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OPERATING MECHANISM FOR METAL CUTTING SHEARS

Filed July 11, 1932

2 Sheets-Sheet 1

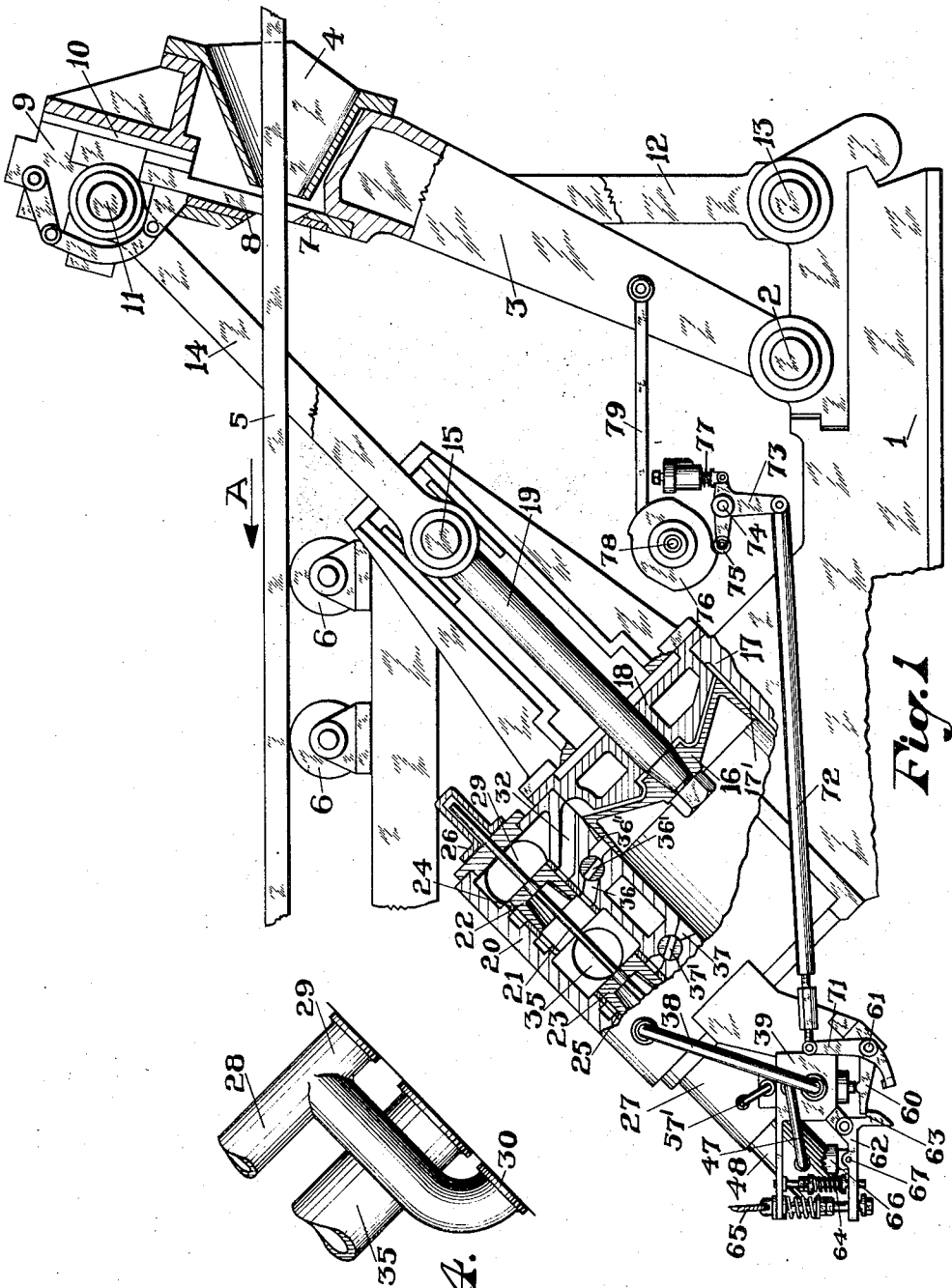


Fig. 1

Fig. 4.

