five-port three-position hydraulic spool valve 78 which feeds hydraulic fluid to the single acting cylinders 46 to control the angle of the jib formed by the boom arms 26 and hence the operating height above the ground of the rotor 28.

Due to the arrangement of the hydraulic manifold, a second master solenoid (not shown) has also to be energised simultaneously to divert the pressure and return lines. This can be achieved by wiring the solenoid drivers in an OR arrangement.

The automatic control can be bypassed when required by means of a selector switch to provide direct operator control of the relays 72 by means of a joystick type switch unit 80. This provides a facility to raise or lower the jib to any desired position irrespective of the engine speed or load. This mode is, however, usually only used on setting-up or during transportation and maintenance and is not normally a recommended operational mode.

Reference is now made to Fig.6 which illustrates an alternative control system for use when hydraulic motors drive the rotor 28, for example as shown in Fig.1a.

The principle of operation of the Figure 6 arrangement is to monitor the rotor torque by measurement of the line input pressure of one or both of the hydraulic motors and to adjust the depth of cut of the flails on the rotor so as to induce a constant drive torque, within, say, a 10% pass band.

The hydraulic pressure is measured by means of a Sensym (Trade Mark) "gauge-pressure" type transducer 80 which provides an output voltage proportional to the applied pressure. Typical limits are 0 - 0.3 volts for 0 - 3000 p.s.i. This signal is amplified using a differential operational amplifier 82 and is referred to the system zero volts. The amplified signal is fed via a gain adjust transducer 84 to one input of a summer 86 whose other input receives an offset from a reference 88 to null the amplifier at the control point. The output of the summer 86 provides an error signal which is used to control the system and which is fed, via switching 90, to a phase delay signal conditioning filter 92 which serves to ensure that the control voltage does not vary too quickly and allow the rotor and flails to leave the ground.

The conditioned signal is sampled and the derivative of this signal, obtained in a derivative operator 94, is summed at circuit element 96 to the proportional error voltage. The resulting signal is amplified at circuit element 98 and fed to a depth control proportional valve 100 controlling the supply of hydraulic fluid to the rams 46. A feedback path is indicated by the chain line 102 corresponding to the resultant effect on the monitored hydraulic pressure arising from a change in the cutting depth of the flails.

The aforegoing system includes a manual mode control which can be selected by the switchgear 90. Operator control is via an analogue joystick 104 which allows the jib to be raised and lowered at a continuously variable rate depending upon the joystick displacement. A control signal from the joystick 104 enters a dead-band operator 106 which gives a null-point of approximately 1.0 volts around the hold-point to allow easy operation of the control without drift. The resulting signal is passed via the switching to the signal conditioner 92 where it is processed as before. The use of the proportional and derivative signals provides an instantaneous output voltage both proportioanl to the displacement of the joystick and to the rate at which the joystick is moved, thus allowing a ground profile to be more easily followed.

As indicated in Figure 7, the system can also include a means of controlling the rotational speed of the motor 28. For control of the motor speed, the illustrated arrangement outputs to four identical proportional valves 108 an analogue control voltage dependent on the demand set by the operator via a potentiometer control 110. The rotor speed is continuously and steplessly variable from zero to maximum, both in forward and reverse modes.

The direction of rotation is controlled via a switch control 112 which provides "forward", "isolation" and "reverse" mode signals for the motor speed control valves 114. A tachometer circuit is used wherein an impulse tachometer 116 senses the speed of the hydraulic motors 60 driving the rotor. The resulting frequency is converted in a frequency/voltage circuit 118 to an analogue voltage level which is amplified at 120 and applied to a summer 122 whose other signal corresponds to the desired speed set at the potentiometer 110. The resulting error signal is fed by way of a speed adjusting unit (for use during start-up) to the direction change switch 112 and thence to the motor speed control valves 114.

It is to be noted that in the system for control of the height of the rotor and hence for control of the cutting depth of the flails, whereas arrangements have been described which use either the engine speed or the hydraulic pressure as a basis for the measurement of rotor load, in other embodiments both of these parameters may be used together to define the rotor load. In the event, the primary signal used is the drive pressure since it tends to be more linear. However, the engine speed can also be introduced to give a more rapid response to overtorque conditions, thus preventing engine stall.

