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(54) FLYING SHEAR MECHANISM AND A WIRE CUTTING-OFF MACHINE INCLUDING THE MECHANISM

(71) We, ORION MACHINERY AND ENGINEERING CORP., of P.O. Box 148, Bosgrove Industrial Park, Branford, Connecticut 06405, United States of America, a corporation organized under the laws of the State of Delaware, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to machines for cutting long lengths of wire into shorter length pieces, and is more particularly concerned with a flying shear mechanism for such a machine to cut off wire fed to the mechanism along a straight-line path.

Wire cutting-off machines are commonly used to cut wire from spools, swifts, drawing machines and other sources of relatively continuous supply, into pieces of generally uniform length of use by other machines in making screws, nails, welding rods and a host of other articles. In such a cutting-off machine it is also well-known to use a flying shear mechanism as the actual cutting mechanism; such a shear mechanism having a knife which is carried by a cutter head moved with the wire as the knife cuts so that a relatively clean cut is made through the wire without the need to interrupt the feed of the wire past a cutting station.

According to the present invention there is provided a flying shear mechanism for a wire cutting-off machine including a frame and means for feeding wire in a straight-line path, the mechanism comprising: two spaced apart guide rods located in a common horizontal plane and each adapted to be parallel to the straight-line path of wire feed; a cutter head mounted on the guide rods for horizontal reciprocation therealong and having a horizontal bore located below the guide rods through which wire is to be passed; a knife slide carried by the head for vertical reciprocation relative thereto and carrying a knife which moves across the bore to cut the wire as the slide is moved vertically between two different positions relative to the head; a crank shaft rotatable about a fixed horizontal axis that extends perpendicular to the vertical planes containing the guide rods; means pivotally connecting a lever eccentrically to the crank shaft at a first location along the length of said lever; means pivotally connecting the lever to the cutter head at a second location along the length of the lever so that the head is horizontally reciprocated along the guide rods as the crank shaft rotates, and means pivotally connecting the lever to the knife slide at a third location along the length of the lever so that the slide is also driven vertically between said two different positions relative to the head as the crank shaft rotates, the lever and the knife slide and the bore all being located generally mid-way between the two vertical planes containing the axes of the two guide rods.

Further according to the present invention there is provided a wire cutting-off machine comprising a frame and a feeding means for feeding wire in a straight-line path continuously past a cutting station fixed relative to the frame and a flying shear mechanism as described in the immediately preceding paragraph.

By the present invention there is provided a flying shear mechanism in which the cutter head and the knife are both driven by the same relatively simple drive mechanism, i.e. the crank shaft and lever.

The crank shaft axis, lever and pivotal connections of the lever to the crank shaft, to the slide and to the cutter head are, preferably, all located above the horizontal bore and therefore the straight-line wire path to make it unlikely for the crank shaft and lever to become contaminated by debris generated during the cutting process and falling by gravity from the cutting zone.

Preferably, the cutter had has a removable cut-off bush through which the wire passes defining said bore, for co-operation with the knife in cutting the wire, and the knife is preferably releasably attached to the knife slide.

One embodiment of the invention will now be described by way of example only, with reference to the accompanying illustrative drawings, in which:

Fig. 1 is a perspective view of a wire cutting-off machine having a flying shear mechanism according to the invention;

Fig. 2 is a view partly in front elevation and partly in vertical section of the wire cutting-off machine of Fig. 1, with the sectional portion of the view being taken generally on a vertical plane containing the axis of the wire;

Fig. 3 is a view partly in side elevation and partly in section with the sectional portion of the view being taken on the line 3—3 of Fig. 2;

Fig. 4 is a sectional view taken on the line 4—4 of Fig. 3;

Figs. 5, 6, 7 and 8 are schematic views generally similar to Fig. 2, showing the parts of the flying shear mechanism as positioned at different times in a cutting cycle, and

Fig. 9 is a schematic diagram of a central system of the flying shear mechanism of Fig. 1.

