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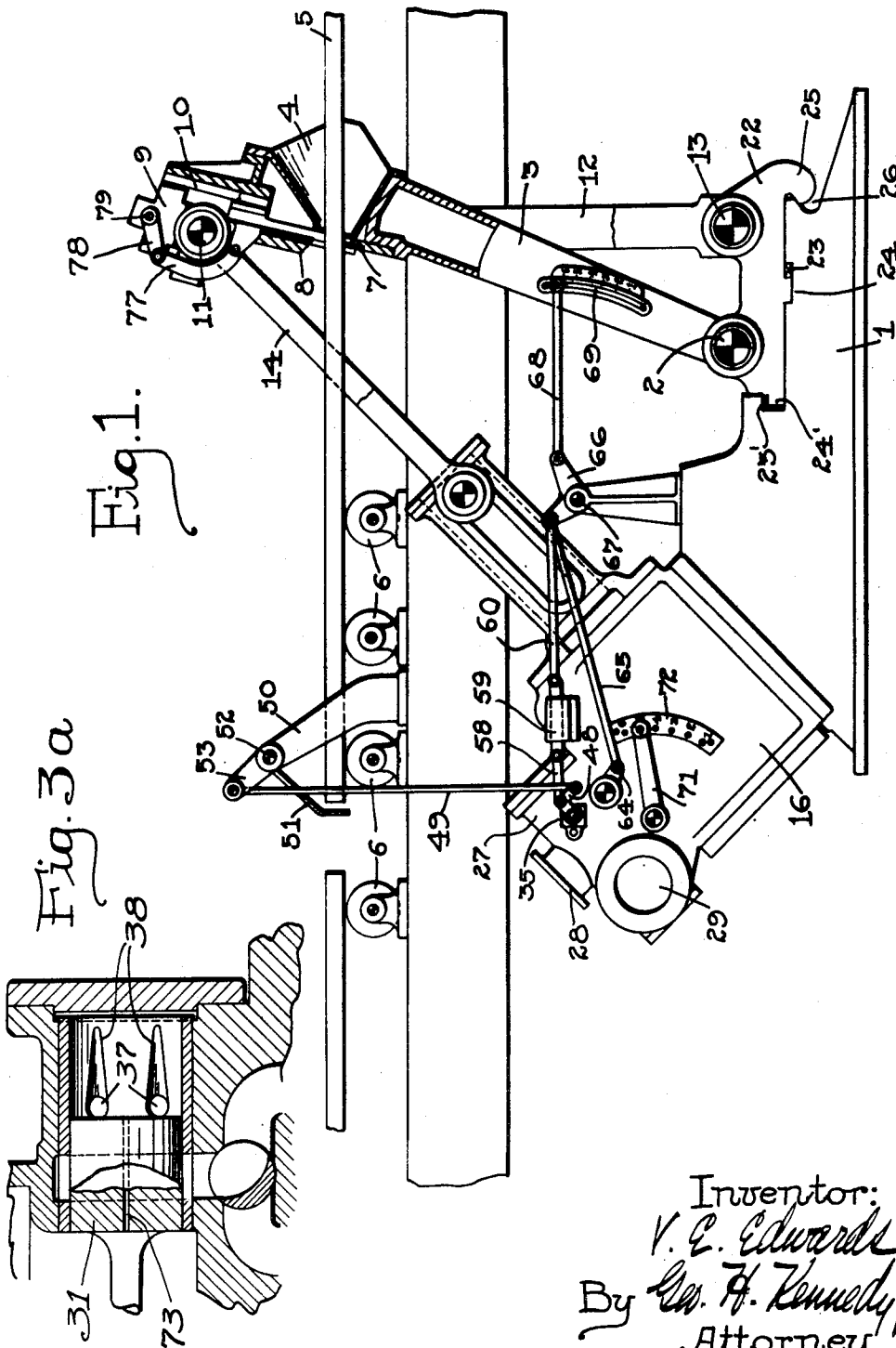
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V. E. EDWARDS

ART OF SHEARING METAL BARS WHILE IN MOTION

Filed July 1, 1921

6 Sheets-Sheet 1



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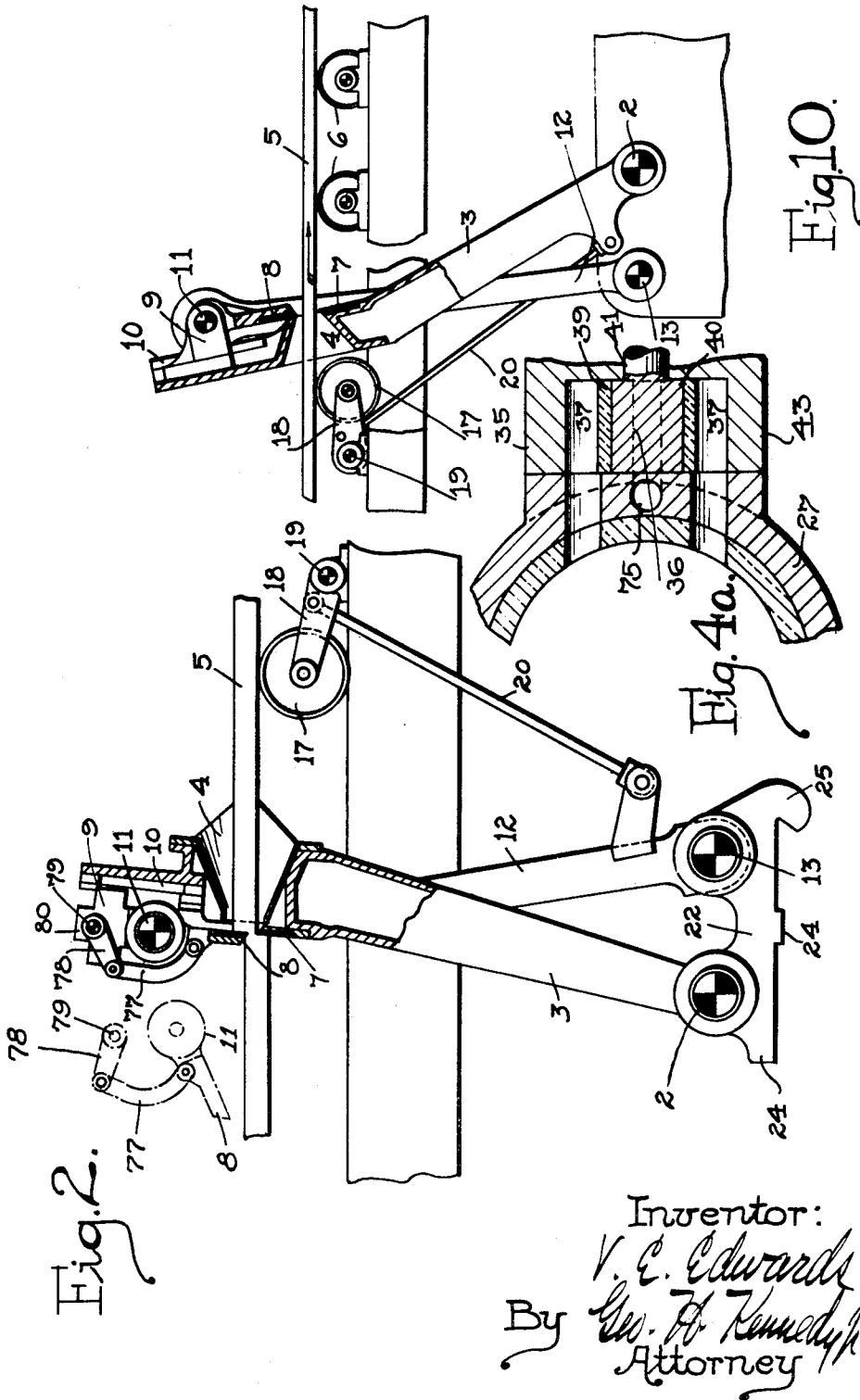
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6 Sheets-Sheet 2