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CLAIMS

1. Terrain clearance apparatus comprising an elongate cylindrical, motor driven rotor (28) carrying a plurality of chain flails (30) around its circumference, characterised by a plurality of pairs of lugs (32) disposed on the cylindrical surface of the rotor (28), each of which provides a mounting point for pivotally connecting a respective chain flail (30) to the rotor, said pairs of lugs (32) being disposed in at least two separate spirals traversing the cylindrical surface of the rotor, the plurality of pairs of lugs in each spiral forming a plurality of parallel rows of pairs of lugs, with the pairs of lugs in adjacent rows in staggered relationship, the stagger between any two said parallel rows being equal at least to the width (X) of the flails.

2. Terrain clearance apparatus according to claim 1, wherein the spacing of adjacent pairs of lugs (32) on each of said spirals is the same.

3. Terrain clearance apparatus according to claim 1 or 2, wherein the stagger is not more than 10% greater than the width of said flails.

4. Terrain clearance apparatus according to claim 1, 2 or 3, wherein each flail comprises a length of chain whose one end is coupled to a metal bar (34) which is pivotally mounted between a pair of said lugs (32a,32b) on the surface of the rotor such that the bar (34) can effect pivotal movement only in a plane perpendicular to the rotational axis of the rotor, and there is provided a stop means (40) on the rotor (28) which serves to restrict the range of pivotal movement relative to the lugs available to the bar (34) in a direction counter to the direction of rotor rotation.

5. Terrain clearance apparatus according to claim 1, 2, 3 or 4, wherein each pair of lugs (32a,32b) is

provided with aligned holes which receive the shank of a bolt (38), the shank of the bolt (38) forming a pivot for the metal bar (34) coupled to the associated chain flail (30).

6. Terrain clearance apparatus according to any of claims 1 to 5, wherein the rotor (28) is supported between two arms (26) which are pivotally mounted to a frame (22) effectively to form a jib which can be raised or lowered, thereby to alter the height of the rotor (28) above the ground and hence the depth of cut of the flails (30), means being provided for automatically controlling the angle of the jib, and hence the height of the rotor, in dependence upon the prevailing drive load presented by the rotor to the motor which drives the rotor.

7. Terrain clearance apparatus according to claim 6, wherein said motor is a diesel or petrol powered engine and wherein the drive load on said motor is monitored by measuring the prevailing operating speed of the engine.

8. Terrain clearance apparatus according to claim 6, wherein the rotor motor comprises at least one hydraulic motor and wherein the drive load on said motor is monitored by measuring the hydraulic drive pressure at the hydraulic motor.

9. Terrain clearance apparatus according to claim 7, including an engine speed sensor (62) providing a signal whose frequency is dependent upon the speed of the engine, a frequency to voltage converter (64) for providing an analogue voltage proportional to said frequency, a comparator (66) which compares said analogue voltage with two predetermined reference levels and provides respective signals for raising or lowering the jib in dependence upon the comparison, the area between said reference levels providing a null-band in which no correction takes place.

10. Terrain clearance apparatus according to claim 8, including a pressure transducer (80) which provides a voltage level dependent upon the output pressure of the hydraulic motor driving the rotor, means (88) providing a reference level with which said voltage level is compared to produce an error signal, means for producing a control signal (94,96) corresponding both to the error signal and to the rate of change of the error signal, the control signal being used to adjust a proportional servo valve (100) controlling the supply of hydraulic fluid to power cylinder means (46) for raising or lowering the jib.

11. Terrain clearance apparatus according to claim 9, further including a manual joystick control (104) which can selectively replace the error signal derived from the pressure transducer (80) for manual control of the jib position.

12. Terrain clearance apparatus according to claim 8, including means for selectively adjusting the rotational speed of the rotor, said means including an impulse tachogenerator (116) which provides a signal whose frequency is dependent upon the rotational speed of the hydraulic motor (60) driving the rotor, a frequency to voltage converter (118) for providing an analogue voltage, proportional to said frequency, a summing means (122) for comparing said analogue voltage with a reference level dependent upon a desired speed setting whereby to provide an error signal, and a plurality of motor speed control valves (114) which respond to said error signal to adjust the rotational speed of said hydraulic motor (60).