The general organization of a wire cutting-off machine having a flying shear mechanism according to the invention is shown in Fig. 1. Referring to this Figure, wire 14 is fed to the cutting station of the machine by a pair of in-feed rollers 10 which receive wire from an associated spool, swift, drawing machine or other means supplying wire as a very long or substantially continuous length. Between the supply means and the in-feed rollers may be a straightener (not shown) for straightening the wire or other devices for performing preliminary operations on the wire. During a given run, the rollers 10 rotate continuously so that the wire is continuously fed to the machine at a steady in-feed speed. Immediately downstream of the in-feed rollers is a wire guide bush 12 which guides the wire toward the cutting station along a horizontal and substantially straight line path of travel.

The machine may be operated to cut the wire into pieces of various different lengths. Where relatively long length pieces are cut, the machine, as shown in Fig. 1, includes a horizontal receiver 16 which slidably receives and vertically supports the downstream end portion of the wire until it is cut. Included in the receiver 16 is a movable gate or bottom 18. After the length of wire contained in the receiver 16 is cut from the remainder of the wire the bottom 18 is lowered to allow the cut piece to fall by gravity from the receiver to an associated receptacle.

The illustrated machine has at the cutting station a flying shear mechanism, indicated generally at 20, for cutting the wire 14 without stopping, slowing down or otherwise modifying its feed by the in-feed rollers 10. Referring to Figs. 1, 2 and 3, this flying shear mechanism includes a cutter head 22 supported for reciprocation relative to the machine frame 24 by two parallel guide rods 26 fixed to the frame and arranged so that the cutter head axis of reciprocation is parallel to the wire feed path. At its lower end the cutter head carries a cutoff bush 28 defining a bore 30 through which the wire 14 passes. The bush 28 is removable from the remainder of the cutter head 22 and may be replaced with other similar bushes to suit different wire sizes and shapes. It is releasably held in place with respect to the remainder of the cutter head by a locking screw shown at 29 in Fig. 1. At its downstream end, the bore 30 of the bush has a portion 32 with a cross-sectional size and shape closely conforming to that of the wire 14 so as to provide a close sliding fit between it and the wire, and at its downstream end the bush has a vertical end face 34 surrounding the bore 30.

For cutting the wire 14, the cutoff bush 28 of the cutter head 22 cooperates with a vertically movable knife 36. As shown best in Fig. 3, the knife 36 has a downwardly facing cutting edge 38 which in a cutting operation moves from a raised position past the downstream end of the cutoff bush bore 30, and adjacent the end face 34, to sever the length of wire located downstream from the end face 34 from the remainder of the wire.

The knife 36 is carried by a knife slide 40 carried by the cutter head 22 for movement relative to the cutter head along a vertical axis perpendicular to the horizontal axis of cutter head reciprocation and to the horizontal axis of wire feed. In particular, the knife slide includes a body 42 which is received in a vertically extending slide recess 44 in the cutter head 22 so as to be restrained to vertical sliding movement relative to the head.

The cutter head 22 is reciprocated back and forth along the rods 26 and the knife slide 40 is reciprocated vertically relative to the cutter head 22 by a single lever 46 eccentrically connected to and driven by a crank shaft 48. As shown best in Fig. 3, the crank shaft 48 is supported for rotation relative to the frame 24 about a horizontal axis perpendicular to the vertical plane containing the path of wire feed by two roller bearing units 50 at opposite ends of a cylindrical housing 52 fixed to and forming part of the frame 24. At its left-hand end, as viewed in Fig. 3, the shaft 48 includes an eccentric journal 54 to which the lever 46 is pivotally connected by a bearing 56 so that the lever is movable relative to the journal about a pivotal axis fixed both to the lever and the journal.

The journal 54 and bearing 56 pivotally connect the lever 46 to the crank shaft 48 at one end of the lever. Between its ends the lever is pivotally connected to the cutter head 22, for movement about a pivotal axis fixed relative both to the lever and the cutter head, by a pivot pin 58 fixed to the cutter head 22 and rotatably connected to the lever by a bearing 60.