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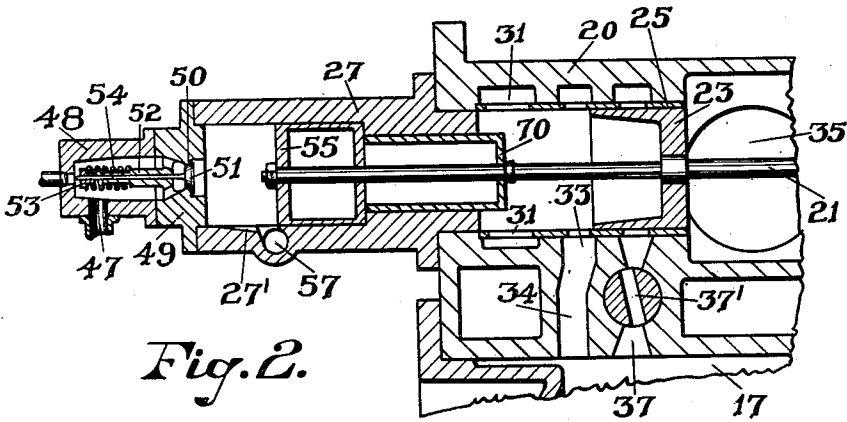


Fig. 2.

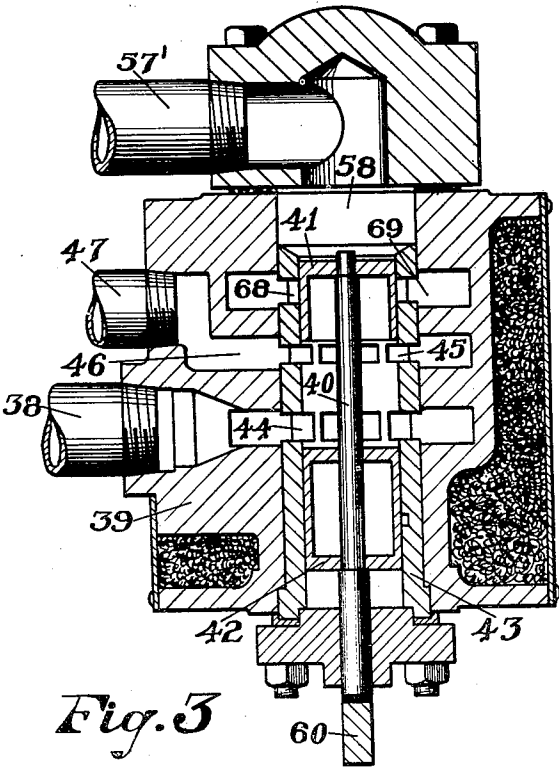


Fig. 3

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UNITED STATES PATENT OFFICE

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OPERATING MECHANISM FOR METAL
CUTTING SHEARSMyles Morgan, Worcester, Mass., assignor to
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5 Claims. (Cl. 164—56)

The present invention relates to operating mechanism for metal-cutting shears of the type known as "flying shears", which are employed in steel mills to cut the rapidly moving rolled product of the mill into commercial lengths as fast as it is delivered from the finishing rolls.

Such a shearing mechanism, employing a steam-operated piston and cylinder unit for securing the travel of the cooperating shear blades in unison with the stock, so as not to retard the movement of said stock while the successive cuts are taking place, is shown and described, for example, in United States Letters Patent No. 1,521,514 of Victor E. Edwards, dated December 30, 1924, and in United States Letters Patent No. 1,844,107 of John W. Sheperdson, dated February 13, 1932.