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6 Sheets-Sheet 3

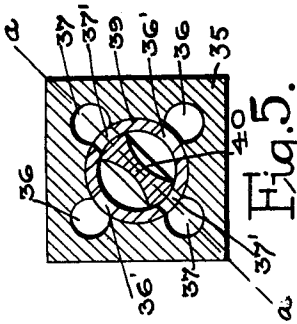
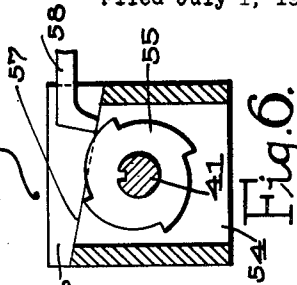
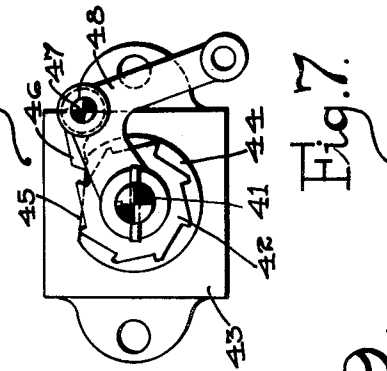
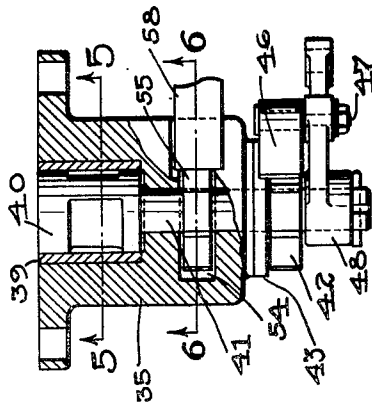


Fig. 4.

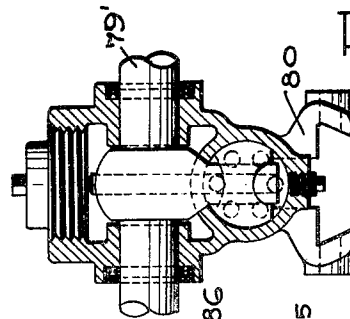


Fig. 9.

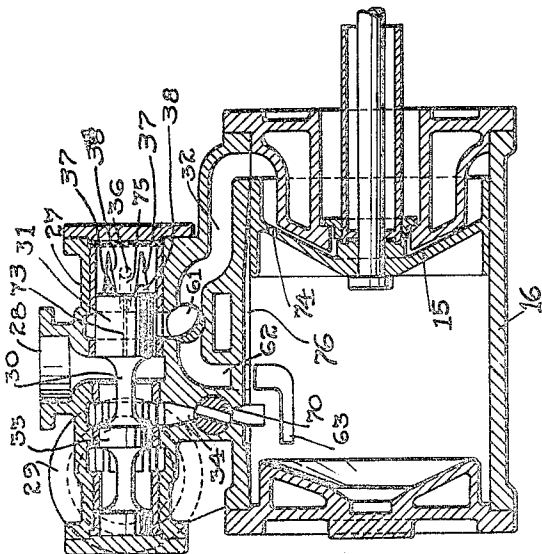


Fig. 3.

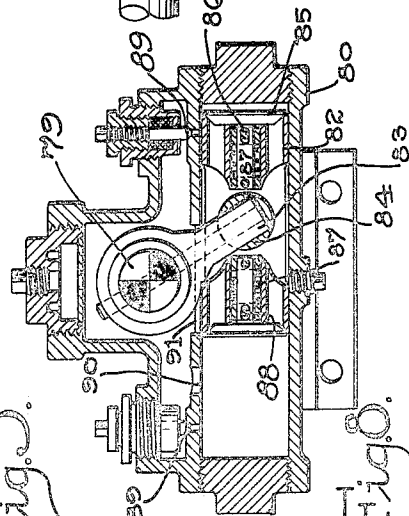


Fig. 8.