From the foregoing, and with reference to Fig. 2, it will be understood that as the crank shaft 48 rotates, the lever 46 will drive the cutter head back and forth along the horizontal rods 26, and at the same time the left end of the lever 46 will move up and down relative to the cutter head. This up and down lever movement is in turn used to vertically reciprocate the knife slide 40 relative to the cutter head. To achieve a driving connection between the lever and the knife slide 40, the left end of the lever is connected to the knife slide for movement of the lever relative to the slide about a pivotal axis fixed vertically relative both to the knife slide and the lever but capable of moving a slight amount horizontally relative to either the knife slide or the lever to accommodate the horizontal component of the arcuate movement of the lever end. Various different means may be used to provide this type of connection without departing from the invention, and in the illustrated case the pivotal connection includes a pressure piece 62 received in a slide recess 64 of the knife slide body 42. Along a horizontal axis, the recess 64 has a constant cross-sectional shape and the pressure piece 64 has a complementary cross-sectional shape so as to be restrained by the wall of the recess to sliding movement along a horizontal axis relative to the knife slide. The left end of the lever 46 is pivotally connected to the pressure piece 62 for pivotal movement about a pivotal axis fixed to both the pressure piece and the lever by a pivot pin 66 fixed to the pressure piece and rotatably connected to the lever by a bearing 68.

The drive for the crank shaft 48, as seen in Fig. 3, consists of a pneumatically operated clutch/brake device 70. The crank shaft 48 is the output of the clutch/brake and a flywheel 72 is its input. The flywheel has a set of circumferential grooves 74 for receiving a set of drive belts (not shown) which drive it continuously from an associated motor which also drives the wire in-feed rollers 10 so that the flywheel 72 is driven at a speed directly related to the wire feed rate. The clutch/brake 70 has a normal STOP mode and may be switched to a DRIVE mode by air pressure supplied to it through a rotary air inlet 76 from an air line 78. In the STOP mode, achieved when no operating air pressure is supplied to the device, the clutch portion 80 of the device is set to disconnect drivingly the flywheel 72 from the crank shaft 48 and the brake portion 82 is set to brake or hold the crank shaft 48 stationary relative to the frame 24. Conversely, when the device is in its DRIVE mode, achieved when air pressure is supplied to it through the rotary air inlet 76, the clutch portion 80 is engaged to connect drivingly the flywheel 72 to the crank shaft 48 and the brake portion 82 is released.

During a given run, the clutch/brake 70 may be operated in either one of two ways depending on the length of the pieces desired to be cut from the supply wire. For the cutting of short length pieces, the clutch/brake is held continuously in its DRIVE mode to cause continuous rotation of the crank shaft and continuous operation of the flying shear mechanism. In this case, the length of wire cut is determined by preselecting the speed of the flywheel 72 relative to the speed of the infeed rollers 10. That is, the length of each piece is determined by the formula:

$$\text{piece length} = \frac{\begin{array}{c}\text{in-feed speed}\\ \text{(feet per minute)}\end{array}}{\text{cuts per minute}}$$

with the in-feed speed being dependent on the speed (rpm) of the in-feed rollers and the cuts per minute being dependent on the speed (rpm) of the crank shaft. The length of the piece, may, therefore, be adjusted by varying the ratio of the in-feed speed to the crank shaft speed as by a variable speed drive between the drive motor and the in-feed rollers or a variable speed drive between the drive motor and the flywheel 72. In this cutting of short length pieces, with the flying shear mechanism 20 continuously in operation, the cutter head may not move at exactly the same speed as the wire during the actual cutting operation, but it does move in the same direction as the wire to produce a good quality cut.

In another alternative way of operating the clutch/brake device, used when cutting relatively longer length pieces, the device, for each cut, is switched from its STOP to its DRIVE and back to its STOP mode to produce one revolution of the crank shaft 48. In this case, use is made of a length detector 84, shown schematically in Fig. 2, having a sensing rod 86 located in the path 88 of wire feed. The sensing rod 86 is normally biased to the position shown in Fig. 2 and is yieldably movable to the right when contacted by the advancing downstream end of the wire. Also, the length detector 84 and its sensing rod 86 may be moved to various different positions along the wire path 88 to provide for the cutting of different length pieces. When the advancing downstream end of the wire contacts the sensing rod 86 the detector produces a signal appearing on the output lines 90, and the sensing rod 86 continues to move to the right along with the wire until the cut is completed and the wire falls from the machine, the sensing rod 86 thereafter returning to the illustrated position of Fig. 2 for use with the next piece.