Objects of the present invention are to improve the operation of shears of this class, by way of securing quick and positive movements of the valves and other moving parts of the shear-actuating instrumentalities, and by way of relieving, in connection with such movements, the blows and shocks resulting from the inertia of such heavy moving parts; other and further objects and advantages of the invention will be made apparent in the following detailed description thereof, reference in this connection being had to the accompanying drawings, wherein—

Fig. 1 is a general view in side elevation, partly in section, showing a flying shear to which the operating mechanism of my invention is applied.

Fig. 2 is a fragmentary vertical sectional view, on a somewhat larger scale than Fig. 1, showing the details of the lower end of the main valve casing and associated parts.

Fig. 3 is a large scale sectional view of the pilot valve and its casing.

Fig. 4 is a diagrammatic plan view, illustrating the steam and exhaust connections of the mechanism.

Like reference characters refer to like parts in the different figures.

Referring first to Fig. 1, the shearing mechanism proper, which may be of substantially the same type as that shown and described in the aforesaid Edwards and Sheperdson patents, is mounted on a suitable base 1, the latter providing a trunnion 2 for the swinging shear frame 3. Said shear frame 3 provides the usual opening 4 for the continuous passage therethrough of the rapidly-moving rolled product 5 of the mill, which product, travelling in the direction of the arrow A on the usual conveyor rollers 6, 6, is to be cut

up, without interruption to its movement, by said shear into pieces of predetermined length.

Adjacent the opening 4, the shear frame 3 carries the usual fixed blade 7, arranged to cooperate with a movable blade 8 which is pivotally carried by a head 9 slidable in ways 10 of the swinging frame 3; according to the usual arrangement, this head 9 is connected to the transverse pivot shaft 11 of the blade 8, as are also the upper ends of a pair of links 12, 12 (only one being shown), which are adapted to swing on a fixed trunnion 13 of the base 1. Also pivotally attached to the transverse shaft 11 are a pair of connecting rods 14, 14 (only one being shown), the same being connected to and operated from a reciprocating crosshead 15, which is attached to a shear-operating piston 16 contained in a steam cylinder 17.

Fig. 1 shows the piston 16 in a position corresponding to the normal "at rest" position of the shear frame 3, said piston 16 being then in close proximity to the upper cylinder head 18, through which passes the piston rod 19 that connects the piston 16 with the crosshead 15. Associated with the cylinder 17 is the inclosing casing 20 of a piston valve 21, hereinafter termed the main valve, said valve, as here shown, including a pair of skirted piston portions 22 and 23 which are mounted, respectively, in ported sleeves 24 and 25 provided by the bore of the casing 20, said bore being closed at the upper end by a head 26, and at the lower end by a supplementary casing 27 (see Fig. 2), for a purpose to be hereinafter described.

As shown in Figs. 1 and 4, a live steam manifold 28 has connections with the bore of main valve casing 20 at the extreme ends of said bore, the upper connection 29 being between the head 26 and the piston portion 22, and the lower connection 30 admitting steam to the interior of sleeve 25 through ports 31, 31 near the lower end of said sleeve. In the normal "at rest" position of the main valve 21 shown in Figs. 1 and 2, the upper piston portion 22 blocks off an inlet connection 32 to the upper end of cylinder 17 from upper live steam inlet 29, while the lower piston portion 23 leaves uncovered a set of ports 33 in sleeve 25 that communicate with an inlet passage 34 to the lower end of cylinder 17, thereby making the pressure of live steam supplied by the lower steam connection 30 effective against the under side of piston 16, any leakage past the piston being made ineffective, due to area reduced by rod 19. The bore of main valve casing 20 has a single exhaust connection 35 between the piston portions 22 and 23 of the main valve; in the movements as hereinafter described of said main valve,

this chamber 35, leading to exhaust, is alternately connected with upper and lower exhaust passages 36 and 37 leading to the interior of cylinder 17, said passages being provided, as shown, with adjustable throttle valves 36' and 37', respectively.

