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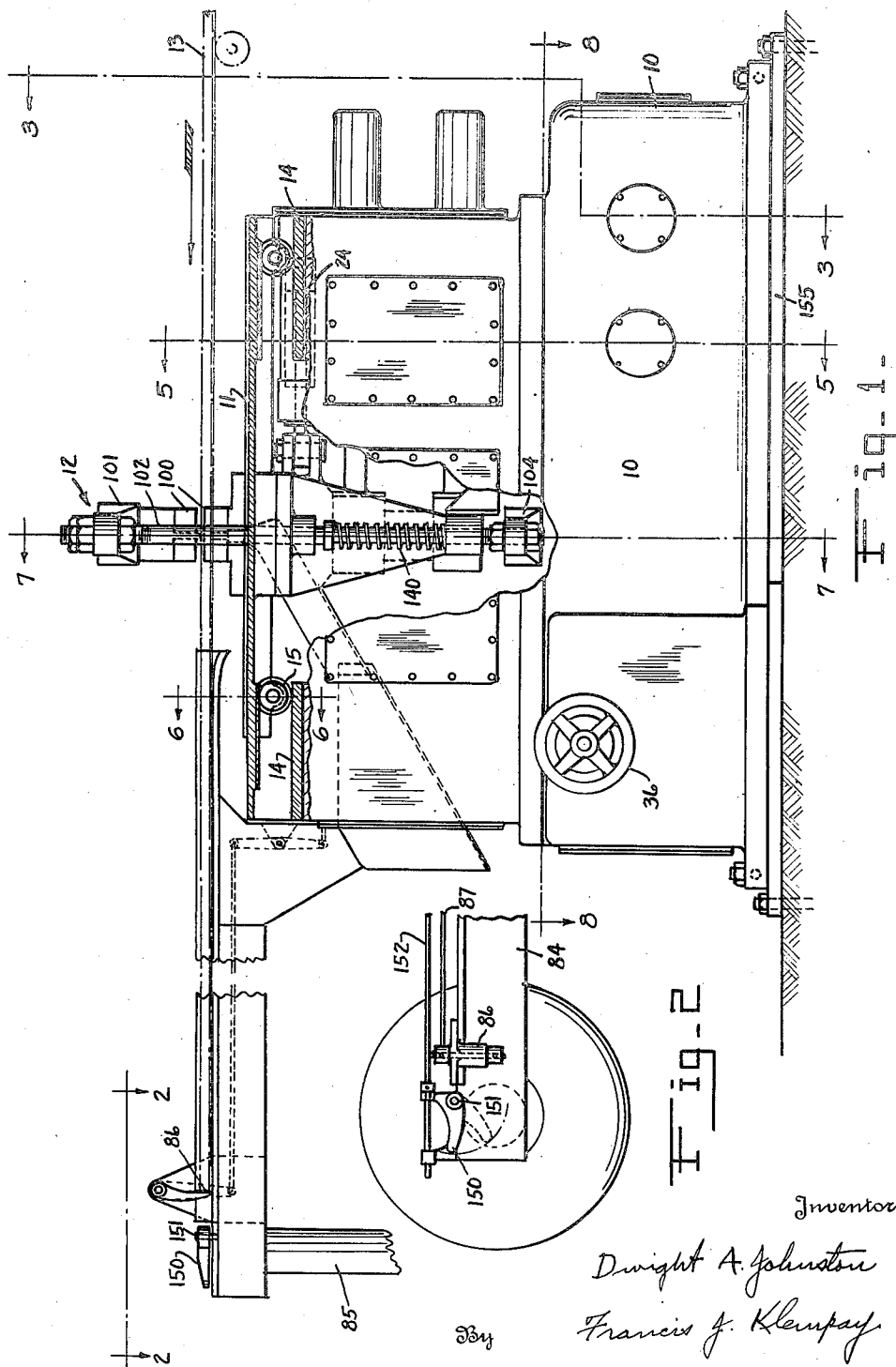
D. A. JOHNSTON

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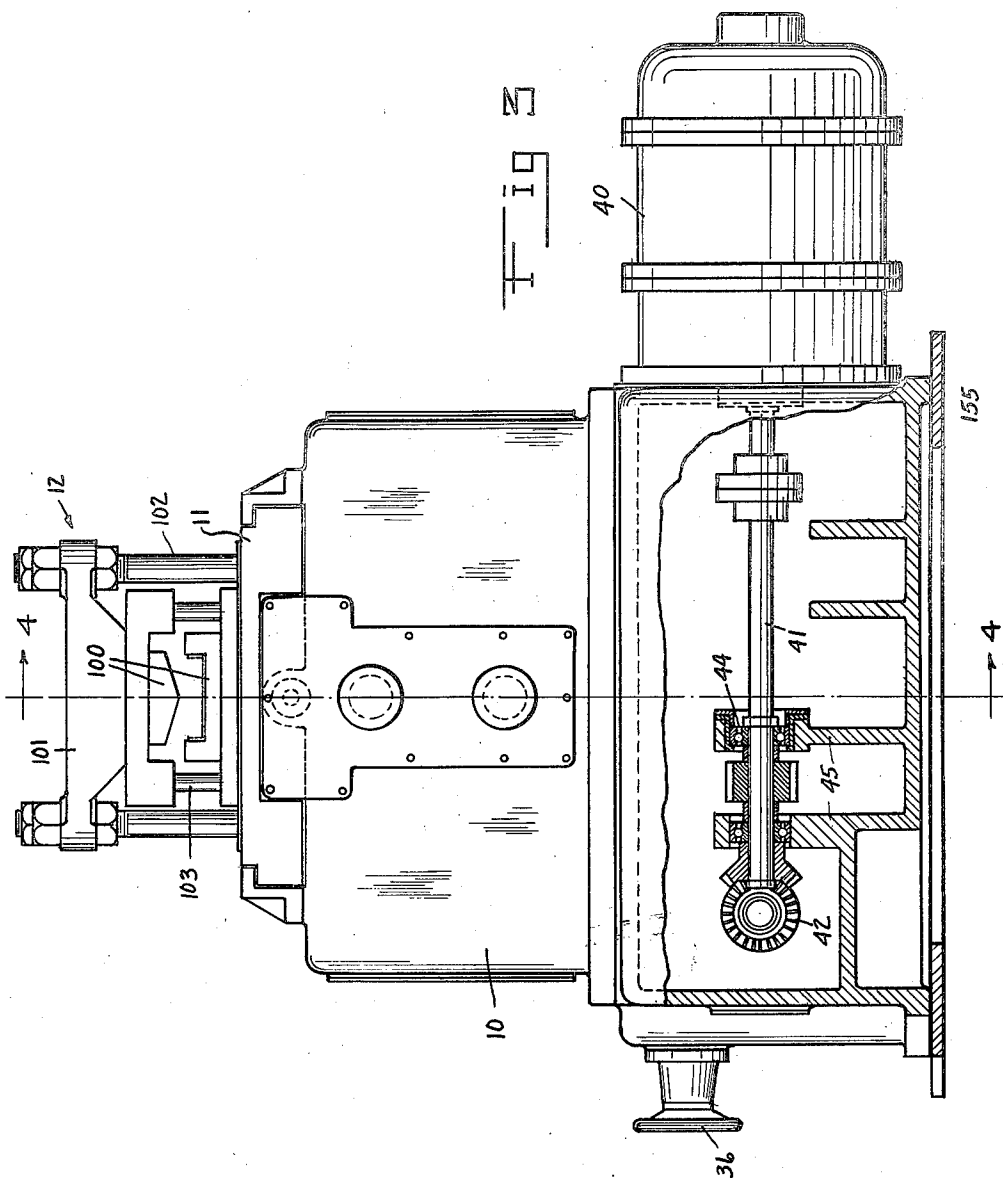
D. A. JOHNSTON

2,278,786

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8 Sheets-Sheet 2



Inventor
Dwight A. Johnston
Francis J. Klemm
Attorney

April 7, 1942.