The signal which appears on the output lines 90 of the length detector 84 is used to switch the clutch/brake 70 from its STOP mode to its DRIVE mode to initiate one revolution of the crank shaft 48. The switching of the clutch/brake 70 back to its STOP mode at the end of one revolution of the crank shaft is done in response to a STOP signal provided by a proximity switch or detector 92 cooperating with a position indicator in the form of a trigger vane 94 fixed to the crank shaft 48 for rotation therewith, as shown in Fig. 3. The trigger vane 94 rotates with the crank shaft 48 and the proximity switch 92 is located along its path, the detector 92 producing an output signal on its output lines 96 whenever the vane 94 moves into approximate angular alignment with it, the signal on the line 96, therefore, indicating a predetermined angular position of the crank shaft. As seen best in Fig. 4, the proximity detector 92 is carried by a bracket 98 rotatably received on the outside of the cylindrical housing 52. This bracket is threadably connected to an adjustment screw 100 which may be manually rotated to angularly shift the bracket 98 and proximity detector 92 relative to the cylindrical housing 52, thereby adjusting the angular position of the crank shaft at which the detector 92 produces its crank shaft position signal.

Fig. 9 shows the control system of the flying shear mechanism of the wire cutting-off machine shown in Fig. 1. Referring to this Figure, the in-feed rollers 10 and the input member or flywheel 72 of the clutch/brake 70 are driven by a common variable speed motor 102. A fixed speed ratio drive train 104 drivingly connects the motor 102 to the in-feed rollers 10, and another drive train 106 including a variable speed device 108 drivingly connects the motor to the clutch/brake flywheel 72, thereby enabling, by adjustment of the variable speed device 108, adjustment of the ratio of the wire in-feed speed to the revolutions per minute of the flywheel 72.

A selector switch 110 may be set to select between continuous and intermittent operation of the clutch/brake 70. For continuous operation of the clutch/brake, as when cutting short length pieces from the supply wire, the switch 110 is set to connect a valve operator 112 to a line 113 which supplies a continuous DRIVE signal. In response to this DRIVE signal the valve operator 112 opens its associated valve 114 to supply pressurized air from a supply line 116 to the clutch/brake to set it to its DRIVE mode in which the flywheel 72 is drivingly connected to the crank shaft 48 to cause continuous repeated operation of the flying shear mechanism 20. With this continuous operation of the flying shear mechanism 20, it will be understood that the length of the pieces cut from the supply wire 14 is controlled by the variable speed device 108. That is, in a given unit of time the in-feed rollers 10 will feed a given length of wire through the flying shear mechanism and the variable speed device 108 will determine the number of cuts the flying shear mechanism will make on that length of wire during that unit of time.

For intermittent operation of the clutch/brake 70 and flying shear mechanism 20 the switch 110 is set as shown in Fig. 9 to connect the valve operator 112 to the output line 118 of a control circuit 120. The control circuit 120 is essentially a flip-flop device having inputs from the length detector 84 and proximity detector 92. When the wire 14 engages the sensing rod 86, the length detector 84 produces a signal transmitted to the circuit 120 which sets the circuit 120 and produces a DRIVE signal on the output line 118, this in turn causing the valve operator 112 to open the valve 114 to set the clutch/brake 70 to its DRIVE mode, thereby drivingly connecting the crank shaft 48 to the flywheel 72 and bringing the flying shear mechanism 20 into play. After the crank shaft 48 completes approximately one revolution, the vane 94 moves into the region of the proximity detector 92 causing the detector 92 to produce another signal transmitted to the control circuit 120. This signal resets the circuit 120 and removes the DRIVE signal from the line 118, thereby causing the valve operator 112 to close the valve 114, switching the clutch/brake device 70 to its STOP mode and disengaging the flywheel 72 from the crank shaft 48. The crank shaft 48 is thereafter held in a stationary condition until a new cycle of operation is initiated by the downstream end of the wire 14 again engaging the sensing rod of the length detector. Of course, during the one revolution of the crank shaft 48 the flying shear mechanism 20 is operated to make one cut in the wire 14. With this type of operation of the machine, the variable speed device 108 is preferably set so that during the time that the knife 36 is actually performing the wire cutting operation, the cutter head 22 is moving at a speed equal to the in-feed speed of the wire to thereby produce a very high quality cut.