Referring to Figs. 1 and 3, the live steam connection 30 to the lower end of main valve casing 20 has a branch connection 38 to a pilot valve casing 39; within this casing works a pilot valve 40, here shown as comprising spaced piston portions 41 and 42 that move together in the bore of a ported sleeve 43 provided by said casing. In the normal "at rest" position of said pilot valve 40, the live steam from connection 38 enters by way of sleeve ports 44 to the space between the piston portions 41 and 42; in this position of the pilot valve, the piston portions leave uncovered other sleeve ports 45 that connect with a casing passage 46, the latter in turn communicating by a suitable connection 47 (see Fig. 2) with the interior of a valve casing 48 carried by the outer end of the supplementary casing 27 that closes the lower end of main valve casing 20.

The valve casing 48 is associated with an apertured member 49 that constitutes the head or end closure for the supplementary casing 27; the passage through member 49, which connects the interiors of casings 27 and 48, is provided with a suitable valve seat 50 against which seats a poppet valve 51. The stem of valve 51 projects through a guide 52 of seat member 49 into the casing 48, said stem being encircled, between said guide 52 and a nut 53 on its outer end, by a spring 54, that operates yieldingly to hold said valve closed against its seat 50. However, in the normal or "at rest" position of the parts, the live steam that is admitted to casing 48 as above described, by way of the pilot valve of Fig. 3, procures by its pressure on the valve 51 the opening of said valve and the admission of said live steam to the interior of supplementary casing 27; in said casing 27, the live steam exerts its pressure against a piston 55 that is secured to the main valve stem 21, i. e., the same stem that carries the piston portions 22 and 23 of said main valve. There is thus effective on said main valve a preponderance of steam pressure to hold it normally in its extreme right hand position, as illustrated in Figs. 1 and 2,—this corresponding to the "at rest" position of the shear.

The interior of casing 27 has a port 57 which communicates through suitable piping 57' with the top end of the pilot valve casing 39, the live steam thereby filling the chamber 58 of said casing and exerting its pressure against the piston portion 41 of the pilot valve. Thus the same steam pressure which normally holds the main valve in the position shown by Figs. 1 and 2 is tending to thrust the pilot valve 40 outwardly, or downwardly in Fig. 3 from the position therein shown, but this outward movement in the normal "at rest" position of the parts is resisted and prevented by the fact that the stem of pilot valve 40, projecting through the head of casing 39, is abutted by a lever arm 60, pivoted at 61, Fig. 1, on a suitable stationary support.

Said member 60 serves normally to hold the pilot valve 40 in the position illustrated by Fig. 3, due to the fact that a pivoted latch arm 62 provides a shoulder 63 which normally engages the free end of member 60 to hold the latter in operative position as an obstacle to pilot valve movement. The release of member 60 from latch arm 62, so as to make the steam pressure in chamber 58 effective for the downward movement of pilot

valve 40, may be obtained by clockwise rocking of the latch arm 62 against the yielding force of a spring 64, which tends to maintain said arm in operative latching position. Any suitable means may be employed to effect this release; for example, a rope or the like 65 may connect the latch arm 62 with a trigger or flag, not herein shown, but which, as in the aforesaid Edwards patent, may be placed so as to be struck by the advancing end of the moving material that is to be cut by the shear. Or, if desired, the rope 65 may be connected to a lever, not shown, in the operator's pulpit; in either event, the upward draft on said rope 65 secures the requisite clockwise movement of the latch arm 62 to withdraw its shoulder 63 from beneath the member 60; this allows the steam pressure in space 58 to force the pilot valve 40 downwardly, to inaugurate, as hereinafter described, a cutting operation of the shear. In addition to or as an alternative for the rope 65, as a means of releasing the member 60, there is shown in Fig. 1 a solenoid 66, whose movable member is connected as shown at 67, to the latch arm 62; when the solenoid is energized, the latch arm 62 is drawn upwardly, thereby to swing the shoulder 63 clear of the member 60. In advance of the return movement of member 60 to its normal illustrated position, which return movement is procured in a manner hereinafter described, the latch arm 62 will always move back to its operative position under the influence of the spring 64.