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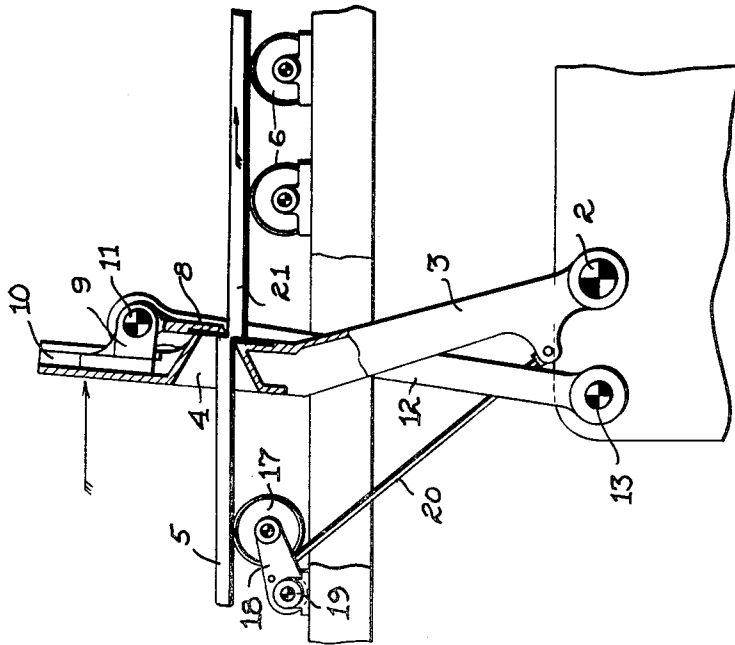
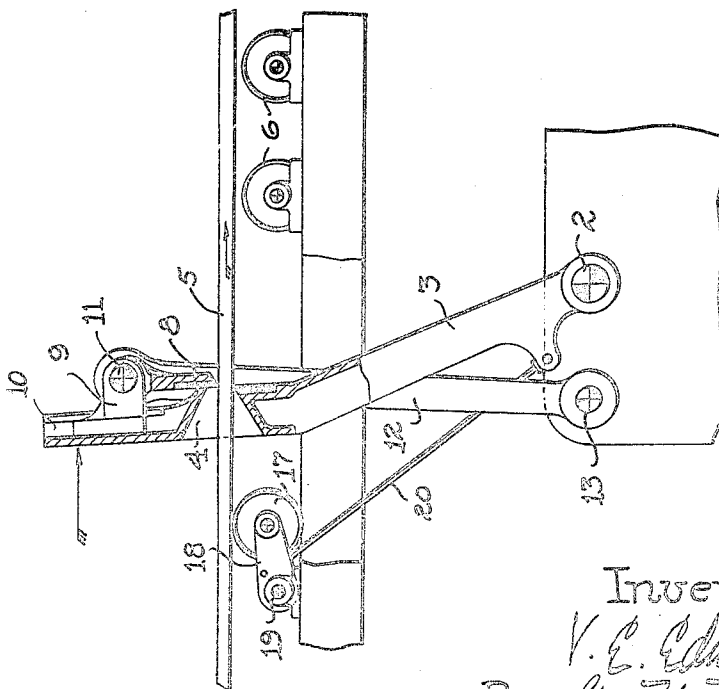
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6 Sheets-Sheet 4



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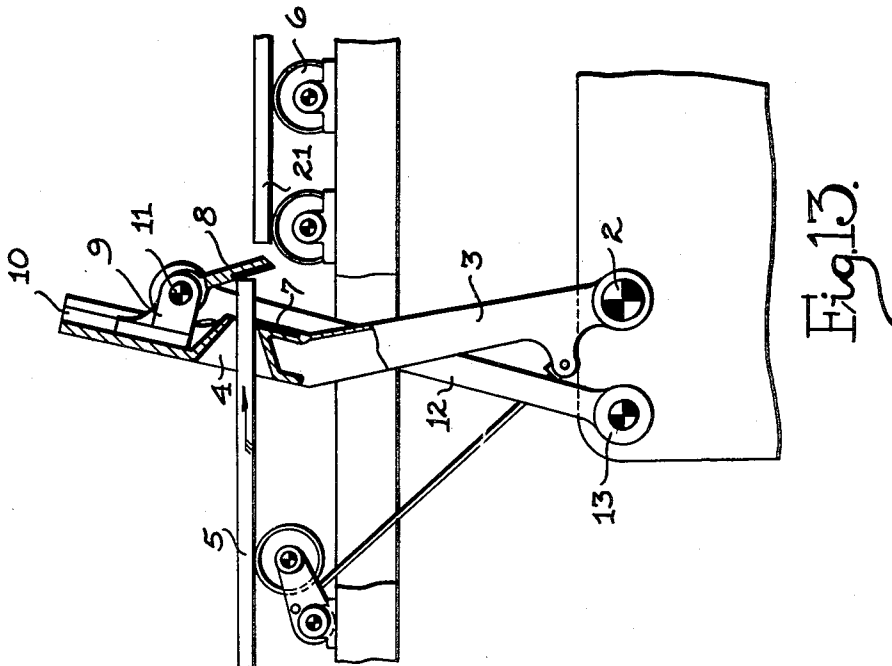


Fig. 13.

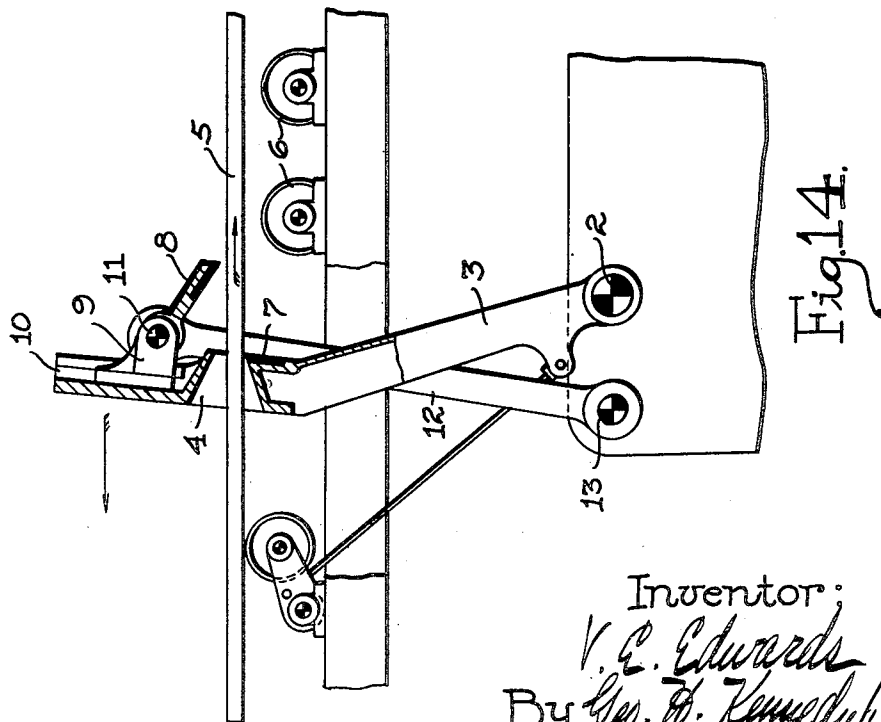


Fig. 14.