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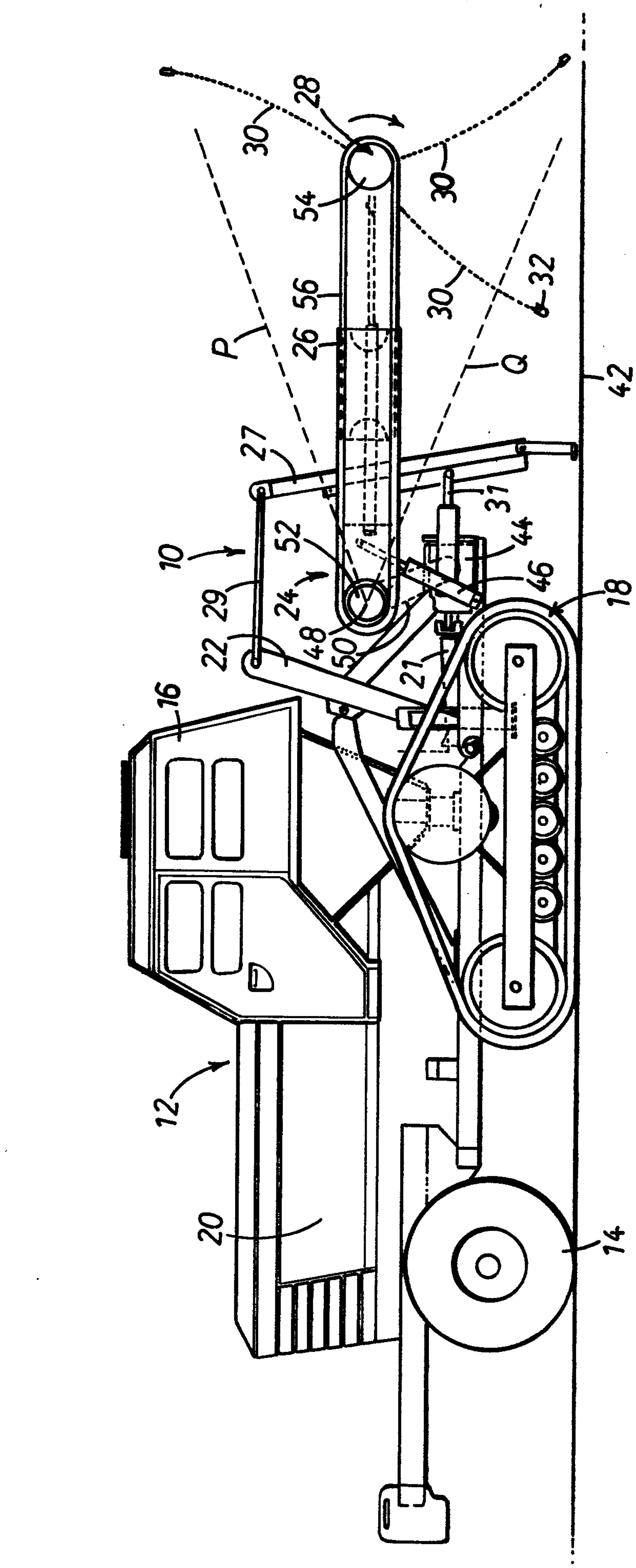

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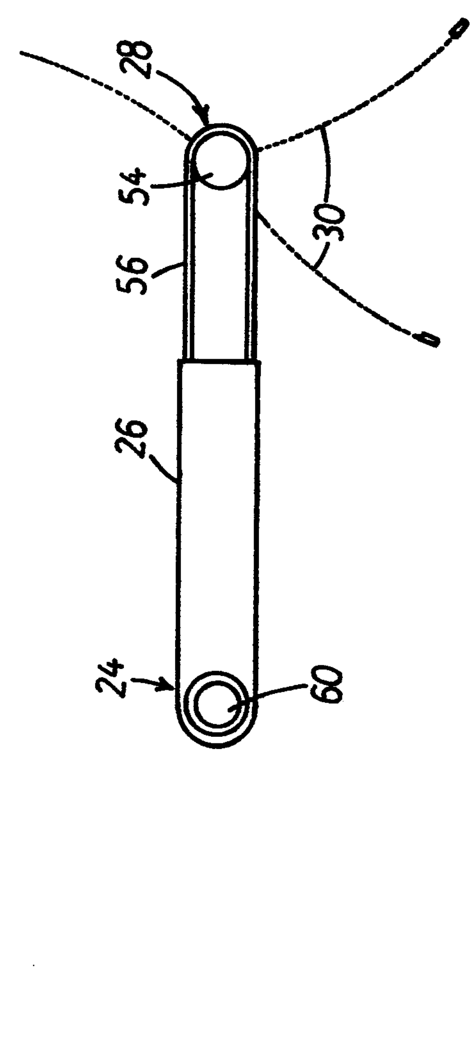
56
P
Q