Upon release of the member 60 from latch arm 62 in any of the ways above described, the pilot valve 40 is forced downwardly by the steam pressure in space 58, this downward movement being cushioned by the dash pot action of the lower piston portion 42 of said pilot valve. This downward movement causes the piston portion 41 of the pilot valve to cover the sleeve ports 45 and simultaneously to uncover other sleeve ports 46, the latter connecting with a casing passage 47 that opens to exhaust, being preferably connected in any suitable way, not shown, to the exhaust connection 35. Thus, simultaneously, the supply of live steam to the poppet valve casing 48 is cut off, and the steam pressure in casing 27 effective against the piston 55 of the main valve is relieved. Thereupon the valve 51 closes, under the influence of spring 54, and the main valve 21, due to the fact that its portions 22 and 23 are balanced, while live steam is effective against its piston 70, moves sharply to the left.

With this left hand shift of main valve 21, its piston portion 23 uncovers the exhaust passage 37 and covers the inlet passage 34, Fig. 2; in this way not only is the ingress of live steam from inlet connection 30 to the interior of cylinder 17 cut off, but the steam then in said cylinder on the left hand side of piston 16 undergoes an immediate drop in pressure, because of the connection established by passage 37 with the exhaust outlet 35. This left hand movement of main valve 21 also carries the piston portion 22 to a position where it covers the exhaust passage 36 and uncovers the inlet passage 32 at the upper end of the cylinder, so that the steam from inlet connection 29 exerts its full pressure against the right hand side of piston 16 to move the latter rapidly downward, for the operative stroke of the shear.

This operative stroke of the shear procures, in any suitable way, the prompt resetting of the pilot valve 40 in its normal position (Fig. 3); to this end, as shown in Fig. 1, the pivot 61 of member 60 also pivotally supports a bell crank

lever 71, the upper arm of which has a link connection 72 to one arm of a three-arm lever 73, pivoted at 74. Another arm of lever 73 carries a roller 75, with which contacts the periphery of an oscillatory cam 76; the third arm of lever 73 is acted upon by a spring 77, causing roller 75 and arm 73 to always contact the surfaces of cam 76. The cam 76 is oscillated on its axis 78 by the swinging movement of the shear frame 3, the latter having a link connection 79 with a crank, not shown, provided by the shaft of said cam; when the shear frame 3 swings to the left on its operative stroke, the cam 76 is rocked counterclockwise, and through lever 73 and other connections, produces the requisite upward movement of the free lower arm of bell crank 71 to reset the member 60 and to reengage its end with the shoulder 63 of latch member 62, thus restoring the pilot valve 40 to the position shown in Fig. 3.

With this return of the pilot valve 40 to its normal position, which takes place during the down or operative stroke of the shear-actuating piston 16, there is an immediate and substantially positive return of the main valve 21 to its normal position,—such return being a condition precedent to the prompt and rapid ensuing upstroke of the piston 16 that carries the shear frame 3 back to rest position in readiness for another cut on the material being sheared. Heretofore, in flying shear mechanisms of the general type herein disclosed, the return of the main steam valve to normal position, after it has been shifted to cause a cutting operation of the shear, has been at best a relatively slow operation; see, for example, the aforesaid patent to Sheperdson, No. 1,844,107, wherein the return movement of the main steam valve to normal position (following its shift to cause a cutting operation of the shear) is invariably delayed until the live steam escaping through a bleed opening in one of the piston portions of said valve can build up sufficient pressure on the other side of said piston portion to move the whole valve back to its normal position. The relative slowness of such a return movement of the main valve necessarily delays the return of the shear frame to normal "at rest" position, and increases the duration of each operating cycle of the shear; this, in turn, prevents the shear from being used for the shearing of the material into relatively short pieces.