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ART OF SHEARING METAL BARS WHILE IN MOTION

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6 Sheets-Sheet 6

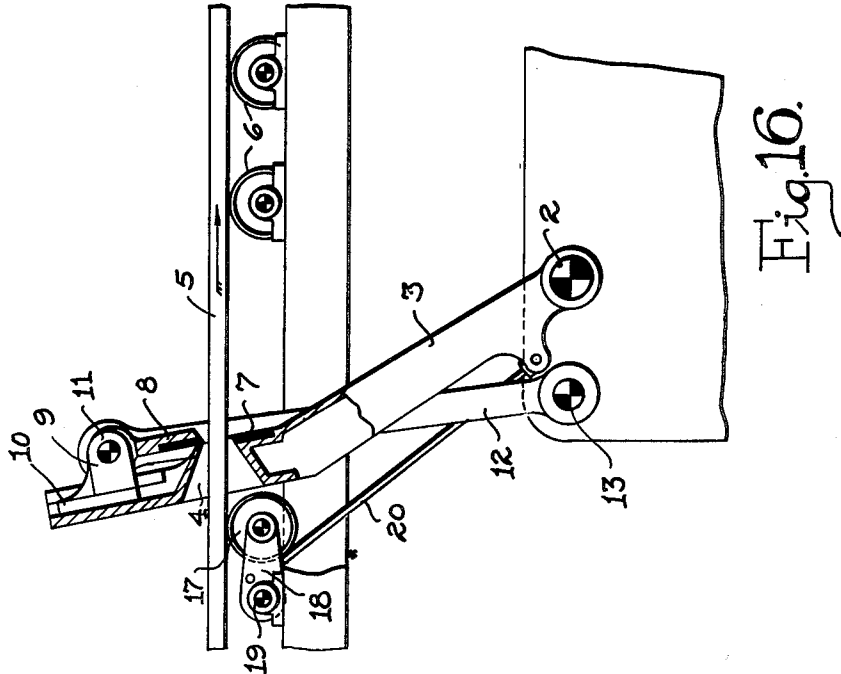


Fig. 16.

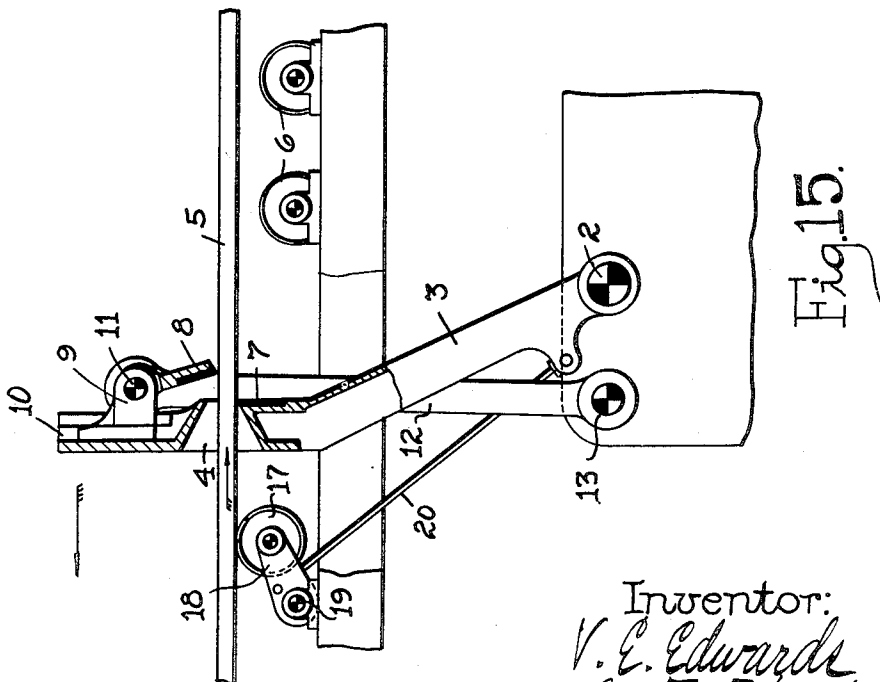


Fig. 15.

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UNITED STATES PATENT OFFICE.

VICTOR E. EDWARDS, OF WORCESTER, MASSACHUSETTS, ASSIGNOR TO MORGAN CONSTRUCTION COMPANY, OF WORCESTER, MASSACHUSETTS, A CORPORATION OF MASSACHUSETTS.

ART OF SHEARING METAL BARS WHILE IN MOTION

Application filed July 1, 1921. Serial No. 481,838.

To all whom it may concern:

Be it known that I, VICTOR E. EDWARDS, a citizen of the United States, residing at Worcester, in the county of Worcester and Commonwealth of Massachusetts, have invented a new and useful Improvement in the Art of Shearing Metal Bars While in Motion, of which the following, together with the accompanying drawings, is a specification.

The present invention relates to the shearing or cutting of metal bars, billets, or the like while the same are in motion, i. e., the practice employed in steel mills where the continuous, rapidly moving rolled product is cut up into commercial lengths as fast as it is delivered from the finishing rolls of the mill.

Devices for thus severing the metal, without stoppage of its normal travel through the mill, are known in the art as "flying shears." The present invention contemplates improvements both in the construction and in the mode of operation of devices of this class, with the end in view of simplifying the mechanism and facilitating the close adjustment of its speed to the speed, however high, of the moving material; also in causing the shear to cut through the metal in an upward direction, thus avoiding bent ends in the severed pieces.

Other and further objects of the invention will be apparent as the description of the same proceeds, reference being had to the accompanying drawings, wherein—

Fig. 1 is a general view in side elevation, and partly in section, of a flying shear and its operating mechanism, as constructed in accordance with the present invention.

Fig. 2 is a similar view of the shear in a different position, the parts being shown in the act of severing, and the operating mechanism being omitted.

Fig. 3 is a view in section of the steam cylinder and associated valve devices of the operating mechanism.

Fig. 3^a is a fragmentary sectional view of the main steam valve.

Fig. 4 is an enlarged sectional view of a pilot valve which cooperates with the main valve of the steam cylinder.

Fig. 4^a is a fragmentary sectional view showing the relation of the pilot valve to the main valve casing, the plane of the section being the line *a—*a** of Fig. 5.

Fig. 5 is a transverse sectional view on the line 5—5 of Fig. 4.

Fig. 6 is a transverse sectional view on the line 6—6 of Fig. 4.

Fig. 7 is a view in front elevation of the parts shown in Fig. 4.

Fig. 8 is a longitudinal sectional view of an air cylinder which cooperates with the movable knife of the flying shear.