Fig 1



24
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56
60

Fig 1a

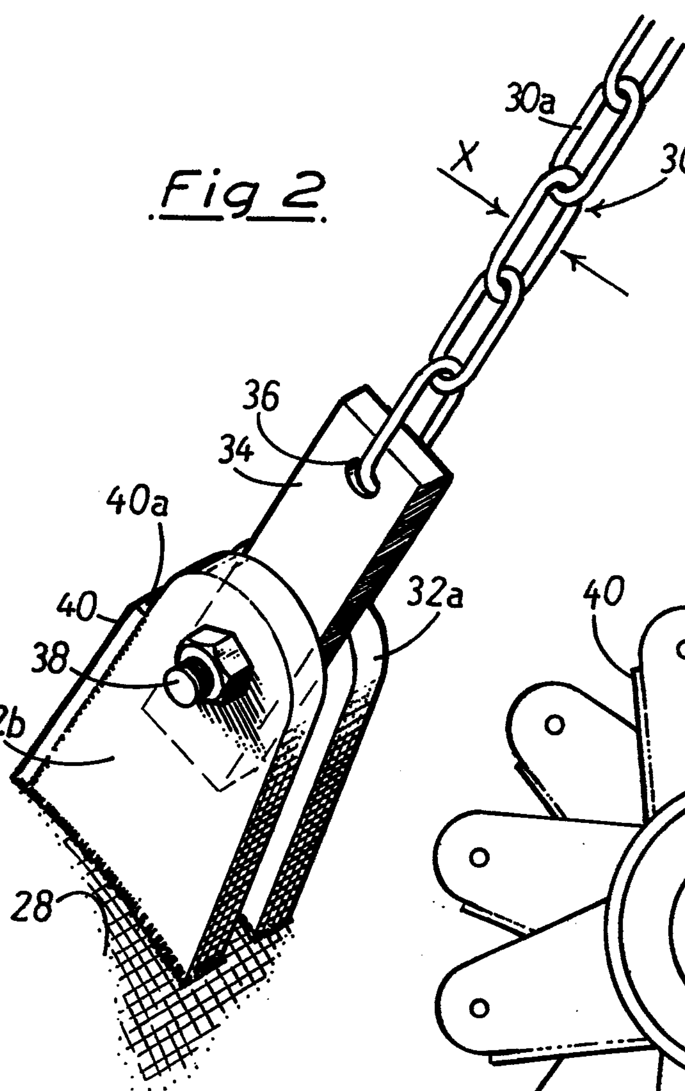


Fig 2

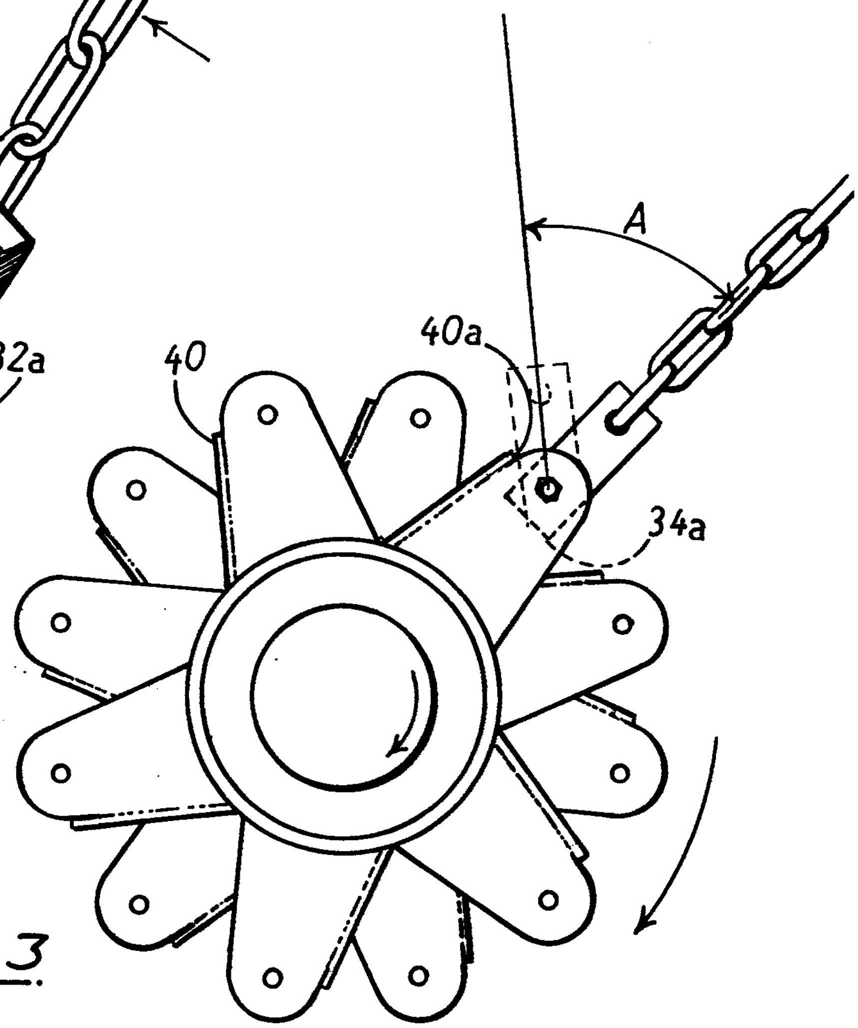