Figs. 5, 6, 7 and 8 show the positions occupied by the major parts of the flying shear mechanism 20 at different intervals of one cutting cycle taken in sequence. Fig. 5 may be taken to be the start of a cutting cycle with the lever 46 positioned to hold the cutter head 22 at its left-most position with the knife 36 slightly raised above the wire 14. During the next 90° of crank shaft rotation, the cutter head 22 is moved to the right, in the same direction as the wire 14, and the knife slide 42 is moved downwardly to drive the knife 36 past the cutoff bush 28 to cut the downstream portion of the wire from the remaining supply. During the next 90° of crank shaft rotation the parts move to the position of Fig. 7 with the cutter head shifting to its right-most position and with the knife 36 being returned to a raised position. During the next 180° of crank shaft rotation the parts are returned to the initial position of Fig. 5, passing on the way the state shown in Fig. 8.

After a piece or length of wire is cut from the supply it thereafter drops by gravity to a receptacle or other collecting means. It will also be noted that the construction and arrangement of the parts of the flying shear mechanism is such that basically all of the parts are located above the cutoff bushing 28. Therefore, any chips or other debris generated by the cutting process will tend to fall harmlessly away from the flying shear mechanism with little likelihood of causing any contamination problems.

As described above, a single motor 102 is used to drive both the flying shear mechanism 20 and the infeed rollers 10. As an alternative to this two separate motors running at the same speed or at some fixed speed ratio could be used, one for driving the flying shear mechanism through a drive train 106 and the other for driving the infeed rollers 10 through a drive train 104. Also, a variable speed device 108 could be placed in the drive train 104 rather than the drive train 106, or two variable speed devices may be used if desired—one in the drive train 106 and the other in the drive train 104.

WHAT WE CLAIM IS:—

1. A flying shear mechanism for a wire cutting-off machine including a frame and means for feeding wire in a straight-line path, the mechanism comprising: two spaced apart guide rods located in a common horizontal plane and each adapted to be parallel to the straight-line path of wire feed; a cutter head mounted on the guide rods for horizontal reciprocation therealong and having a horizontal bore located below the guide rods through which wire is to be passed; a knife slide carried by the head for vertical reciprocating relative thereto and carrying a knife which moves across the bore to cut the wire as the slide is moved vertically between two different positions relative to the head; a crank shaft rotatable about a fixed horizontal axis that extends perpendicular to the vertical planes containing the guide rods; means pivotally connecting a lever eccentrically to the crank shaft at a first location along the length of said lever; means pivotally connecting the lever to the cutter head at a second location along the length of the lever so that the head is horizontally reciprocated along the guide rods as the crank shaft rotates, and means pivotally connecting the lever to the knife slide at a third location along the length of the lever so that the slide is also driven vertically between said two different positions relative to the head as the crank shaft rotates, the lever and the knife slide and the bore all being located generally mid-way between the two vertical planes containing the axes of the two guide rods.

2. A mechanism as claimed in claim 1 in which the crank shaft axis, the lever, and the pivotal connections of the lever to the crank shaft, to the slide and to the cutter head are all located above the horizontal bore.

3. A mechanism as claimed in claim 1 or claim 2 in which the bore of the cutter head is defined by a cut-off bush carried by and removable from the remainder of the cutter head.

4. A mechanism as claimed in any one of the preceding claims in which the knife is releasably attached to the knife slide.