Fig. 9 is a transverse sectional view of the parts shown in Fig. 8.

Figs. 10 to 16 inclusive are diagrammatic views of the shear mechanism proper, illustrating successive stages in the cycle of operations thereof.

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

Referring first to Fig. 1, the mechanism is shown as mounted on a suitable base 1; the latter, in a manner hereinafter described, supports a member which provides a trunnion 2 for a swinging shear frame 3. The shear frame 3 provides the usual opening 4 for the passage of the continuously moving billet or bar 5, the latter being normally supported and moved on the usual conveyor rolls 6, 6.

Adjacent the opening 4, the frame 3 provides the usual fixed blade 7, the latter arranged to cooperate with a movable shear blade 8 which is pivotally carried by a head 9 which is slidable in ways 10, 10 of the frame 3; as is usual in devices of this type, the head 9 is carried by the transverse pilot shaft 11 of blade 8, which is connected to a pair of links 12, 12 adapted to swing on a fixed pivot or trunnion 13 at their lower ends. The transverse shaft 11 is also pivotally attached to a pair of connecting rods 14, Fig. 1, the latter being operated in the usual manner from the reciprocating cross head of a piston 15 in the steam cylinder 16.

As is well understood by those conversant with this type of machinery, the movement of the shear frame 3 to the left in Fig. 1, causes the blades 7 and 8 to sever the bar or

billet 5 without interruption to the movement of the latter. This drawing together of the blades or knives during the swinging movement of the shear is due to the fact that the head 9 carrying movable knife 8 must maintain a fixed distance from the pivot or trunnion 13, because of its connection thereto by link 12; therefore, as the frame 3 swings to the left, Fig. 1, the head 9 travels downwardly in the ways 10 of frame 3, causing the blade 8 to approach the blade 7. In all previous constructions, this action resulted in the cutting stroke being taken almost entirely by the upper knife; in other words, the arrangement heretofore has been such that the stationary blade 7, at the instant of cutting, is at substantially the same height that it normally occupies when the shear is at rest, the result being that the tail end of the severed piece was bent downwardly.

According to the present invention, this difficulty is overcome by a somewhat different arrangement of the swinging shear frame 3 and swinging tension link 12, in conjunction with the provision of means for momentarily elevating the bar or billet at the instant of shearing, so that the bending of the tail end of the severed piece is eliminated. As shown diagrammatically in Fig. 10, which illustrates the shear at rest, the tension link 12 occupies a position slightly inclined from the vertical, the shear blades being almost vertically over the tension trunnion 13. Because of this arrangement, it follows that during the cutting of the piece, the fixed knife 7 carried by the shear frame 3 will be passing through the highest part of its path, in contradistinction to the prior devices of this class as shown in Edwards Patent No. 505,512, September 26, 1893, where the actual cutting is done somewhat below the normal plane of travel of the billet or bar.

As a result of this rearrangement, the vertical movement of the knife 8 during the cutting period is reduced to a minimum; on the other hand, the relative movement between the two knives 7 and 8 is just as much as in the previous constructions, because the fixed knife 7 swings upwardly to meet the descending movable knife 8. As a consequence of this, the severance of the piece is accomplished mostly by this elevation of the lower knife instead of by the descent of the upper knife, and it is to be noted that during the shearing, the moving piece is supported by means of a lifting conveyor roll 17, the latter being carried in arms 18 attached to a pivot shaft 19. The arms 18 have a link connection 20 either with the shear frame 3, as shown in Figs. 10 to 16 inclusive, or with link 12, as shown in Fig. 2. This connection 20 causes the roll 17 to move upwardly as the knives make their cut, as shown in Fig.

11, the maximum elevation being reached, as shown in Fig. 12, just as the cut is completed, so that the advancing end of the billet or bar is held up high enough to pass without obstruction through the opening 4. The tail end 21 of the severed piece falls by gravity to the fixed plane of support provided by rolls 6, 6',—instead of being bent below said plane, as in previous constructions, by the movable knife.

As shown in Figs. 1 and 2, the shear frame trunnion 2 and the tension trunnion 13 are carried in a supporting frame member 22, the latter being secured detachably to the base 1. In the event of breakage or accident, this permits the quick replacement of the shearing mechanism as a unit. The mode of attachment is such that the principal stresses set up in the shear frame 3 and tension link 12 are transmitted directly to the base 1; only minor stresses being exerted on the keys or wedges 23 and 23', by which the frame 22 is secured, detachably, to the base 1. To this end, projections 24, 24' of the frame 22 are interlocked with corresponding recesses of larger size, provided in the base 1, and, in addition, the frame 22 has a downwardly projecting lip 25 that enters an undercut portion 26 of the base. Rigidity in a horizontal direction is obtained by driving in the key or wedge 23, which forces the frame 22 toward the left in Fig. 1, and holds it solid against lateral displacement. Any tendency of the frame to tip in a vertical plane is resisted by the key or wedge 23', and obviously, these wedges 23 and 23' are readily removable, and when removed, permit easy detachment of the frame and shearing mechanism from the base 1.

In connection with the actual cycle of operations of the shear, the present invention contemplates far-reaching improvements in the mode or manner of obtaining rapid acceleration and rapid deceleration without jar; the invention also contemplates a highly developed mode or manner of controlling this necessary acceleration and deceleration to correspond with the different speeds at which the metal is moved.

As shown in Fig. 3, the cylinder 16 is provided with a valve casing 27, the latter having a steam inlet connection 28 and an exhaust steam connection 29. Within the bore of valve casing 27 is disposed a main valve generally indicated by the numeral 30, said valve having a portion 31 for controlling passage 32 leading to the cylinder, and a portion 33 for controlling the passage 34 to the cylinder.

That end of main valve casing 27 which contains the valve portion 31 has projecting from its side a pilot valve casing 35, as shown in Fig. 1, and on an enlarged scale in Figs. 4, 4^a and 5. The pilot valve casing 35 provides two pairs of diametrically opposite

passages 36, 36 and 37, 37, the last named having extensions opening through the side wall of the main valve casing 27, as shown in Figs. 3, 3^a and 4^a. From the open end of each passage 37, 37, the lining of casing 27 provides interior recesses 38, 38 extending longitudinally, as shown in Figs. 3 and 3^a. The passages 36 and 37 all open inwardly to the central bore of the pilot valve casing 35 by means of ports 36', 36' and 37', 37' in a sleeve 39, Fig. 5, which surrounds the pilot valve 40.