All of the above mentioned difficulties are overcome by the mechanism of my invention, wherein the return movement of the main valve 21 is made instantly responsive to the resetting of the pilot valve 40. As soon as the pilot valve is restored to the position shown in Fig. 3 (this taking place as above described before the shear-actuating piston 16 completes its down stroke), there is an inrush of the live steam, which has been constantly maintained between the pistons 41 and 42 of said pilot valve, into the passage 46, connection 47 and casing 48, to build up the pressure of the steam which was cut off from said spaces by the previous closure of ports 45. Such ingress of live steam is effective immediately to open the valve 51 and to exert its full pressure on the piston 55 in the supplementary casing 27,—said piston 55 at that time being directly adjacent the valve 51, and therefore covering the casing port 57 which communicates, through connection 57', with the space 58 of the pilot valve casing 39. Therefore, the full force of the pressure of the live steam is exerted immediately against piston 55 of the main valve 21 to return it to its normal

position, just as soon as the pilot valve, by the operation of the shear, is reset.

It should be noted also that not only does my invention secure a quick and positive return of the main valve 21 to normal position (through the above described direct application thereto of the live steam supply, in response to resetting of pilot valve 40), but also that the other or opposite movement of said main valve 21 into shear actuating position is accomplished with a minimum of shock, notwithstanding the high speed movement of this relatively heavy member. This is due to the fact that immediately upon the release and descent of the pilot valve 40 as above described, the valve 51 automatically closes, under the influence of spring 54, thus converting the interior of casing 27 into a check cylinder that substantially takes care of the inertia of the left-hand moving main valve 21. In the absence of the self-closing valve 51, a different situation would prevail; upon release of the steam pressure effective against the piston 55 (by descent of pilot valve 40), the main valve 21 would encounter no resistance in its left hand movement and would therefore strike a severe blow on the head 49.

After the pilot valve 40 has been reset, causing the above described quick and positive return of the main valve 21 to its normal position, the return stroke of the shear actuating piston 16 is effected. That is to say, the main valve piston portion 22 uncovers the exhaust passage 36 so as to connect the right hand end of cylinder 17 with the exhaust outlet 35; at the same time, the main valve piston portion 23 uncovers the inlet passage 34 and thereby allows the full pressure of steam from inlet 30 to be exerted against the left hand side of piston 16, so as to produce a rapid return movement of said piston to the normal "at rest" position shown in Fig. 1. In this way, the return stroke of the shear frame 3 is effected, the same as the operative stroke, by opening one end of the cylinder to exhaust and by making the full steam pressure effective on the other side of the piston; in other words, for each complete cycle of operation of the shear frame (operative swing and return swing), there is simultaneously procured an admission of live steam against one side of the piston and an exhaust of steam from the other side toward which the piston movement takes place. Thus the return swing of the shear frame may be made just as rapid and just as positive a movement as the operative swing.

As the piston 16 nears the end of its return stroke, it moves over the inner end of exhaust passage 36. In consequence of this, the end of the return stroke is cushioned by the steam that is trapped at this time between said piston and the cylinder head 18, since such steam, with passage 36 covered by the piston, has only the restricted entrance to said passage afforded by the shallow cylinder wall recess 36". The piston 16 comes completely to rest at the end of the return stroke, since the valve mechanism, as above described, has already been returned and latched in the position shown in Fig. 1, where the steam pressure through the passage 32 is cut off. In this rest position, which disposes the shear in readiness for taking its next cut, the full pressure of the steam supply 30 is transmitted to the interior of cylinder 17 through the passage 34; this steam pressure in the rest or stationary position of the piston 16 becomes effective on both sides of said piston, due to the clearance or leakage

space 17' provided between the piston and the wall of the cylinder 17. Consequently, upon the next-ensuing movement of the main valve 21 to exhaust the steam from the lower or left hand side of the piston simultaneously with the admission of steam to the upper or right hand side of the piston, the resulting positive movement is not delayed by the necessity of building up steam pressure on the right hand side thereof, since the full steam pressure already prevails on said right hand side.