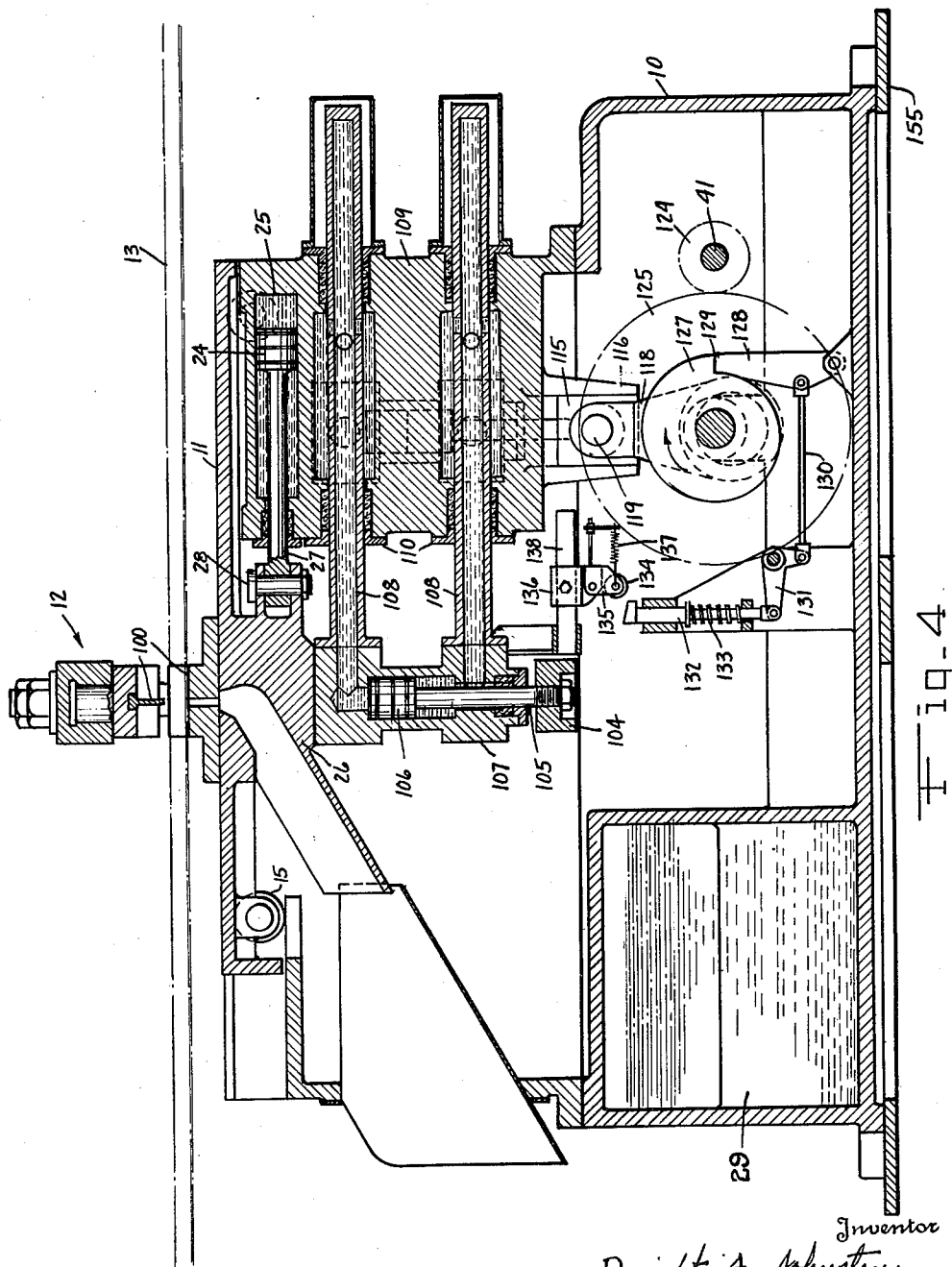
D. A. JOHNSTON

2,278,786

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8 Sheets-Sheet 3



Inventor
Dwight A. Johnston

Francis J. Kempf

By

Attorney

April 7, 1942.

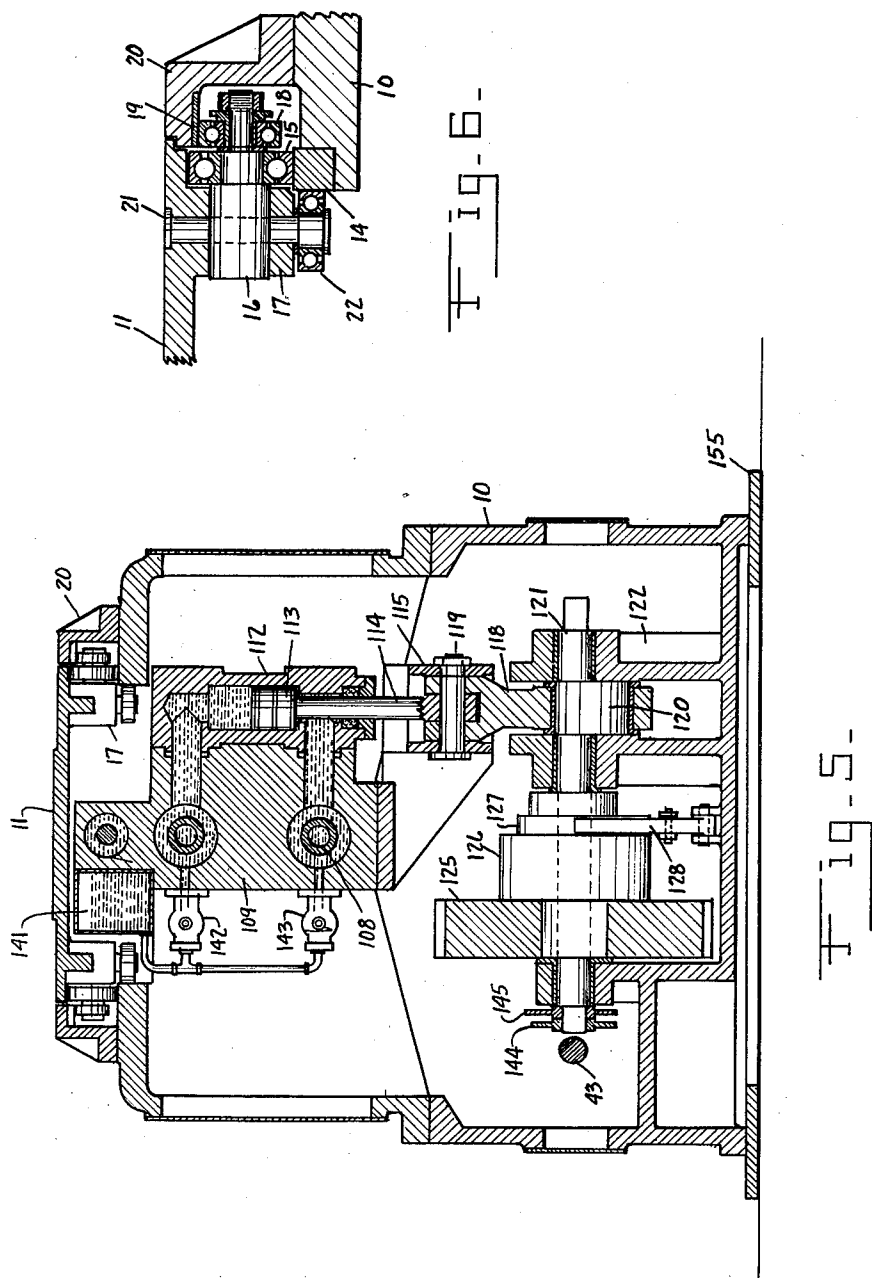
D. A. JOHNSTON

2,278,786

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Inventor

Dwight A. Johnston

Francis J. Kempf

Attorney

April 7, 1942.