5. A mechanism as claimed in any one of the preceding claims in which the lever is connected in said pivotal manner at one end to the crank shaft and at its other end to the knife slide, said second location lying between the ends of the lever, the means pivotally connecting the lever eccentrically to the crank shaft being such that the pivotal axis of the lever relative to the crank shaft is fixed relative both to the lever and the crank shaft, the means pivotally connecting the lever to the cutter head being such that the pivotal axis of the lever relative to the head is fixed both to the lever and the head, and the means pivotally connecting the lever to the knife slide including a pressure piece, means supporting the pressure piece on the knife slide for movement relative to the slide solely along an axis parallel to the axis of the bore, and means pivotally connecting the lever to the pressure piece for movement of the lever relative to the pressure piece about a pivotal axis fixed relative both to the lever and the pressure piece, the means supporting the pressure piece on the knife slide including means defining a slide cavity in the slide having a constant cross-sectional size along an axis parallel to the axis of the bore, and the pressure piece being received in the slide cavity and having a complementary cross-sectional shape so as to be restrained to sliding movement relative to the slide along the axis of the cavity.

6. A mechanism as claimed in any one of the preceding claims including a length detector adapted to be located in the straight-

line path of wire feed at a point downstream from the cutter head, and means for rotating the crank shaft through one revolution to produce one cutting cycle of the cutter head and knife slide when the downstream end of wire fed through the bore of the cutter head contacts said length detector.

7. A mechanism as claimed in claim 6 in which the means for rotating the crank shaft through one revolution comprises: a continuously rotated drive member for the crank shaft; a clutch/brake device between the continuously rotated drive member and the crank shaft for drivingly connecting and disconnecting the drive member from the crank shaft, the clutch/brake device having a STOP mode in which it brakes the crank shaft and disconnects the crank shaft from the drive member, the clutch/brake device also having a DRIVE mode in which it releases the crank shaft and drivingly connects the drive member to the crank shaft, the clutch/brake device being normally in the STOP mode; means responsive to the downstream end of wire contacting the length detector for switching the clutch/brake device from the STOP mode to the DRIVE mode, and means operable when the crank shaft thereafter reaches a predetermined angular position relative to said frame for switching the clutch/brake device from the DRIVE mode back to the STOP mode.

8. A mechanism as claimed in claim 7 in which the said means for switching the clutch/brake device back to the STOP mode includes an indicator element fixed to the crank shaft for rotation therewith and a detector device located along the path of the indicator element and co-operable with the indicator element to produce a signal indicating the predetermined angular position when the indicator element moves into the zone of the detector device.

9. A mechanism as claimed in claim 8 including means for adjusting the position of the detector device angularly along the path of the indicator element to vary the angular position of the crank shaft at which said signal is produced.

10. A flying shear mechanism substantially as herein described with reference to the accompanying drawings.

11. A wire cutting-off machine comprising a frame and a feeding means for feeding wire in a straight-line path continuously past a cutting station fixed relative to the frame and a flying shear mechanism as claimed in any one of the preceding claims.

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1600829 COMPLETE SPECIFICATION

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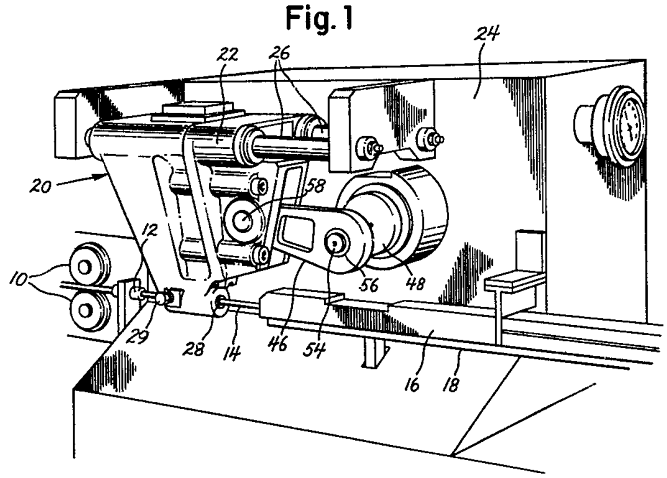
Sheet 1