The pilot valve 40 extends diametrically across the sleeve 39, and in the position shown in Fig. 5, blanks off the two passages 37, 37 from the interior of said sleeve. Pilot valve 40 is secured to the end of a valve stem 41, by the rotation of which said valve is carried into different positions, relatively to the passages 36, 36 and 37, 37. That is, the valve 40 is adapted to be moved, intermittently, through angles of 45°, in order, first, to connect adjacent passages 36 and 37 and then to blank off either pair of diametrically opposite passages, repeating this operation for each operation of the shear.

For operating the valve 40, the stem 41 provides two independent ratchet mechanisms, one, responsive to the travel of the bar or billet, for opening the valve to make the cutting stroke, and the other, responsive to the movement of the shear, to make the return stroke. The valve opening mechanism comprises a ratchet wheel 42 secured to the outer end of shaft 41, said ratchet wheel being disposed adjacent to a plate 43 on the end of casing 35, which has a boss 44 of generally circular outline, with a flat surface 45 at the top. The teeth of the ratchet wheel 42 are adapted to be engaged by a pawl 46 which is pivoted at 47 to a bent lever 48, the latter being journaled loosely on the end of valve stem 41. The pawl 46 overhangs the inner edge of the ratchet wheel 42, and thereby is superposed upon the flat surface 45 of boss 44, as shown in Figs. 4 and 7.

The free end of bent lever 48 is connected by means of a link 49 with the trigger mechanism of the shear, designated generally in Fig. 1 by the numeral 50. Said trigger mechanism may take any well known form; in the present instance, it is shown as providing a depending finger 51, normally projected into the path of the moving bar or billet, said finger being secured to a rock shaft 52 which carries a rocker arm 53 to which the link 49 is attached. When the moving bar or billet strikes the finger 51, and knocks it upwardly, this motion is communicated by link 49 to the bent lever 48, causing the pawl 46 to engage with the ratchet wheel and move the valve stem or shaft 41. No matter how much the movement imparted to the finger 51, by the blow of the

moving billet, it is impossible for this pawl and ratchet engagement to carry the valve through more than 45°, because the pawl 46 is forced to travel along the flat surface 45. Said pawl can thus engage only one tooth at each movement, and can only remain in engagement with said tooth through a predetermined arc, regardless of how far said pawl is caused to travel. Such engagement is adapted to move the valve 40, from successive oblique positions, such as shown in Fig. 5, into either a vertical or a horizontal position, thereby establishing communication between adjacent passages 36 and 37 and procuring the movement of piston 15 to the left in Fig. 3, in the manner herein-after described.

The valve closing mechanism has a similar mode of operation, with the end in view of procuring a 45° movement of the valve into one of its oblique positions, thereby to blank off one or the other of the sets of passages 36, 36 or 37, 37. In a suitable recess 54 provided in the auxiliary casing 35, the shaft 41 has keyed thereto a ratchet 55, the latter having just half the number of teeth or projections as the ratchet 42. The recess 54, in which is disposed the ratchet 55, opens at its upper end into a slot 56 of slightly greater width than the recess, whereby to provide a ledge or shoulder 57, inclined as shown in Fig. 6. The operation of ratchet 55 is effected by the end of a slidable member 58 which rides on the ledge 57, and, in consequence of the inclination can only remain in engagement with a tooth of the ratchet 55 for a limited period, just sufficient to carry the shaft 41 through 45°. Said member 58 is actuated by a sliding rod 59 which is in turn connected to a link 60, Fig. 1, that derives its motion, in a manner hereinafter described, from the shear frame 3.

Disposed in the cylinder passage 32 is a valve 61, the latter being operable to by-pass the steam to the opposite or head end of the cylinder, through a passage 62 that provides an elongated port 63 extending beyond the opening of cylinder passage 34. The stem of valve 61 is provided with an arm 64 as shown in Fig. 1, the latter being connected by a link 65 which derives its motion, in a manner hereinafter described, from the shear frame 3.

As here shown, the links 60 and 65 are connected to one arm of a bell crank lever 66, pivoted at 67 and having its other arm connected by a link 68 to the shear frame 3. The connection to the shear frame 3 is an adjustable one, here shown in the form of a vertically disposed graduated segment 69, whereby the throw of the bell crank 66 may be varied, in accordance with the speed at which it is desired to operate the shear. In the exhaust passage 34, leading from the

head end of the cylinder, is disposed a valve 70, the latter being adjustable, manually, by means of an arm 71 working on a graduated segment 72, to vary the maximum speed of the shear, as hereinafter described.

The normal position of the shear operating parts, when the shear is at rest, is illustrated in Fig. 3, and it will be noted that the main steam valve 30 is maintained by the steam pressure in its extreme left hand position, because of the fact that the steam has access to the right hand end of casing 27 by a restricted bleed passage 73 through valve portion 31, the latter presenting a larger area than portion 33. In this position of the main valve 30, the portion 33 shuts off communication with the exhaust 29, and the full pressure of the steam supply 28 is transmitted to the cylinder 16 through cylinder passage 34; this steam pressure is effective on both sides of the piston 15, due to the restricted bleed opening 74 provided in said piston.

When the pilot valve 40 is shifted through 45° by the actuation of the trigger mechanism 50, the two passages 37, 37 opening into the right hand end of casing 27 are connected simultaneously with the exhaust recesses 36, 36, the latter being in communication with an exhaust passage 75 leading to the atmosphere, as shown in Fig. 4^a. This immediately relieves the steam pressure against the right hand end of main valve portion 31, and thereupon the entire valve 30, due to its unbalanced construction, as above noted, moves sharply into its extreme right hand position, the steam escaping during this movement, by way of the recesses 38, 38 to the passages 37, 37 and 36, 36. This right hand movement of portion 31 uncovers cylinder passage 32 and connects it directly with the steam supply 28; coincidentally, the other cylinder passage 34, by movement of valve portion 33, is connected with the exhaust opening 29.

The rapid movement of the piston 15 toward the head end of the cylinder at once ensues, due to the sudden release of steam pressure by the opening of the exhaust; it will be noted that this mode of operation gives an exceedingly rapid acceleration, owing to the fact that full steam pressure is already exerted on the right hand side of the piston 15 when the parts are at rest, and no delay ensues by any initial condensation of the steam. Of especial importance is the direct control of this action by the valve 70, the position of which determines the maximum speed of the shear.