D. A. JOHNSTON

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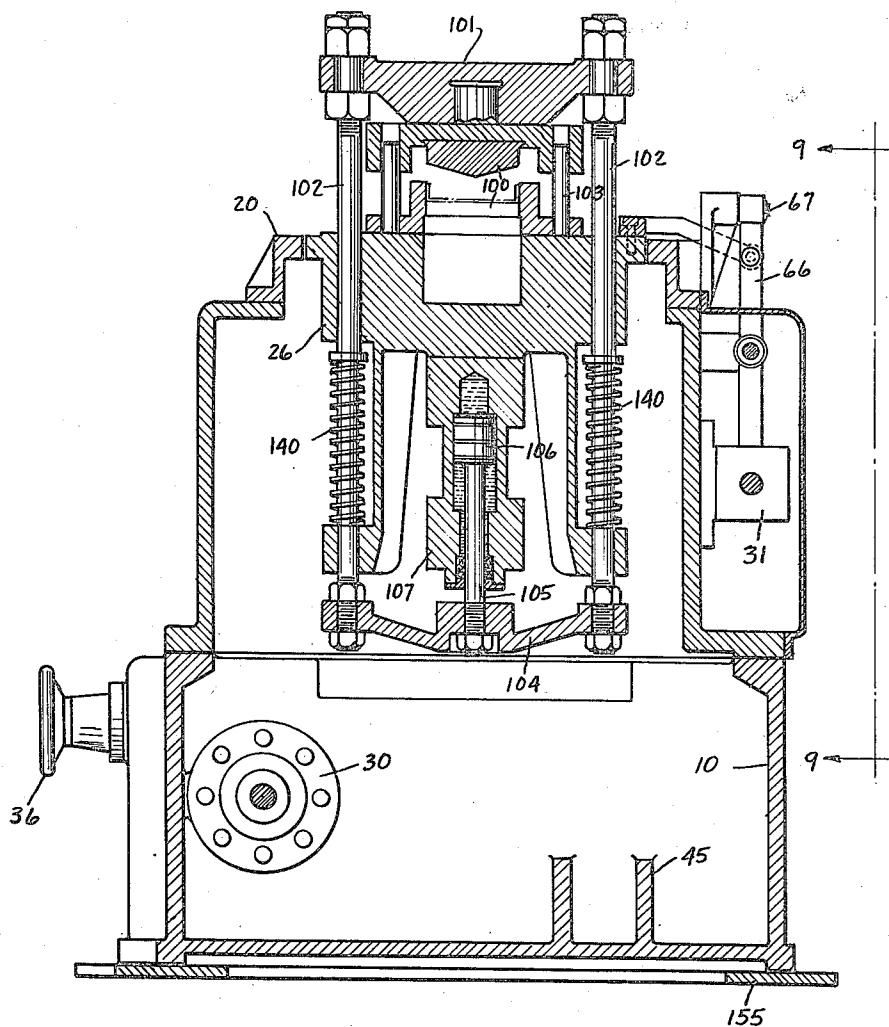


Fig. 7.

Inventor
Dwight A. Johnston

By

Francis J. Kempf

Attorney

April 7, 1942.

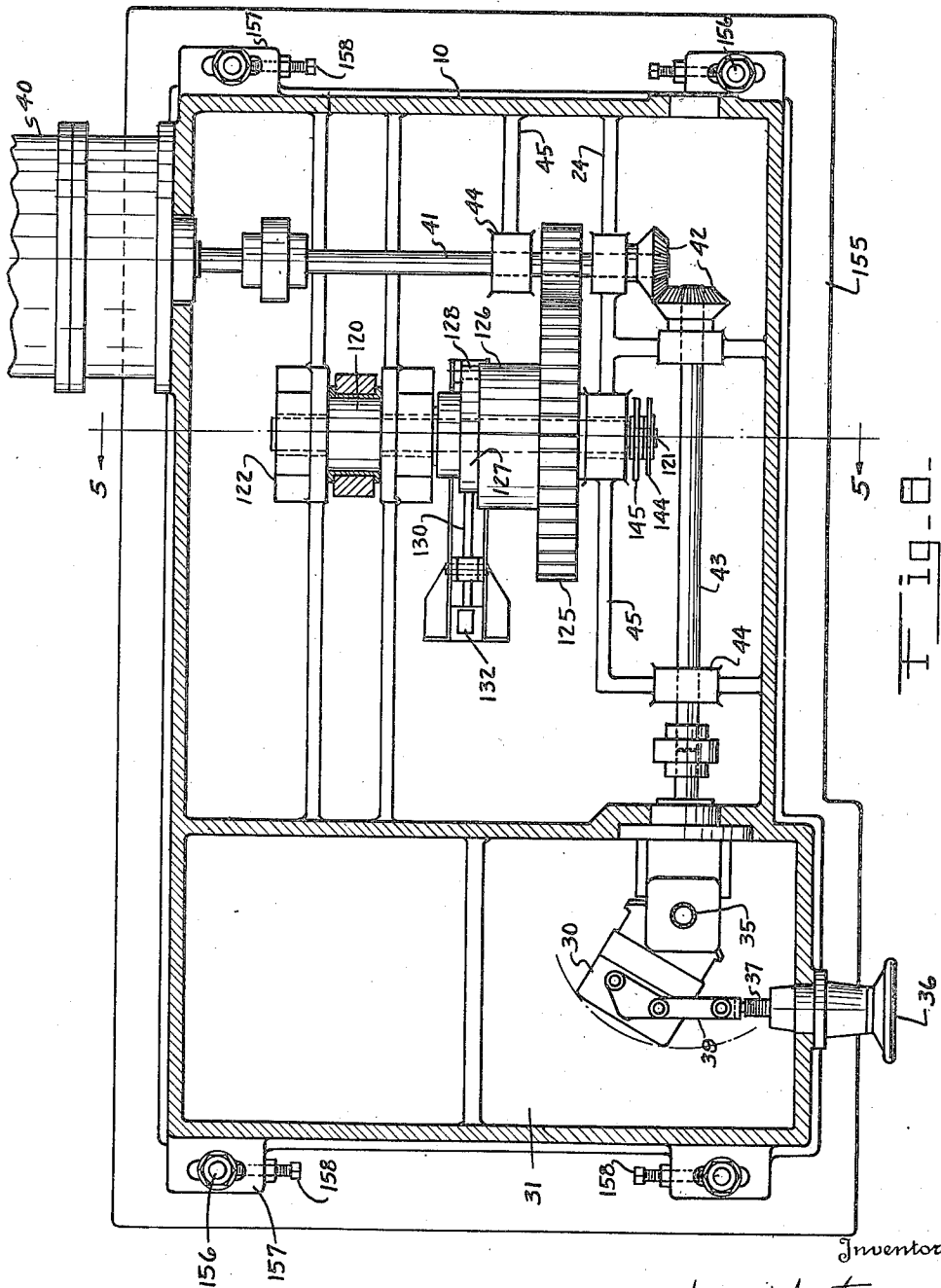
D. A. JOHNSTON

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Dwight A. Johnston

Francis J. Klempf

Attorney

April 7, 1942.