Fig 3

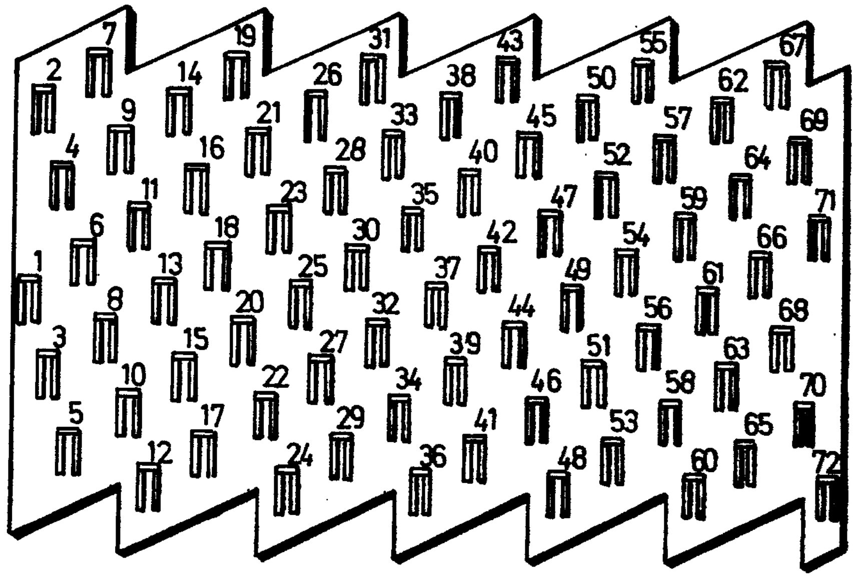
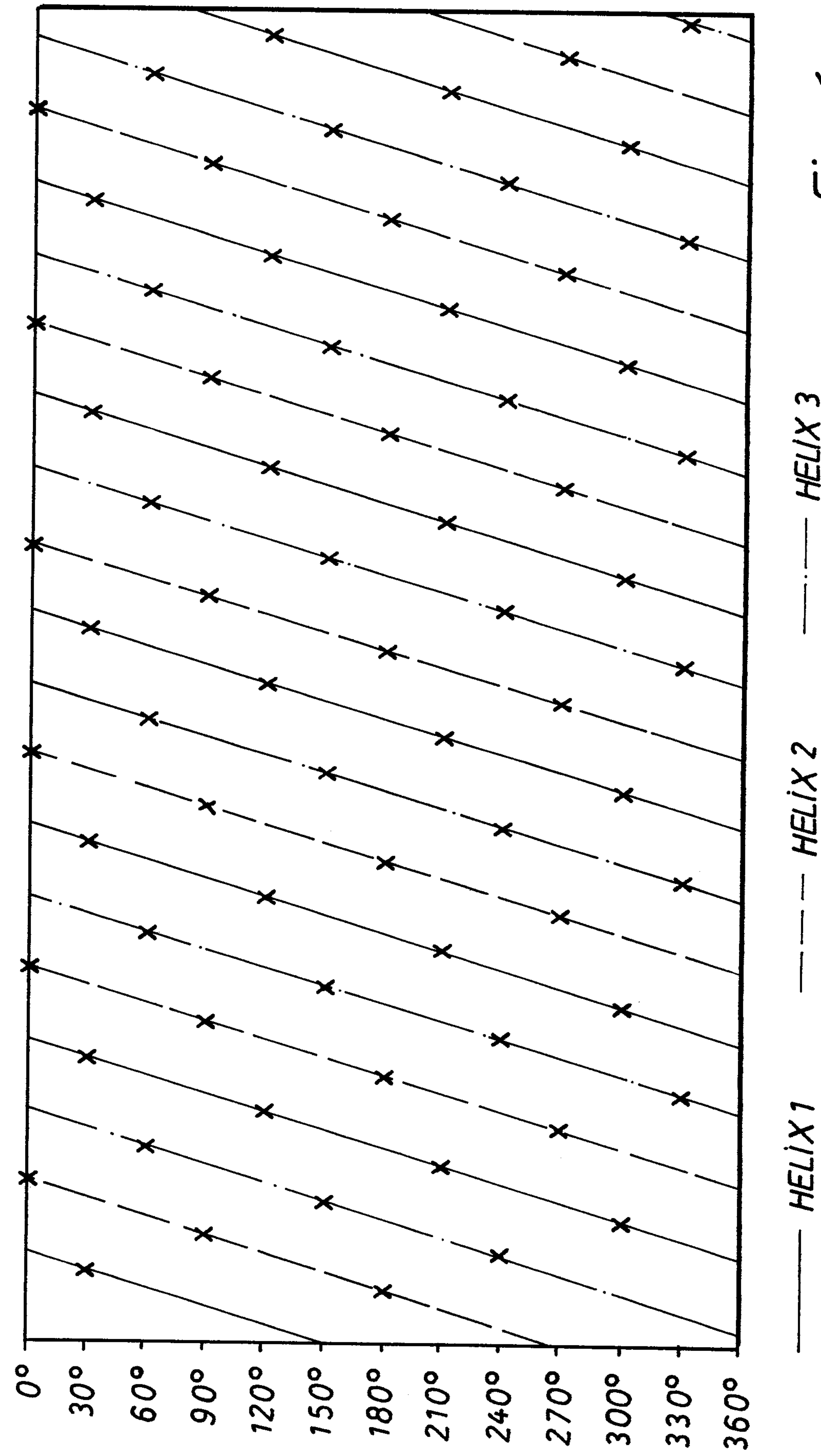