That is to say, the speed of the cutting stroke of the shear may be definitely and nicely predetermined by the setting of exhaust valve 70, through the manipulation of arm 71, on the graduated segment 72. Said valve 70 furnishes a means for procuring the

forward travel of the shear frame 3 at a speed which corresponds, accurately, to the speed of the moving material; in this way, by a predetermined setting of the exhaust valve, for the particular speed at which the material is delivered from the mill, the shear can be made to sever said material while moving at the same speed as the material, thereby performing its function without interruption to the travel of the material.

The successive stages of the forward and return movements of the shear are shown diagrammatically in Figs. 10-16 inclusive, wherein the large arrows indicate the direction of shear movement. After the cut has been taken, the knife 8 is pushed outwardly by the forward end of the material, as shown in Figs. 13 and 14, and thereafter gradually returns to cutting position, as shown in Figs. 15 and 16, as the shear frame itself moves rearwardly. Said knife 8, swinging about the shaft 11 as a pivot, is connected by a link 77 to an arm 78 on a shaft 79, disposed in a suitable casing 80 carried by the head 9.

The shaft 79, both in respect to its clockwise movement and its reverse movement (to return the knife 8 to original position) is subject to the action of a dash pot mechanism of improved construction, as shown in Figs. 8 and 9. Said dash pot mechanism is disposed in the casing 80, which has a cylindrical bore 81 for the movement of an elongated sleeve 82. Said sleeve is caused to reciprocate in the bore 81 by the oscillation of shaft 79, the latter having a downwardly projecting arm 83 which engages with a rocking trunnion bar 84 journaled transversely and centrally of the sleeve. The opposite ends of the sleeve 82 are normally maintained closed by spring seated mushroom valves 85, 85, the latter being capable of a slight unseating movement as limited by the lengths of slots 86, 86 in their stems 87, 87, which slots engage the pins 88, 88. When the shaft 79 is swung in a clockwise direction, as shown by dotted lines in Fig. 2, the sleeve 82 travels to the left in Fig. 8, and the imprisoned air at this end of the cylinder is vented through an adjustable bleed 89. The first part of this movement of the sleeve is without appreciable resistance, since the air escapes through the permanent vent 90 and passes to the other end of the cylinder through an opening or slot 91 and past the right hand valve 85. On the return of shaft 79 to normal position, by the gravity movement of the knife 8, a similar retarding effect is accomplished, through the reversal of sleeve 82, the latter constituting, as will be apparent, a double acting dash pot having each end of the same adjustable, to vary the conditions attendant upon both the outward swing and the return swing of the hinged knife.

The retardation of shear travel which

takes place in the interval between the positions illustrated in Figs. 12 and 13, and also the reverse movement of the shear frame back to its normal position of rest, as illustrated by the successive positions depicted in Figs. 14, 15 and 16, is accomplished by the following automatic operation of the described parts:—

As soon as the shear frame 3 begins to move forward on its rapidly accelerating cutting stroke, the link 68 procures rocking movement of bell crank 66, thereby causing the actuation of slidable member 58 through link 60, to effect a 45° closing movement of pilot valve 40. This shuts off ports 37', 37' of valve casing 27 from the exhaust passage 75, thereby permitting a building up of pressure in the right hand end of the main valve chamber, the steam entering the same through the bleed passage 73. This quickly returns the main valve to its normal position illustrated in Fig. 3, and it is to be noted here that whatever the adjustment of the link 68 along the graduated quadrant 69, to give a greater or less throw to the bell crank 66, the closing movement of the pilot valve 40 is always the same namely 45°, although the member 58 may have a throw or travel that greatly exceeds this movement on the arc of contact with ratchet 55.

The forward stroke of the shear frame 3 initiates the operation of by-pass valve 61 through the link 65 that connects the valve arm 64 with bell crank 66. Obviously, the setting of link 68 with reference to the graduated segment 69 is a determining factor in controlling the operation of valve 61, i. e., whether its shut off of the steam supply and its by-passing to the head end of the cylinder shall be accomplished early or late in the movement to the left, Fig. 3, of the piston 15. In any event, it will be clear that at a predetermined point in the working stroke of the piston 15, the latter will be retarded by the access of pressure medium to the head end of the cylinder, as delivered by the by-pass 62 and the elongated port 63; also, to a certain degree, by leakage of steam past the piston 15, along the interior recess 76. The port 63 remains effective even after the piston has passed and shut off the passage 34, or head cylinder port.

Accompanying the retardation thus produced, is the restoration of full steam pressure in the head end of the cylinder, owing to the fact that the main valve 30 has been returned to its normal position, shown in Fig. 3. Thereupon, because of the larger effective area of the piston 15 on its left hand side, said piston is forced back to its normal position at the right hand end of the cylinder, corresponding to the position of rest of shear frame 3, as illustrated in Fig. 16 as the end of the cycle. Coincidentally, the by-pass valve 61 is rocked into nor-

mal position by the return stroke of the shear, and the parts are then in readiness for another cutting operation, which takes place when the advancing end of the material again strikes the trigger mechanism 50.

I claim,

1. The herein described method of operating a flying shear, which consists in confining the downward movement of the upper knife of the shear to a zone above the normal plane of support of the moving material, whereby to prevent bending of the rear end of the severed piece.

2. In the art of shearing metal bars or billets while in motion, the improvement which consists in causing severance of the metal during the upward swing of the lower knife of a flying shear, and simultaneously elevating a billet supporting roll on the entering side of said shear.

3. In a flying shear, the combination with a swinging frame having cooperating upper and lower knives, of a swinging link controlling said upper knife, the pivots of said frame and said link being so disposed that a plane normal to the moving material at a point of engagement therewith of the knives is nearer to the link pivot than to the frame pivot.

4. In a flying shear, the combination with a swinging frame having cooperating upper and lower knives, of a link connecting said upper knife to a fixed pivot, said knives being substantially over said fixed pivot when the shear is at rest.

5. In a flying shear, the combination with a movable frame carrying cooperating upper and lower knives, of a supporting roll for the moving material on the entering side of said shear, and means operable by the movement of said shear for elevating said roll simultaneously with the upward movement of said lower knife.

6. In a flying shear, the combination with a swinging frame having cooperating upper and lower knives, of a swinging link controlling said upper knife, said link having a backward inclination in the normal position of rest of said shear frame.

7. In a flying shear, the combination with a swinging frame having cooperating upper and lower knives, of a link connecting said upper knife to a fixed pivot, the initial movement of said link, at each operation of the shear, being toward a vertical position.