I claim:

1. The combination with a flying shear, of a fluid pressure cylinder and piston unit for actuating the same, to secure each cutting stroke of said shear and its return to open or rest position, a main valve movable to initiate each cutting stroke of the shear by opening one end of said cylinder to fluid pressure and the other end to exhaust, a pilot valve whose movement produces the shear-actuating movement of said main valve, by relieving the fluid pressure normally effective against a portion of said main valve, means responsive to the cutting stroke so initiated for resetting said pilot valve, a connection between said pilot valve and said main valve by which, on resetting of the former, the full fluid pressure is directly restored on said main valve portion for shifting said main valve to open the first-named end of said cylinder to exhaust and the other end to fluid pressure, thereby to produce the return of said shear to normal open or rest position, and means in said connection, responsive to said relieving of the fluid pressure, for cushioning said shear-actuating movement of said main valve.

2. The combination with a flying shear, of a fluid pressure cylinder and piston unit for actuating the same, to secure each cutting stroke of said shear and its return to open or rest position, a main valve movable to initiate each cutting stroke of the shear by opening one end of said cylinder to fluid pressure and the other end to exhaust, a pilot valve whose movement produces the shear-actuating movement of said main valve, by relieving the fluid pressure normally effective against a portion of said main valve, means responsive to the cutting stroke so initiated for procuring by said pilot valve the shifting of said main valve to open the first-named end of said cylinder to exhaust and the other end to fluid pressure, thereby to produce the return of said shear to normal open or rest position, and a check valve, between said pilot valve and said main valve, adapted to close automatically upon said relieving of the fluid pressure, to provide a cushion for the shear-actuating movement of said main valve.

3. The combination with a flying shear, of a fluid pressure cylinder and piston unit for actuating the same, to secure each cutting stroke of said shear and its return to open or rest position,

a valve operable to initiate each cutting stroke of the shear by opening one end of said cylinder to fluid pressure and the other end to exhaust, and movable into shear-actuating position by the release of fluid pressure normally effective against a portion of the same, a check valve made operative by said release of pressure to intercept the outflow of pressure fluid, thereby to cushion the shear-operating movement of said first-mentioned valve, and means responsive to each cutting stroke so initiated for shifting said first-mentioned valve to open the first-named end of said cylinder to exhaust and the other end to fluid pressure, thereby to produce the return of said shear to normal open or rest position.

4. The combination with a flying shear, of a fluid pressure cylinder and piston unit for actuating the same, to secure each cutting stroke of said shear and its return to open or rest position, a valve operable to initiate each cutting stroke of the shear by opening one end of said cylinder to fluid pressure and the other end to exhaust, and movable into shear-actuating position by the release of fluid pressure normally effective against a portion of the same, means responsive to the resulting operative swing of the shear for restoring directly the fluid pressure in full against said valve portion, for shifting said valve to open the first-named end of said cylinder to exhaust and the other end to fluid pressure, thereby to produce the return of said shear to normal open or rest position, and a check valve made operative by said release of pressure to intercept the outflow of pressure fluid, thereby to cushion the shear-operating movement of said first-mentioned valve.

5. The combination with a flying shear, of a fluid-pressure cylinder and piston unit for actuating the same to produce at each actuation a single cutting stroke of said shear and its return to open or rest position, a main valve movable to initiate each cutting stroke of the shear by opening one end of said cylinder to fluid pressure and the other end to exhaust, a pilot valve adapted for movement by pressure fluid to relieve the fluid pressure normally effective, in the open or rest position of said shear against a portion of said main valve, thereby to permit, by fluid pressure, the shear-actuating movement of said main valve, means responsive to the shear's cutting stroke so initiated for resetting said pilot valve, and a passage, opened by said pilot valve on its resetting movement, to produce an inrush of pressure fluid directly against said main valve portion, for the immediate return of said main valve to normal position, thereby to open the first-named end of said cylinder to exhaust, and the other end to fluid pressure, for procuring the piston movement that returns said shear to its normal open or rest position.

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