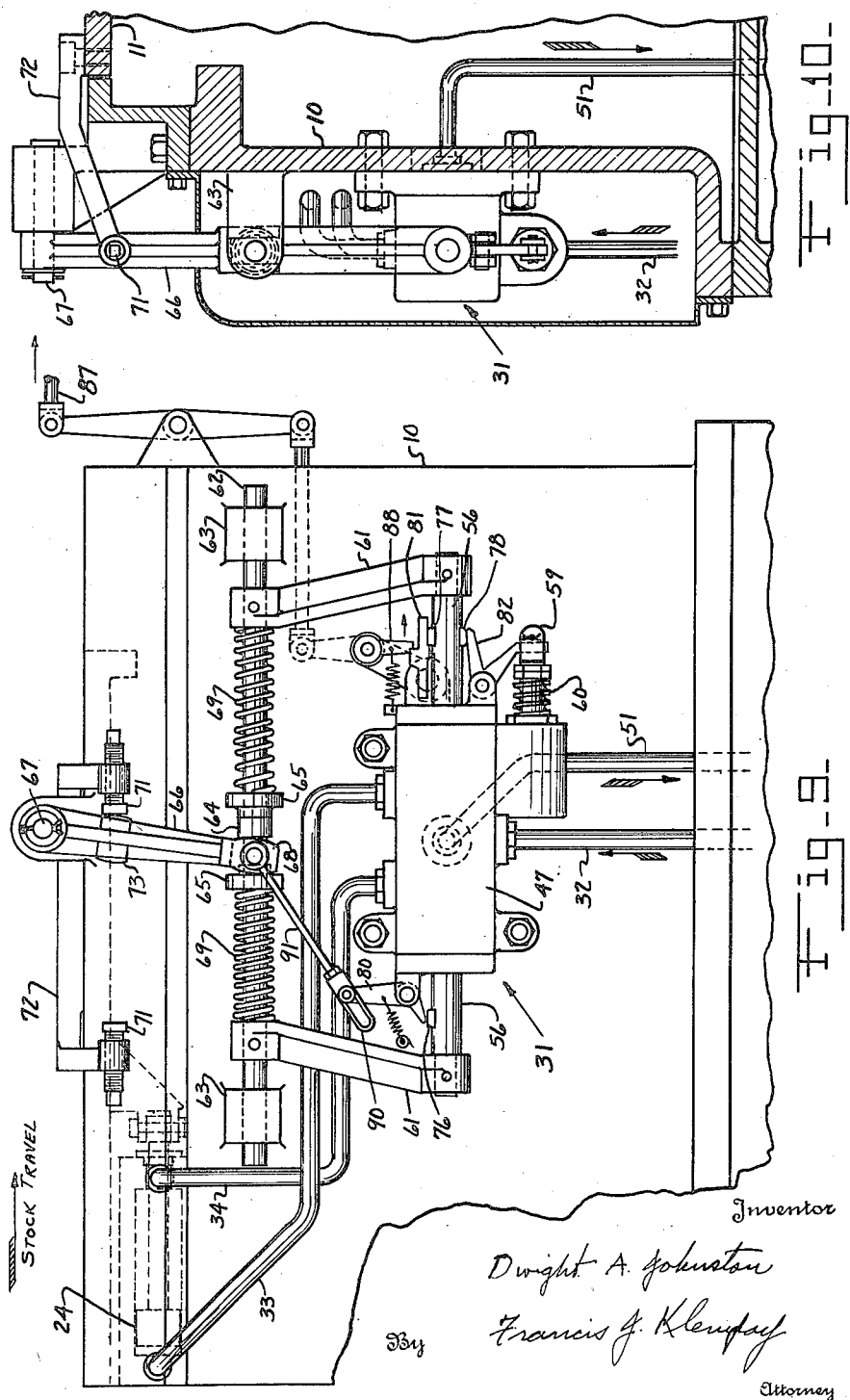
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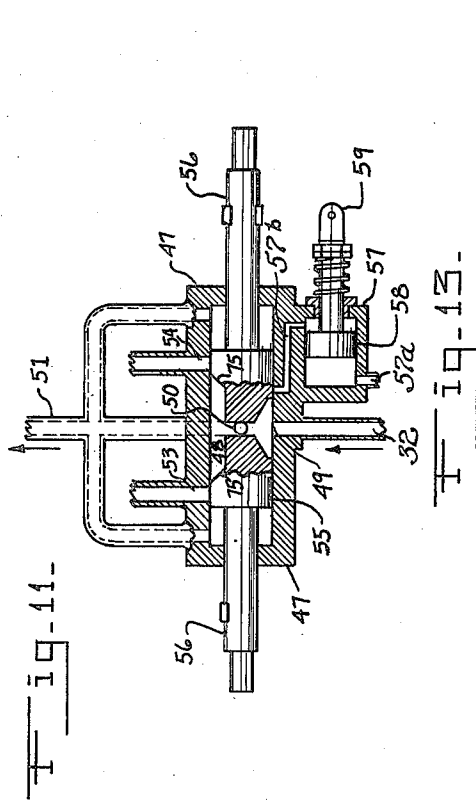
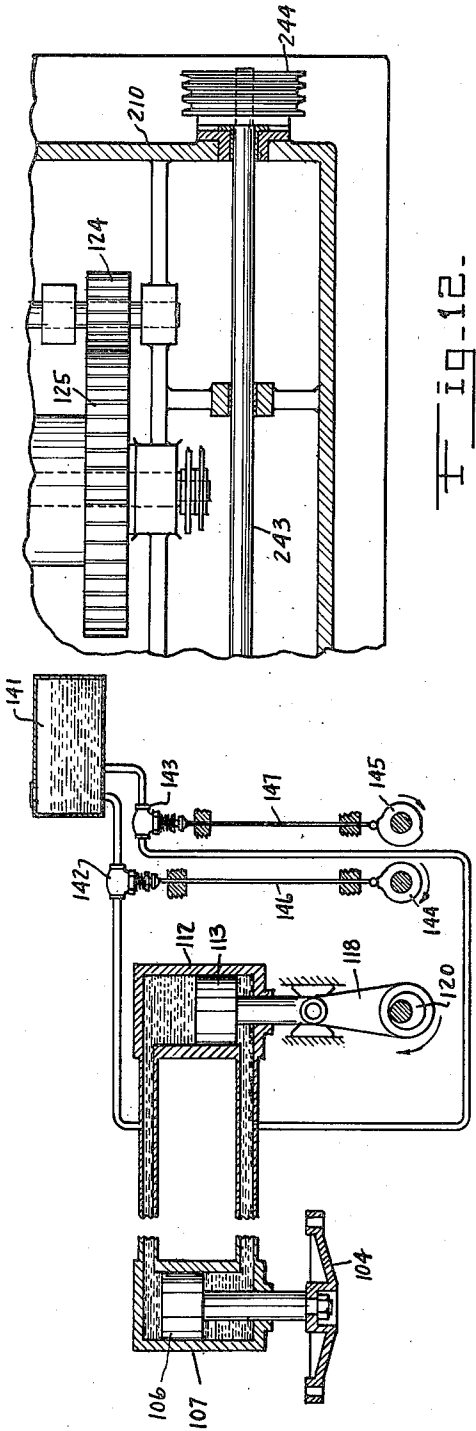
D. A. JOHNSTON

2,278,786

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Inventor
Dwight A. Johnston
Francis J. Kempf
Attorney

UNITED STATES PATENT OFFICE

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FLYING SHEAR

Dwight A. Johnston, Youngstown, Ohio, assignor
to McKay Machine Company, Youngstown,
Ohio, a corporation of Ohio

Application April 21, 1939, Serial No. 269,269

20 Claims. (Cl. 164—56)

This invention relates generally to a machine for shearing off lengths of stock and more particularly to an automatic machine for shearing off predetermined lengths of formed metallic sections of stock of such sections as the stock issues from a forming machine or other apparatus utilized in the production or finishing of the same. The invention also relates to various mechanical devices and arrangements the use of which in the combinations to be hereinafter stated enables a machine for the purpose stated to have certain desirable operating characteristics which will be later set out.

Heretofore, in machines for the purpose described difficulty has been encountered in synchronizing the movement of the cutting mechanism with the movement of the stock as it issues from the production line and the difficulty is especially aggravated in the case of high stock speeds where the requirements are that the stock be sheared into relatively small lengths having a reasonable degree of uniformity in length. The cutting of the rapidly moving stock into short lengths necessarily requires a high rate of reciprocation of the structure immediately supporting the cutting dies or other tools and, by reason of the fact that in the devices heretofore employed for the purpose the parts making up the reciprocating parts were of substantial mass and weight, the operation of the devices was attended by excessive vibration of the machine as a whole resulting in rapid wear and loosening of the parts and frequent break downs of the machines. It is the principal object of the invention to provide an improved construction in a machine for the purpose described which will provide better synchronization between the rate of travel of the dies or other tools performing the cutting and the rate of travel of the length of stock being cut, and a more particular object of the invention is the provision in a machine having better synchronization as aforesaid of improved design whereby violent oscillations and hammering of the parts of the machine are reduced to a minimum.

A further object of the invention is the provision in a machine of the type described of an arrangement whereby the rate of travel of the stock cutting implements may be synchronized with the rate of travel of the stock through a forming machine or other production or finishing apparatus in such manner that variations in the speed of operation of such forming machine or other apparatus will be reflected by corresponding variations in the speed of operation of the

automatic cut-off. This feature is of importance where the cut-off machine is used in conjunction with a high speed continuous or semi-continuous production line as it enables the cut-off machine to be coupled closely to the production apparatus and prevents variations in the lengths of the pieces being cut off and minimizes danger of injury to the cutting mechanism.

Another object of the invention is the provision in a machine for the purpose described of an arrangement whereby the rate of travel of the cutting implements along the path of travel of the stock being cut may be very readily and minutely adjusted by the simple manipulation of a readily accessible controlling element. In the operation of automatic cut-off machines where relatively high stock speeds are encountered, it is impractical to rely on any mechanical contact between the stock and the cutting implements or the carriage immediately supporting such implements to effect synchronism between the stock and implements and it has, therefore, been proposed to provide a quick acting power means to initiate and maintain movement of the carriage supporting the cutting implements and to provide a lightly actuated trip for the purpose of instigating actuation of the power means. In arrangements of this character the length of stock being sheared is necessarily determined by the position of the trip lever, the rate of movement of the stock, and the time interval between the instigation of actuation of the power means and the moment of contact between the cutting implements and the stock and it should therefore be apparent that for satisfactory operation of machines of this character such intervals of time must be constant for each successive cycle of operation and that in addition the rate of travel of the cutting implement as they encounter the stock must be capable of precise adjustment. By the use of certain instrumentalities to be hereinafter fully described such characteristics are attainable.

Yet another object of the invention is the provision in a machine of the type utilizing a shear or cutting dies movable along with the stock being cut of an arrangement whereby the stresses imposed on the shear elements or dies and their immediate supporting and operating elements are proportional to the shearing and cutting resistances of the stock being cut. In the case of stock having the same physical characteristics, the stresses imposed are proportional to the cross-sectional area of the stock and, in either event, the imposition of lighter loads in the cutting of

thinner or softer stock results in a material prolonging of the life of the machine since unnecessary stresses and forces are obviated.