8. In a flying shear having a swinging frame and a tension link, the combination with a supporting base, of a member providing trunnions for said frame and link, said member and its connected parts being secured to said base, and being detachable therefrom by the removal of two keys.

9. In a flying shear having a swinging frame and a tension link, the combination with a supporting base, of a member provid-

ing trunnions for said frame and link, and a pair of keys for detachably securing said member to said base.

10. In a flying shear having a swinging frame and a tension link, the combination with a supporting base, of a member providing trunnions for said frame and link, and removable wedging devices for securing said member to said base, said devices being removed from the major stresses transmitted through said member by said frame and link.

11. In the art of shearing metal bars while in motion, the improvement which consists in procuring variations in the speed of the cutting stroke of a flying shear by the setting of an adjustable valve, to regulate the exhaust of steam from one side of a shear actuating piston.

12. In the art of shearing metal bars while in motion, the improvement which consists in controlling the speed of a flying shear by the setting of a normally open valve adapted to regulate the exhaust of steam from the head end of a cylinder containing a shear actuating piston.

13. The improvement in the art of shearing metal bars or billets while in motion, which consists in procuring the cutting stroke of a flying shear at the speed of movement of the travelling metal, by adjustment of a normally open speed control valve to vary the rate at which steam is exhausted from one side of a shear actuating piston.

14. The combination with a flying shear and a piston-equipped cylinder for actuating said shear, of a passage leading from the head end of said cylinder, and an adjustable normally open valve in said passage for controlling the speed of the cutting stroke of said shear.

15. The combination with an apparatus for cutting metal bars or billets while in motion, of an actuating steam cylinder and piston therefor, and a normally open exhaust valve in said cylinder, subject to different settings corresponding to the speed of the moving metal, whereby to obtain the cutting movement of said apparatus at the same speed as the metal moves.

16. The herein described method of obtaining retardation of a flying shear, which consists in adjusting a by-pass valve, between opposite ends of a steam cylinder containing a shear actuating piston, to be opened by movement of the shear after any desired part of the working stroke of said shear has been completed.

17. In a flying shear apparatus, the combination with a steam cylinder containing a piston for actuating said shear, of a passage from one end of said cylinder, adapted to be opened to exhaust in procuring the operative stroke of said piston, a by-pass for

pressure medium from the other end of said cylinder, said by-pass opening into the first mentioned end of the cylinder at a point beyond said passage, and a valve, operated by said shear, for controlling said by-pass.

18. In a steam cylinder containing a piston for actuating a flying shear, a cylinder passage for by-passing said piston, a valve for opening and closing said passage, and adjustable means for positively opening and closing said valve at any desired point in the stroke of said piston.

19. In a steam cylinder containing a piston for actuating a flying shear, a passage for the admission of steam to one side of said piston to procure the operative stroke of the shear, and a valve in said passage adapted in one position to connect said cylinder with the steam supply, and in another position to by-pass said piston.

20. In a flying shear apparatus, the combination with a steam cylinder containing a piston for actuating said shear, of a main valve therefor controlling the supply and exhaust of steam, and a positively operated valve between the main valve and the cylinder, said last named valve being adjustable to by-pass the steam around said piston after any predetermined part of the shear actuating stroke of said piston has been accomplished.

21. In a steam cylinder containing a piston for actuating a flying shear, a cylinder passage by-passing said piston and a positively operated valve in said passage, said valve being adjustable to open said passage at any desired part of the stroke of said piston.

22. The combination with a steam cylinder containing a piston for actuating a flying shear, of a main valve therefor adapted to control the connection of steam supply and exhaust with two cylinder ports, the steam supply entering the casing of said valve between the two cylinder ports.

23. The combination with a steam cylinder containing a piston for actuating a flying shear, of a main valve therefor adapted to control the connection of steam supply and exhaust with two cylinder ports, the steam supply entering the casing of said valve between the two cylinder ports and the steam exhaust being at one end of said valve beyond said cylinder ports.

24. The combination with a steam cylinder containing a piston for actuating a flying shear, of a main valve therefor adapted to control the connection of steam supply and exhaust with two cylinder ports, the steam supply entering the casing of said valve between the two cylinder ports, with one cylinder port having passages leading to both ends of said cylinder, and a positively operated valve at the junction of said passages.

25. The combination with a steam cylinder containing a piston for actuating a flying shear, of a main valve controlling the supply and exhaust of steam to said cylinder, and a manually adjustable valve for controlling the speed of the working stroke of said shear.

10 26. The combination with an unbalanced piston valve for the piston-equipped steam cylinder, of a flying shear, of a speed control valve interposed between said first named valve and said cylinder.

15 27. The herein described method of obtaining retardation of a flying shear, which consists in reversing the main valve of a steam cylinder containing a shear actuating piston, and in opening a by-pass valve in a cylinder passage to secure compression in the head end of said cylinder, after the piston has passed the head end cylinder port.

20 28. In apparatus for operating a flying shear, the combination with a main valve for a steam cylinder having a shear actuating piston, of a by-pass valve adapted to be opened with the reversal of said main valve, for securing compression in the head end of said cylinder.

25 29. The combination with a flying shear and a piston-equipped steam cylinder for actuating said shear, of an unbalanced piston valve for controlling the supply and exhaust of steam, and a rotary pilot valve for procuring the shear-actuating and reversing movements of said piston valve.

30 30. The combination with a main steam valve of a shear-actuating steam cylinder, of

a pilot valve for procuring the shear actuating and reversing movements of said main valve, said pilot valve procuring both of said operations by movements in the same direction.

31. The combination with the main steam valve of a shear-actuating steam cylinder, of a pilot valve adapted for rotation always in the same direction for procuring both shear actuating and reversing movements of said main valve, and means for preventing excess rotation of said pilot valve.

32. The combination with the main steam valve of a shear-actuating steam cylinder, of a trigger-operated pilot valve for procuring the shear-actuating movement of said main valve, and a connection to the shear for moving said pilot valve for the reversal of the main valve, both movements of said pilot valve being in the same direction.

33. The combination with the main steam valve of a shear-actuating steam cylinder, of a trigger-operated pilot valve for procuring the shear-actuating movement of said main valve, a connection to the shear for moving said pilot valve for the reversal of the main valve, both movements of said pilot valve being in the same direction, and means for limiting both movements of said pilot valve to a predetermined arc, regardless of excess motion of said trigger or of said connection.

Dated this 28th day of June, 1921.

VICTOR E. EDWARDS.