Fig 4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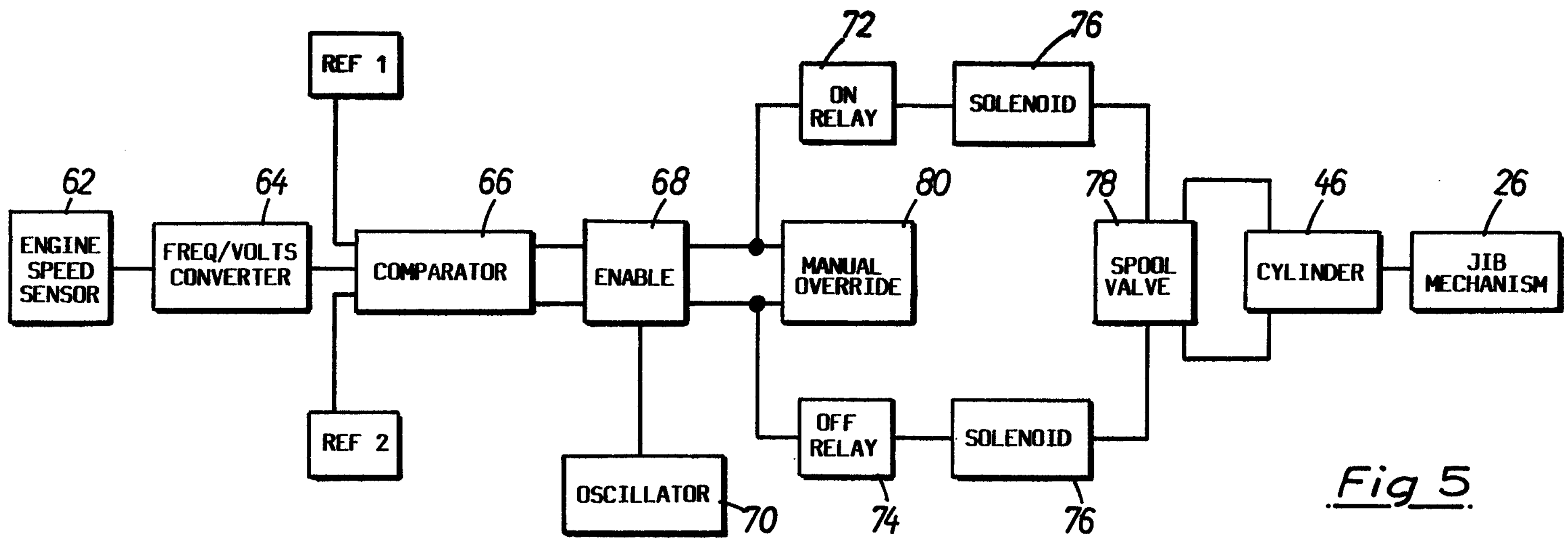
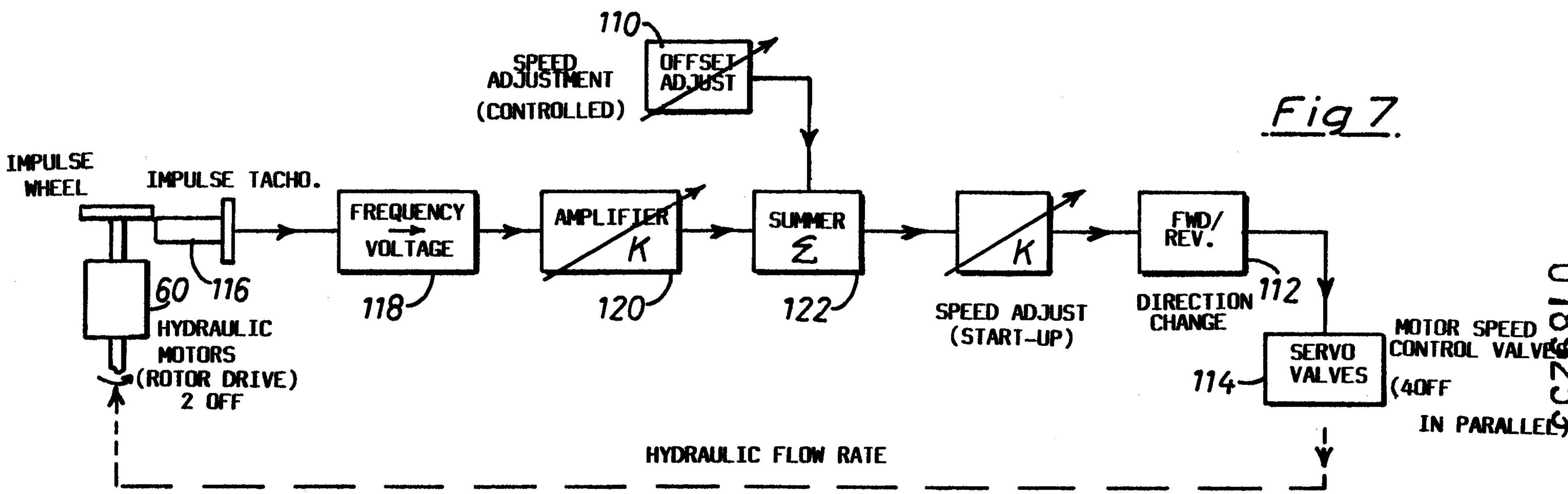
30°
60°
90°
120°
150°
180°
210°
240°
270°
300°
330°
360°
HELIX 1
HELIX 2
HELIX 3