A still further object of the invention is the provision of an improved arrangement for slidably mounting the die carriage which reciprocates back and forth and, during the time of actual cutting, moves in synchronism with the continuously moving stock. The purpose of the improved mounting means is to afford a more accurate and uniform alignment of the carriage with the path of travel of the stock and various operating mechanisms associated with the carriage in the machine. It is also my intent that improved means be provided to reciprocate the carriage whereby a cushioning action at the end of each stroke of the carriage be inherently effected by the action of the carriage reciprocating means in order that shock and vibration due to impact may be reduced to a minimum.

I also propose to provide an improved arrangement for the cyclic movement of the shearing dies on the reciprocating carriage which will result in the optimum distribution of power and the optimum variation in the rate of movement of the shearing dies throughout each cycle. With the cutting implement in outer inoperative position a large force is exerted to initiate movement of the same toward the stock, the force resulting in progressive acceleration from the starting position, an average uniform rate of travel during the cutting operation, and a decreasing rate of travel to the inward limit of its stroke. The completion of the cycle, i. e., the return of the die to its outer inoperative position, is accomplished in the same manner but, due to the fact that no cutting takes place, no stresses, other than that required to move the die, is set up in any of the parts.

It is a more general object of the invention to provide an improved apparatus for moving and controlling the movement of a reciprocating carriage and of a member cyclically movable on such carriage. The general purpose is to enable sufficient operative power to be applied to an element whose movement is required to be so compounded and to control such means in such manner that more complete adjustments may be effected, less input power required, smoother operation effected, ruggedness enhanced, and required maintenance substantially reduced.

Included among the advantages sought to be attained by the apparatus of this invention are the prolonging of the life of the shearing means employed, the insurance of the accuracy as to length of the pieces being severed and a compact design of the machine capable of utilizing the principles of the invention. These and other objects and advantages of the invention will become apparent from a consideration of the accompanying drawings and the following detailed specification wherein there is specifically disclosed an automatic cut-off machine utilizing the principles of the invention. It should be understood, of course, that the machine disclosed represents but a preferred embodiment of the invention as obviously many novel principles incorporated herein are applicable to a wide variety of uses.

In the drawings:

Figure 1 is a side elevation, partly in section, of an automatic cut-off machine;

Figure 2 is a plan view of a portion of the machine of Figure 1;

Figure 3 is an end elevation, partly in section, of the machine of Figure 1;

Figure 4 is a cross-section of the machine taken along the line 4—4 of Figure 3;

Figure 5 is a cross-section of the machine taken along the line 5—5 of Figure 1;

Figure 6 is a cross-sectional detailed view illustrating the manner of slidably mounting the oscillating carriage;

Figure 7 is a sectional view taken along the line 7—7 of Figure 1;

Figure 8 is a cross-section of the machine of Figure 1 taken along the line 8—8;

Figure 9 is an elevation of the instrumentalities employed to control the reciprocation of the carriage;

Figure 10 is an end view of the apparatus of Figure 9;

Figure 11 is a schematic diagram of a synchronizing arrangement utilized in the machine of Figure 1;

Figure 12 is a fragmentary sectional plan view of the machine of Figure 1 illustrating a modified driving arrangement; and

Figure 13 is a sectional view of the valve of Figures 9 and 10.

Referring now to the drawings and more particularly to Figures 1 to 4 thereof, the machine representing the preferred embodiment of the invention consists essentially of a base 10, a carriage 11 mounted for reciprocating movement on said base, a tool slide 12 carried by said carriage and mechanism within the base 10 to effect reciprocating movement of the carriage relative to the base and reciprocating movement of the tool slide relative to the carriage. In accordance with the usual practice the machine is constructed to afford passage of continuously moving stock, indicated by reference numeral 13, as the latter issues from a forming mill or other production machine with which the instant machine may be used in operative relation with the carriage, and includes driving means for the carriage which is of such character that the carriage may be moved along with the stock—reaching a synchronous speed with the stock during a portion of its travel. The means employed to reciprocate the tool slide is operative to move the shearing or other tool employed into engagement with the moving stock and to effect its intended function within the stated portion of travel of the carriage.

Base 10 is provided along its upper wall with a plurality of spaced pairs of parallel hardened steel rails 14 which are removably secured to suitable recesses provided in the upper wall of the base and whose upper and inwardly directed surfaces are carefully aligned and machined to provide an accurate path for the reciprocating movement of the carriage. Engaging the rails 14 on their upper faces are the outer races of bearings 15 carried on stepped sections of horizontal spindles 16 carried in turn by downwardly extending projections 17 of the carriage 11. See Figure 6. To prevent upward movement of the carriage relative to the base during operation of the machine, outward extensions of the spindles 16 have secured thereto anti-friction bearings 18 the outer races of which move underneath hardened steel strips 19 carried by the Z bars 20 suitably fastened to the upper wall of the machine base 10. To provide means to maintain the lateral alignment of the carriage 11 as the same reciprocates back and forth, each of the projections 17 carries vertically positioned

spindles 21 which extend below the projections to mount anti-friction bearings 22 the outer races of which move along the inner vertical surfaces of the rails 14. The carriage and base is provided with four assemblies as shown in Figure 6—one at substantially each of the corners of the carriage. It should be apparent that the above described construction provides an improved arrangement for the anti-friction sliding support of the reciprocating carriage on the base. The hardness and quality of races and rolling elements of the bearings, together with similar characteristics of the rails 14 and strips 19, results in very accurate guidance and long life. Also the maintenance of the sliding support is simplified since the bearings, rails and strips are readily replaceable.

Carriage 11 is slidably moved on the support described above by a piston 24 housed within cylinder 25 (Figure 4) and connected with an integral downwardly extending projection 26 of the carriage 11 by means of the piston rod 27. A pivot pin 28 connects the rod 27 with the projection 26 to allow for slight variations in the alignment of the parts. Fluid under pressure is supplied to either end of the cylinder 25 by a fluid pump 30 located in a bath 29 of hydraulic fluid in the lower portion of the base 10. The outlet of fluid pump 30 is connected with a four-way valve, indicated generally at 31, (see Figures 8 and 9) by means of a conduit 32 and the valve in turn is connected with the front and rear ends of the cylinder 25 by the conduits 33 and 34, respectively.

Pump 30 is a variable displacement pump, preferably of the "Vickers" type and, as is well understood in the art, will deliver a constant predetermined volume of liquid against any variable head pressure normally encountered in the operation of the machine. Since the construction and operation of pumps of this type is well known and forms no part of the present invention, the pump will not be described in detail. In accordance with the operating requirements of the pump shown, a portion thereof is mounted for swinging movement about a vertical axis 35 to vary the displacement of the pump and consequently its rate of fluid delivery. To provide a convenient manually engageable adjustment for the angular position of the pivoted portion of the pump, a hand wheel 36 is mounted exteriorly of the base 10 and is provided with an interiorly threaded bore for engagement with a threaded rod 37 which is in turn pivotally connected with a link 38 pivotally connected with the movable pump portion. It should be apparent that rotation of the wheel 36 results in pivotal movement of the swinging pump portion and consequently a change in the rate of delivery of the pump.

Pump 30 is, in one embodiment of the invention, driven by a motor 40 conveniently mounted on a side wall of the base 10 through the shaft 41, bevel gears 42, and shaft 43. As illustrated in Figures 3 and 8 of the drawings, the shafts 41 and 43 are conveniently rotatably supported in anti-friction bearings 44 mounted in apertures in webs 45 extending upwardly from the bottom wall of the base 10. Motor 40 and consequently pump 30 are normally in continuous operation during operation of the machine and the former is of sufficient power to maintain constant pump speed during each cycle of operation of the machine.

Referring now to Figures 9, 10 and 13 of the drawings the valve 31 consists of a housing 47

having a chamber 48 therein. Port 49 provides communication between the chamber and the supply conduit 32. A port 50 provides communication between the chamber and a conduit 51 leading back to reservoir 29 and ports 53 and 54 are connected with conduits 33 and 34, respectively, leading to the cylinder 25. A valve, indicated generally at 55, is positioned within the chamber 48 and is carried for reciprocating movement therein by a valve stem 56 projecting outwardly from either end of the housing 47. For a purpose to be later described the valve is provided with a cylinder 57 in open communication with port 54 and conduit 34 and within cylinder 57 is a piston 58 connected with a yoke 59 and biased to outer position by a coil spring 60. One end of cylinder 57 is open to the atmosphere by means of a suitable port or tube 57 and the other end communicates with cylinder 47 through passage 57b. See Figure 13. When valve 55 is in its right hand position, as viewed in Figure 5, passage 57b is simultaneously in communication with port 54 and supply line 32.