Fig. 1



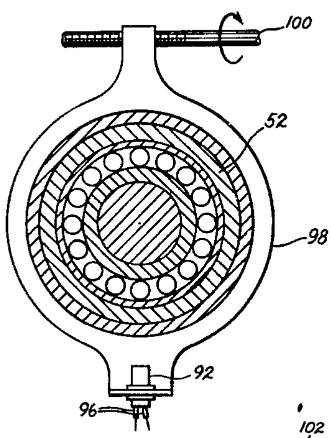


Fig. 4

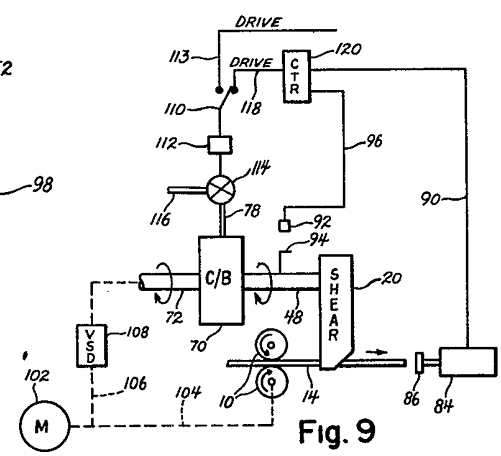


Fig. 9

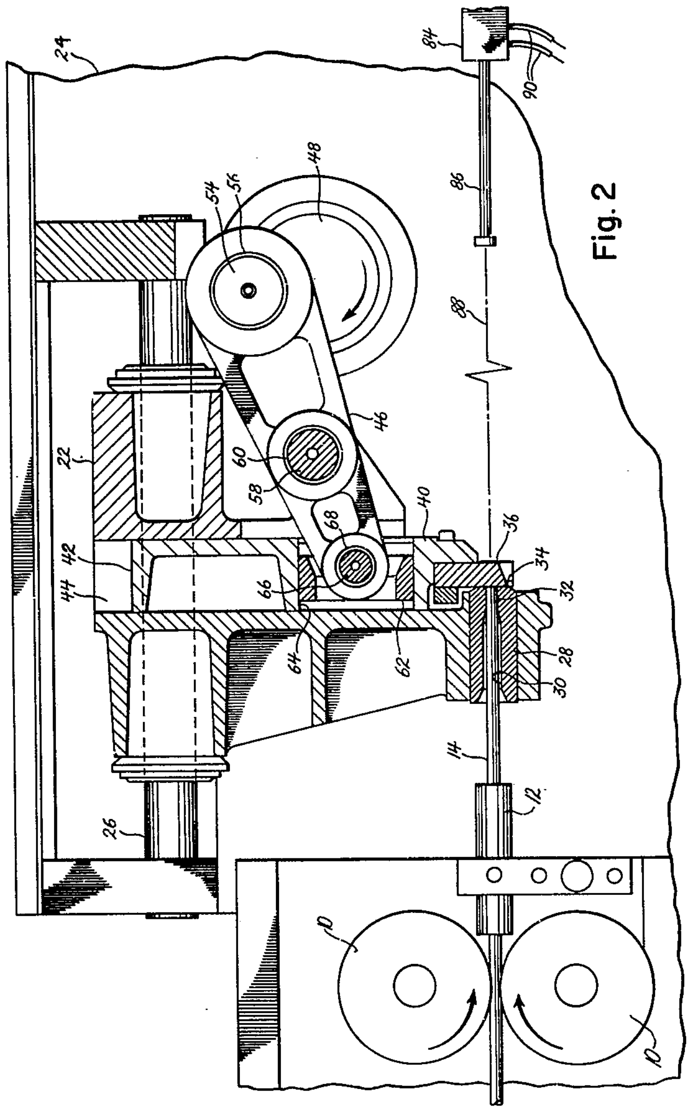

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Fig. 2

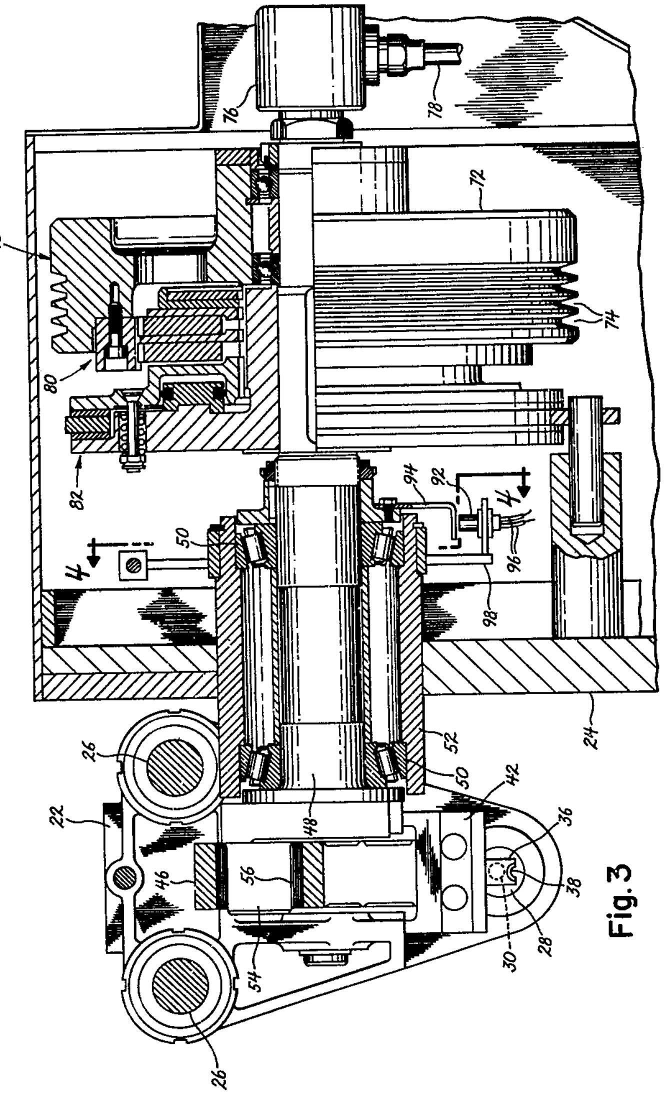
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Fig. 3