Fig 4a



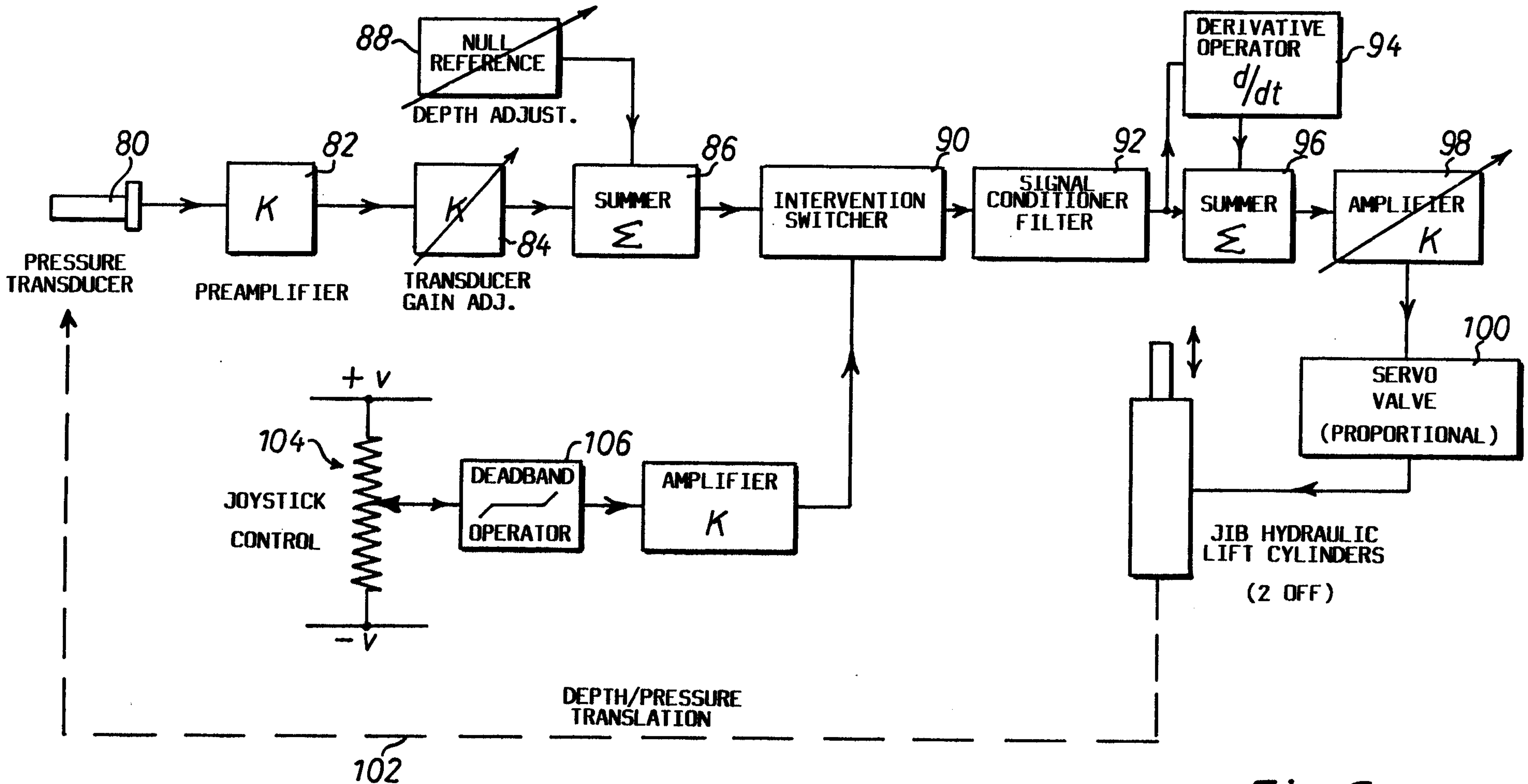
62
ENGINE SPEED SENSOR
64
FREQ/VOLTS CONVERTER
REF 1
REF 2
66
COMPARATOR
68
ENABLE
OSCILLATOR
70
72
ON RELAY
74
OFF RELAY
80
MANUAL OVERRIDE
76
SOLENOID
76
SOLENOID
78
SPOOL VALVE
46
CYLINDER
26
JIB MECHANISM

Fig 5



IMPULSE WHEEL
IMPULSE TACHO.
60
116
HYDRAULIC MOTORS (ROTOR DRIVE) 2 OFF
FREQUENCY → VOLTAGE
118
AMPLIFIER K
120
110
SPEED ADJUSTMENT (CONTROLLED)
OFFSET ADJUST
SUMMER Σ
122
K
SPEED ADJUST (START-UP)
FWD/ REV.
112
DIRECTION CHANGE
SERVO VALVES
114
MOTOR SPEED CONTROL VALVES (4OFF IN PARALLEL)
HYDRAULIC FLOW RATE

Fig 7



80
PRESSURE TRANSDUCER
82
K
PREAMPLIFIER
K
84
TRANSDUCER GAIN ADJ.
88
NULL REFERENCE
DEPTH ADJUST.
86
SUMMER
Σ
90
INTERVENTION SWITCHER
92
SIGNAL CONDITIONER FILTER
DERIVATIVE OPERATOR
d/dt
94
96
SUMMER
Σ
98
AMPLIFIER
K
100
SERVO VALVE (PROPORTIONAL)
JIB HYDRAULIC LIFT CYLINDERS
(2 OFF)
+v
104
JOYSTICK CONTROL
-v
106
DEADBAND OPERATOR
AMPLIFIER
K
DEPTH/PRESSURE TRANSLATION
102

Fig 6

0189255

European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 86 30 0120

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Y	FR-A-2 356 767 (L. TRENKLE) * Claim 1; figures 1-7 * ---	1,6	E 02 F 3/78 F 41 H 11/16
Y	GB-A- 573 753 (A.S. JACOBUS DU TOIT) * Claims 1-3; figure 1 * ---	1,6	
A	GB-A-2 126 958 (R.D. MACWATT) * Abstract; figure 1 * -----	1	
			TECHNICAL FIELDS SEARCHED (Int. Cl.4)
			E 02 F F 41 H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	09-04-1986	ANGIUS P.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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