Valve stem 56 has rigidly attached to it at its ends upwardly extending members 61 which in turn are rigidly pinned at their upper ends to a longitudinally slidable bar 62 mounted in projections 63 extending outwardly from the side wall of the base 10. Bar 62 is provided with a centrally disposed integral shoulder 64 against which collars 65, slidably mounted on the bar, may abut. A member 66, pivotally connected at its upper end on the pin 67, supported on the base, is provided at its lower end with a yoke 68 positioned between the collar 65 and adapted to slide the collars along the bar 62. A coil spring 69 is positioned between collar 65 and the upper end of member 61 on either side of the bar 62. Member 66 is pivotally moved about the pin 67 by members 71 which are adjustably carried by a support 72 rigidly attached to the carriage 11, a partially cylindrical element 73 being provided on member 66 for engagement by the elements 71.

As apparent from a consideration of Figure 13, the valve 31 is of the type which, when in its neutral position, will provide communication between ports 49 and 50, thus providing in effect a by-pass for the passage of fluid to relieve any load on the fluid pump when power is not required. In addition, the valve provides for throttling of the flow of fluid to either side of the cylinder 25 and this is accomplished by means of the conical surfaces 75 on the valve body 55 by partially closing off the flow of fluid to either one or the other of the conduits 34 and allowing such conical surfaces to meter the flow of fluid. A reduction in the speed of movement of the piston 24 is attained as the same approaches the end of either of its strokes and consequently the shock which would result from quickly stopping the movement of the carriage is obviated. Suitable elements, now to be described, are provided to give the required intermittent movement to the valve stem 56.

Secured to the valve stem 56 are the projections 76, 77 and 78 located as shown in Figure 9, projections 76 being engageable by a latch 80, projections 77 being engageable by the compound latch 81 and projection 78 being engageable with a latch 82 operated by the yoke 59 connected with the piston 58. Referring briefly to Figures 1 and 2 of the drawings, the machine specifically disclosed is provided with an outwardly extending table 84 supported by the ma-

chine proper and by a spaced stanchion 85 and pivotally mounted on the table 84 is a flag 86 adapted to be engaged by the leading end of stock passing through the machine. Flag 86 operates a rod 87 which, by referring to Figure 9, is connected through suitable means with the operative element 88 of compound latch 81. Latch 80 is operated in a manner to be later described by a slotted yoke 90 connected with the lower end 68 of the pivotally mounted member 66 by a rod 91 pivotally connected with end 68. With the parts as described, assembled as shown in Figure 9 of the drawings, which illustrates the position the parts occupy immediately previous to the actuation of flag 86 by impingement of the stock, the operation is substantially as follows:

The stock is moving in the direction indicated by the arrow and it is obviously desired to move the carriage along with the stock upon actuation of the flag and, therefore, the piston 24 is in its left limiting position as viewed in Figure 9. As the flag is tripped latch 81 is released allowing left coil spring 69, which as shown is under compression, to move valve stem 56 rapidly to the left and causing the valve member 55 to connect port 49 with port 53, and port 54 with port 50. This results in the forward movement of the carriage along with the stock and, as the carriage proceeds, left element 71 engages element 73 on arm 66 moving arm 66 in a counter-clockwise direction and causing its lower end 68 to engage right collar 65 thereby compressing right coil spring 69. This results in movement to the right of the valve stem 56 until projection 76 is engaged by latch 80 at which position of the valve stem a throttling position of the valve 55 is attained, which results in throttling of the flow of fluid under pressure to the left of piston 24 and consequently deceleration of the carriage. Latch 80 remains engaged with projection 76 until carriage 11 reaches a predetermined position and it is then disengaged from projection 76 by reason of the adjustable connection 66, 68, 90, 91. At this time right spring 69 will have become compressed and upon release of the latch 80 valve stem 56 will be moved rapidly to the right, resulting in a reversal of the flow of fluid in conduits 33 and 34 and return of the carriage. As the carriage returns, right element 71 will engage arm 66 as the carriage approaches the end of its stroke, again compressing left spring 69 and moving valve stem 56 to the left. Valve stem 56 will move to the left until projection 78 engages the spring-pressed latch 82 which position establishes another throttling position of the valve 55 to restrict the flow of fluid through conduit 34 and deceleration of the return movement of the carriage. The carriage, however, will move backwards to its initial starting position until a positive stop (not shown) is reached, at which time abnormal pressure will build up in port 54 and conduit 34. This results in movement of piston 58 against the action of spring 60 and release of latch 82, allowing compressed left spring 69 to resume left movement of valve stem 56 and such movement will continue until projection 77 engages latch 81, which occurs when the neutral position of the valve 55 is reached. This completes the cycle and, as stated above, the valve, when in its neutral position, bypasses fluid from conduit 32 directly into the return conduit 51. The parts then will all be returned to their position as shown in Figure 9 and upon subsequent actuation of the

flag 86 the cycle above described is repeated. Due to the employment of a positive and uniform displacement motor as the cylinder 25 and a positive displacement pump, as described, the rate of movement of the carriage is directly proportionate to the displacement of the pump and by simply varying the displacement of the pump the rate of movement of the carriage may be varied. The valve and its operating accoutrements, described above, provide a satisfactory control for the system, releases the load on the motor and pump, except when work is being done, and provides an inherent method for eliminating shock due to quick reversal of movement of the carriage, thereby decreasing the vibration and jarring of the mechanism as a whole.

The invention includes improved means for operating the cutting element during the forward travel of the carriage and in the particular embodiment described the cutting element consists of a die set 100 (Figures 4 and 7), the one part of the die set being fixed in relation to the carriage and the other part of the die set being carried by a vertically movable cross-head 101 supported and moved by a pair of vertically extending rods 102 slidably received in vertical apertures in the projection 26 of the carriage 11. In accordance with usual practice, guide pins 103 may be provided to maintain the alignment of the two parts of the cutting die set.

The cross-head 104 is rigidly connected at its ends with the lower ends of the rods 102 and at its center with the rod 105 of a piston 106 vertically movable in the cylinder 107 rigidly connected with the carriage portion 26, a sliding tube 108 is rigidly connected with either end of the cylinder 107, the space within the tubes being in communication with the adjacent end space of the cylinder. Tubes 108 each extend through a housing 109 provided with an elongated chamber for each of the tubes. Suitable packing means 110 is provided between the tubes and the apertures in the end walls of the chambers to prevent the leakage of hydraulic fluid as the tubes oscillate. A series of apertures in the side walls of the tubes connect the spaces within the tubes with the spaces within the chambers.

Referring now to Figure 5, the chambers are in communication with the upper and lower ends, respectively, of a cylinder 112 mounted adjacent the chambers and in which a piston 113 is positioned for reciprocating movement. A rod 114 connects the piston with a cross-head 115 which is arranged for vertical reciprocating movement in the guide 116 (Figure 4). Cross-head 115, and consequently piston 113, is driven by a connecting rod 118 pivotally mounted at 119 with the member 115 and connected at its lower end with the throw 120 of the crank-shaft 121. The latter is journaled in spaced supports 122 extending upwards from the bottom wall of base 10. Shaft 121 is arranged to be intermittently driven by shaft 41 through gears 124 and 125, the latter being of substantial mass to provide a fly-wheel effect and the single revolution clutch 126.

Inasmuch as clutches of the kind mentioned are well known in the art and no novelty is claimed herein for the clutch per se, no detailed description of the construction or operation of the clutch will be attempted. Suffice it to say that in accordance with usual practice the clutch is provided with a latch 127 (Figure 4) rotatable along with the driven shaft of the clutch and engageable by the pivoted dog 128. The operation of the clutch is such that upon movement of

the dog 128 away from the latch 127 the clutch will engage and rotate the driven shaft through one complete revolution in the direction shown, the movement being arrested by the reengagement of surface 129 of latch 127 with the dog 128. Dog 128 is connected through rod 130 and pivoted lever 131 with an operating plunger 132 biased by spring 133 to upper position whereby dog 128 will be biased to latching position.