1600829 COMPLETE SPECIFICATION

4 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 4

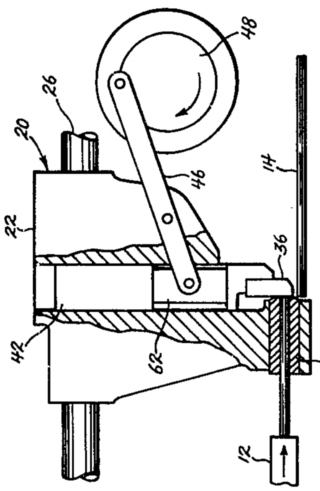

Fig. 6

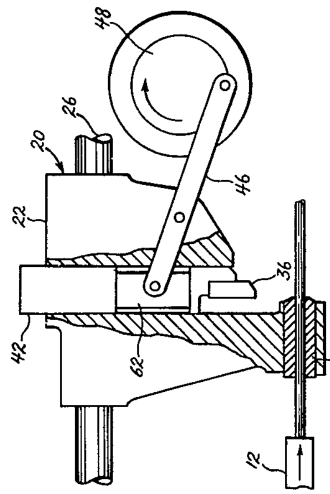

Fig. 8

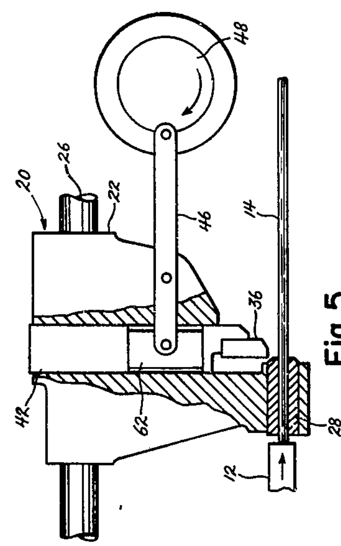

Fig. 5

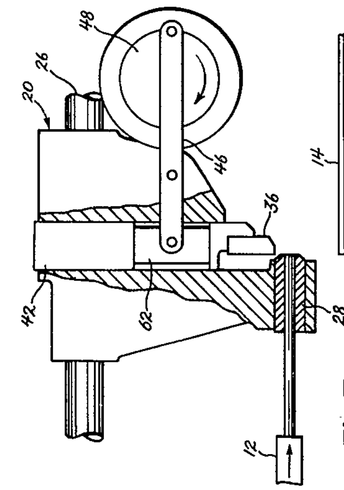

Fig. 7