Plunger 132 is adapted to be engaged and moved downwardly to initiate the movement of crank shaft 121 by a roller 134 carried by a frame 135 pivoted to a support 136. The connection between members 135 and 136 allows clockwise rotation of the former relative to the latter but limits counter-clockwise rotation to the position shown in Figure 4. A spring 137 biases member 135 to the position shown. Member 136 is adjustably mounted on a bar 138 rigidly secured to cylinder 107 and extending in a direction parallel with the tubes 108. In operation, as the carriage is advanced along with the stock, due to operation of certain instrumentalities specifically described above, a predetermined distance, depending on the adjustment of member 136, the roller 134 will actuate plunger 132 and initiate rotation of the crank shaft 121. The cylinder 107, tubes 108, the elongated chambers in member 109 and the cylinder 112, together with all passages leading into and out of the cylinders, having been previously completely filled with hydraulic fluid, rotation of shaft 121 with the consequent up and down movement of the piston 113 results in the down and up movement of piston 106. Consequently, each release of the dog 128 will result in a cycle of movement of the movable die of the die set 100, which cycle consists of a downward and upward stroke of the movable die member. Sufficient kinetic energy is stored in the continuously revolving gear 125 to insure the uninterrupted movement of the die through its cycle, irrespective of the shape or cross-sectional area of the stock being cut, provided the resistance encountered is not greater than that for which the machine is designed. The cycle takes place during the forward movement of the carriage 11 and the time elapsed during the cycle is determined by the speed of rotation of shaft 41 and the ratio of the gears 124—125.

By reason of the employment of the crank 120 to move the die relative to the carriage, the optimum distribution of force applied to the die carrier and optimum variation in the rate of movement of the die is effected. As shown in Figure 4, the crank when at rest is at the bottom of its path of travel and as it proceeds from its starting position its vertical component of movement gradually increases in relation to its horizontal movement, thus providing maximum force to accelerate movement of the die and connected reciprocating parts and allowing the die to substantially attain its maximum speed before the stock is encountered. The arrangement also inherently provides for gradual deceleration of the reciprocating parts which further contributes to the smoothness of operation of the machine. Springs 140 encircling rods 102 are employed to balance the weight of the assembly 100—106 and therefore with the stock in the machine the stresses imposed on the parts are only those required to lend movement to the parts and these stresses are equal in both the upward and downward movement of the assembly 100—106. The stresses other than those required to lend the

movement to the parts are proportional to the resistance encountered in cutting the stock and, this being so, the total power required during the normal operation of the machine is reduced to a minimum.

To insure the synchronous movement of piston 106 relative to piston 113 it is obviously required that all the spaces interconnecting cylinders 107 and 112 by completely filled with fluid and that piston 106 be in its upper position and piston 113 be in its lower position at the start of a cycle of movement. In accordance with my invention this is accomplished by providing a reservoir 141 of hydraulic fluid above the level of the cylinders and spaces mentioned, the reservoir being connected with the upper and lower spaces through valves 142 and 143, respectively. See Figure 5. A pair of cams 144 and 145 are keyed to the shaft-carrying gear 125 and suitable connecting means, as indicated schematically at 146 and 147 in Figure 11, are provided to operate the valves 142 and 143, respectively. As the clutch 126 is actuated the cams 144 and 145 obviously move in synchronism with crank 120 and, by referring now to the diagram of Figure 11 which illustrates the condition of the parts as the dog 128 is about to be released, the operation of the synchronizing arrangement will be explained. Both valves 142 and 143 are shown in open position which, if the machine has been idle for some time, will result in the complete filling of the cylinders and spaces mentioned. Crank 120 is stopped just short of dead center and, as the cycle commences at the instant the throw commences its upward movement, the high point of cam 144 will have passed member 146 allowing valve 142 to close. During upward stroke of piston 113 the power is transmitted through the upper ends of the cylinders, the fluid in the lower end being simply flowed from one cylinder to the other. During this stroke valve 143 remains open and in case of any leakage past piston 106 the excess fluid will simply move towards reservoir 141. As piston 113 commences its downward stroke valve 143 is closed to allow the power to be transmitted but it will be opened again before crank 120 reaches its resting position and, if piston 106 has not already reached its upper position, the springs 140 will move the assembly 100—106 to its upper limiting position. As crank 120 approaches its resting position cam 144 opens valve 142 to allow the spaces above the piston to be completely filled. Now, since the spaces above the pistons are completely filled with fluid and since piston 113 is in its proper starting position and piston 106 in its proper upper starting position, synchronous movement of the parts is insured during each cycle of operation.

The mechanism described above for moving the cutting die relative to the carriage 11 is capable of being applied in mechanisms in which any type of means may be employed to reciprocate the carriage 11 in synchronism with the speed of movement of the stock being acted upon. This arises from the fact that initiation of movement or energization of the die moving means is accomplished by a mechanism responsive to the position of the carriage during its forward stroke. In the modification specifically disclosed, this mechanism consists of the clutch latch 127—129 operated by plungers 132 engageable by wheel 134 carried along with the carriage 11. It is therefore possible to utilize the die moving means of the present invention in combinations where means other than that disclosed

is employed to oscillate carriage 11. Such other means may consist, for example, of a rigid stop on the carriage 11 for engagement by the end of the stock being cut if such stock is of sufficient strength and rigidity to move the carriage, or of an arrangement utilizing an automatically operated clamp rigidly carried by the carriage and a target engageable by the leading end of the stock being cut to actuate the clamp to securely clamp the stock to the carriage during the cutting cycle of the machine. In accordance with usual practice, spring or other biasing means may be employed to return the carriage to its initial starting position.

In addition to the flag 86 on the table 84, I provide a member 150 mounted on a vertical pivot 151 and operated by a rod 152 for the purpose of engaging cut lengths of stock and moving the same away from the next succeeding length whereby actuation of flag 86 is not interfered with. As member 150 moves to the position shown in dotted lines in Figure 2, the cut length is kicked off the table 84. Rod 152 is intermittently actuated by the carriage through a suitable connection, not shown.

Base 10 is adjustably mounted on a plate 155, bolts 156 passing through slotted lugs 157 fastened to the base and adapted to be threaded into suitable threaded apertures in plate 155 to clamp the base to the plate. Screws 158 threaded to lugs 157 and engaging bolts are provided to provide precise adjustment of the lateral and angular position of the machine relative to a forming mill or other apparatus with which the machine may be used. In accordance with usual practice the plate is fixed in relation to the floor of the plant in which the machine is located.

Figure 12 illustrates a modified form of drive for the fluid pump 30 in which bevel gears 42 are eliminated and shaft 43 replaced with a longer shaft 243 extending outwardly of the base (indicated at 210). A pulley 244 or other connecting means is attached to the end of the shaft to which may be connected a power transmission member driven from the forming mill or other apparatus with which the cut off machine is used or driven from a common driving means used to drive both the cut off and the forming mill or such other apparatus. In either event the shaft 243 will rotate in synchronism with the mill or such other apparatus and for reasons advanced above, the rate of movement of the carriage will be proportional to the speed of operation of the mill or other apparatus irrespective of variations in such speed.

It should now be apparent that I have provided a machine capable of attaining the objects initially set out. The machine is capable of cutting rapidly moving stock into short lengths and by reason of the design and operating characteristics thereof this may be accomplished in a more accurate and satisfactory manner. The machine is rugged and smooth in operation requiring a minimum of maintenance and repair. The required synchronization of its moving parts is readily effected and adjusted and its power requirements are kept reasonably low.

The above specifically described embodiments of the invention should be considered as illustrative only as obviously many changes may be made therein without departing from the spirit of scope of the invention as bounded by the appended claims.

What I claim is:

1. In apparatus of the character described, the

combination of a base, a carriage mounted for reciprocating movement on said base, a die mounted for reciprocating movement on said carriage, means to impart reciprocating movement to said carriage comprising a positive displacement fluid motor, means to supply a uniform flow of fluid to said motor, means to vary the volume of said uniform flow of fluid, means to impart reciprocating movement to said die comprising a cylinder and piston mounted on said carriage, a cylinder and piston on said base and extendable conduits connecting said cylinders whereby movement of the last mentioned piston results in movement of the first mentioned piston.

2. Apparatus according to claim 1 further including means to operate the piston carried by the base, said means comprising a continuously rotating shaft, a second shaft, means connecting said second shaft and said last mentioned piston whereby rotation of the former results in reciprocation of the latter, and a clutch of the single revolution type interconnecting said shafts.

3. Apparatus according to claim 1 further including power means to operate the piston carried by the base and means responsive to the movement of said carriage in control of said power means.

4. In combination, a machine comprising a base, a carriage mounted for reciprocating movement on said base, said carriage being adapted during one stroke of its movement to move in synchronism with continuously moving stock on which the machine is to work, a working tool on said carriage, means to move said carriage comprising a power source having a normally continuously moving element, means to vary the ratio of movement between said element and said carriage, means to move said tool during movement of said carriage, and means to couple said moving element with the moving element of a driving mechanism of a production machine preceding said first named machine in a production line whereby fluctuations in the rate of stock delivery of said second mentioned machine is reflected in the rate of operation of said first mentioned machine.

5. In combination, a machine having a base, a carriage mounted on said base for reciprocating movement, a tool on said carriage, means to actuate said tool during movement of said carriage, means to move said carriage comprising a power source having a normally continuously moving element, said last mentioned means including means to vary the ratio of movement between said movable element and said carriage, means to effect connection and disconnection between said power source and said carriage, a member engageable by the forward end of stock moving through said machine in control of said connecting means, and means coupling said moving element with a normally continuously moving element of a driving mechanism of a production machine preceding said first mentioned machine in the stock production line whereby the rate of movement of said carriage is synchronized with the rate of delivery of said second mentioned machine.

6. An automatic cut-off for shearing off predetermined lengths from continuously moving stock as the stock issues from a forming mill or other production machine comprising a cutter movable along with said stock and operative to sever such stock during such movement, means

to move said cutter in synchronism with said stock comprising a cutter moving mechanism, means comprising the driving means of said forming mill or other production machine to drive said mechanism and means to vary the speed of said cutter independent of the speed of movement of said forming mill or other production machine driving means.

7. Apparatus of the character described comprising a base, a tool carriage mounted for reciprocating movement on said base, means comprising a positive displacement fluid motor for moving said carriage, a tool holding slide mounted on said carriage, a cutting tool on said slide, means to move said slide comprising a cylinder and a piston mounted on said carriage, a cylinder and piston mounted on said base, extendable conduits connecting said cylinders, a hydraulic fluid filling said conduits and the spaces within said cylinders not occupied by said pistons, means to drive said last mentioned piston comprising a continuously rotating shaft, a second shaft, means connecting said second shaft and said last mentioned piston whereby rotation of the former results in reciprocation of the latter, a clutch of the single revolution type interconnecting said shafts, a variable displacement pump for supplying fluid under pressure to said motor, means to drive said continuously rotating shaft and said pump, means to vary the displacement of said pump whereby the rate of movement of said carriage may be varied, means to drive said clutch comprising a member adjustably mounted on said carriage, the arrangement of the parts being such that the time interval between the starting of the carriage on its forward stroke and the starting of the movement of the slide on the carriage may be varied.

8. In apparatus of the character described, the combination of a base, a carriage slidably mounted on said base, a tool slide on said carriage, a cutting tool on said slide, means to move said slide on said carriage comprising a cylinder and piston on said carriage and means connecting said piston and slide, a cylinder and piston on said base, a chamber connecting with the space in said second cylinder above said second piston, a chamber connecting with the space in said second cylinder below said second piston, a tube rigidly connected with said carriage and in communication with the space within said first cylinder above said first piston, said tube extending in slidable relation through opposing side walls of said first mentioned chamber, a second tube rigidly connected with said carriage and in communication with the space in said first cylinder below said first piston, said second tube extending in slidable relation through opposing side walls of said second mentioned chamber, packing means between said tubes and the walls of said chambers, apertures in said tubes within said chambers, means to maintain the spaces in said chambers, tubes and cylinders completely filled with hydraulic fluid, and means to oscillate said second mentioned piston.

9. In apparatus of the character described, the combination of a base, a carriage mounted for reciprocating movement on said base, a slide on said carriage, means to operate said slide comprising a cylinder and piston on said carriage and means connecting said piston and said slide, a cylinder and piston on said base, an extendable conduit connecting one end of one of said cylinders with one end of the other of said cylinders, a second extendable conduit connecting

the other end of one of said cylinders with the other end of the said other of said cylinders, means to reciprocate said second mentioned piston, means to keep said conduits and cylinders completely filled with hydraulic fluid, said means being operative to insure synchronous movement between said pistons.

10. In apparatus of the character described, the combination of a reciprocating driven member, a reciprocating driving member, means to transmit the moving force of said driving member to said driven member and to synchronize the movement between said members comprising a piston and cylinder connected to each of said members, a conduit connecting the upper ends of each of said cylinders, a conduit connecting the lower ends of each of said cylinders, said driven member biasing its connected piston to upper position in its cylinder, a reservoir of hydraulic fluid positioned above said conduits and cylinders, a conduit connecting said reservoir with said first mentioned conduit, a conduit connecting said reservoir with said second mentioned conduit, valves in each of said conduits connected with said reservoir and means to operate said valves in synchronism with said driving member in such manner that the first mentioned conduit will be in communication with said reservoir for a short interval of time as the piston connected with the driving member approaches its lowermost position and that the second mentioned conduit will be in communication with said reservoir while the piston connected with said driving member traverses its upward stroke.

11. Apparatus of the character described comprising a base, a carriage slidably mounted on said base, a metal working tool movably mounted on said carriage, means within said base to reciprocate said carriage, means within said base to move said metal working tool on said carriage, means comprising a manually engageable element accessible from outside said base to vary the speed of movement of said carriage and means to vary the time relation of movement of said tool relative to the movement of said carriage.

12. In apparatus of the character described, the combination of a base, a carriage mounted on said base for reciprocating movement, means mounting said carriage comprising a pair of spaced parallel hardened steel rails removably mounted on said base, an inwardly facing retaining flange on said base extending parallel with each of said rails and spaced outwardly therefrom, a plurality of bearings carried by said carriage and disposed at right angles to each other to engage the outer and inner side surfaces of said rails and other bearings carried by said carriage to engage the inner faces of said flanges.

13. In apparatus of the character described, the combination of a base, a carriage mounted for reciprocating movement on said base, a stock severing device mounted on said carriage, means to impart reciprocating movement to said carriage comprising a positive displacement hydraulic fluid motor, means to supply a volumetrically uniform flow of hydraulic fluid to said motor, means to turn said supply on and off whereby movement of said carriage may be controlled, and means to vary the volume per unit of time of said flow of hydraulic fluid whereby the rate of travel of said carriage when said supply is turned on may be varied to synchronize the movement of the carriage with the movement of

the stock, and means to actuate said stock severing means during movement of said carriage.

14. In apparatus of the character described, the combination of a base, a carriage mounted for reciprocating movement on said base, a stock cutting means on said carriage adapted to be moved into engagement with the stock to be severed while said carriage moves along with said stock, means to impart reciprocating movement to said carriage in synchronism with movement of said stock comprising a positive displacement hydraulic fluid pump, a positive displacement hydraulic fluid motor operatively connected to said carriage, controllable means to connect the outlet of said pump with said motor, and means to vary the output volume of said pump whereby the rate of travel of said carriage may be varied.

15. Apparatus according to claim 14 further includes a hydraulic fluid motor on said carriage for moving said stock severing means, a positive displacement hydraulic fluid pump on said base, and means to conduct fluid from said last mentioned pump to said last mentioned motor.

16. Apparatus according to claim 14 in which said controllable means comprises means operative in response to the advanced position of a length of said stock.

17. In apparatus of the character described, the combination of a base, a carriage mounted for reciprocating movement on said base, a stock cutting device mounted on said carriage, means to impart movement to said carriage comprising a positive displacement fluid motor, means to supply a uniform flow of fluid to said motor, means to turn said supply full on and full off, means to vary the volume of said uniform flow of fluid, means to move said device into engagement with said stock comprising a cylinder and piston mounted on said carriage, a cylinder and piston on said base and conduits connecting said

cylinders whereby movement of the last mentioned piston results in movement of the first mentioned piston.

18. In apparatus of the character described, the combination of a base, a carriage mounted for reciprocating movement on said base, a slide on said carriage, means to operate said slide comprising a cylinder and piston on said carriage and means connecting said piston and said slide, a cylinder and piston on said base, a conduit connecting one end of one of said cylinders with one end of the other of said cylinders, a second conduit connecting the other end of one of said cylinders with the other end of the other of said cylinders, and means comprising a single revolution clutch to reciprocate said second mentioned piston.

19. Apparatus according to claim 18 in which said last mentioned means comprising a weighted continuously rotating element, and a single revolution clutch interconnecting said element and piston whereby said piston will be reciprocated through one complete cycle upon actuation of said clutch.

20. In combination with a machine for severing predetermined lengths from longitudinally moving stock and having a carriage movable with the stock and a cutting tool on said carriage, of an adjustable flag engageable by the forward end of the stock to initiate movement of the carriage, a horizontally disposed support for the severed lengths of stock, a member pivoted adjacent said support and having a portion adapted to move laterally across the path of travel of the stock, and a rod engaging said member and adapted to be operated by movement of the carriage to throw the succeeding severed lengths off said support upon completion of the successive severing operations.

DWIGHT A. JOHNSTON.