April 16, 1940. F. C. BIGGERT, JR 2,197,391

PRESS AND DRIVE THEREFOR

Filed May 4, 1937 5 Sheets-Sheet 1

Fig. 1

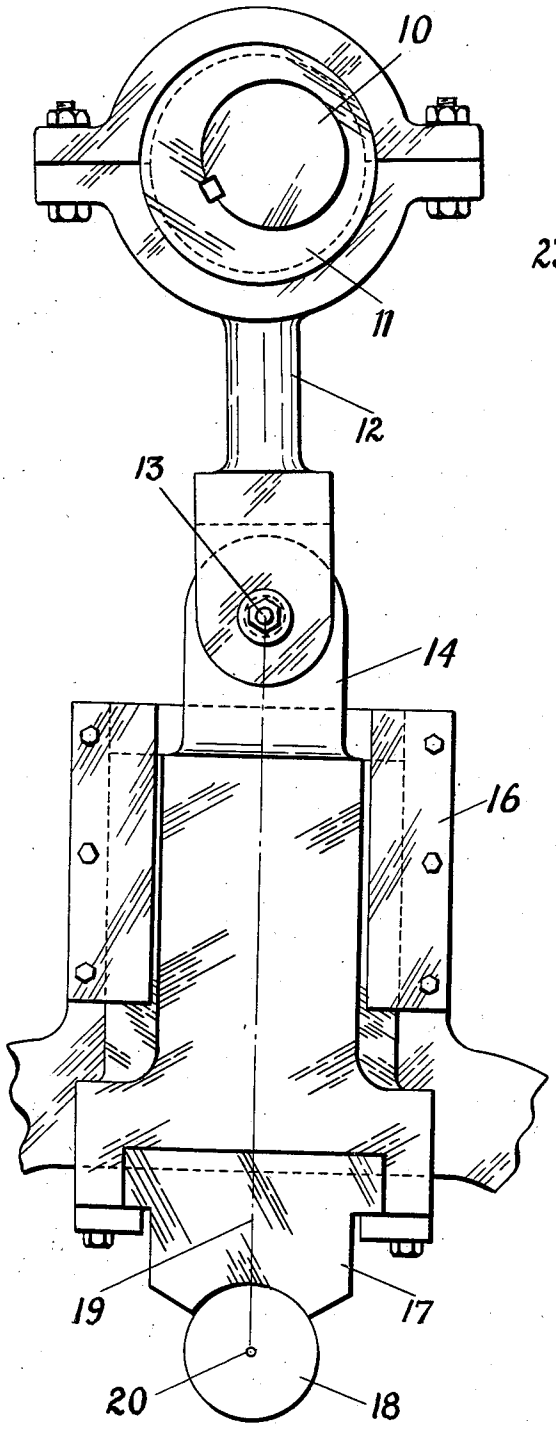
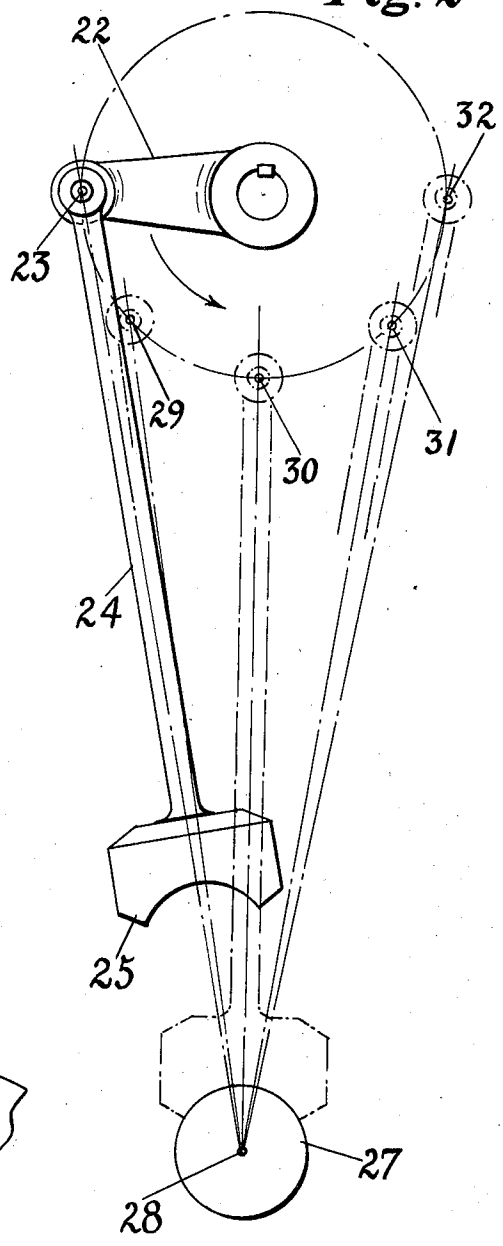


Fig. 2



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Filed May 4, 1937 5 Sheets-Sheet 2

Fig. 3

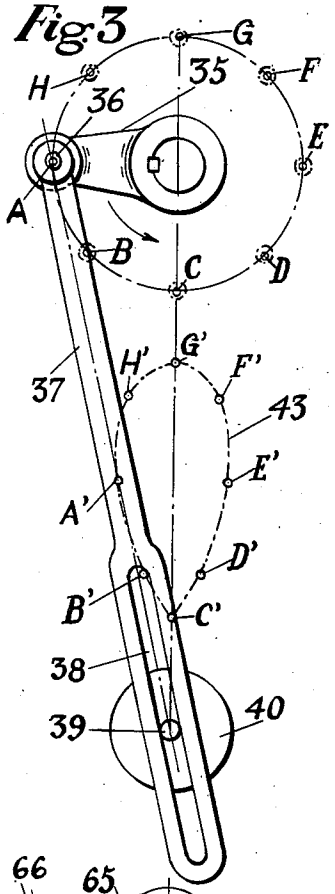


Fig. 4

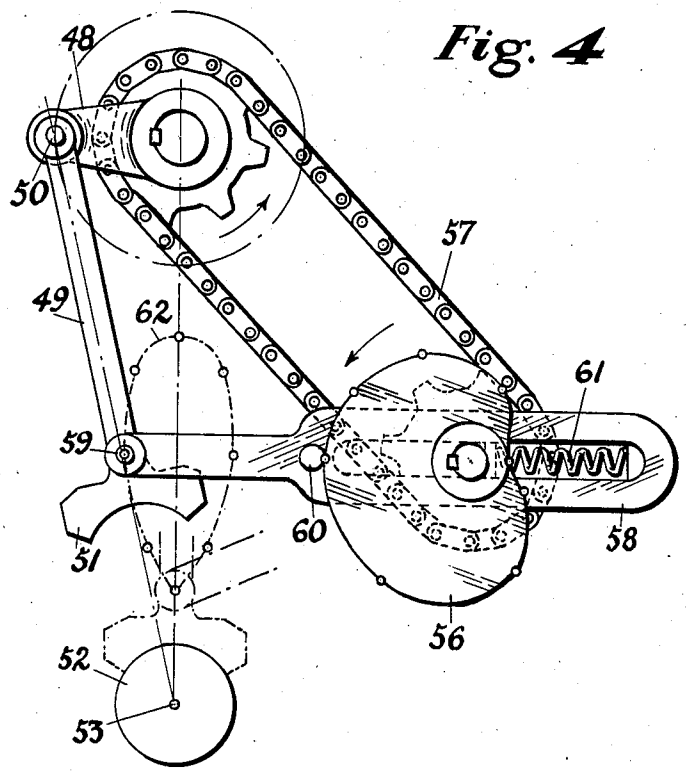
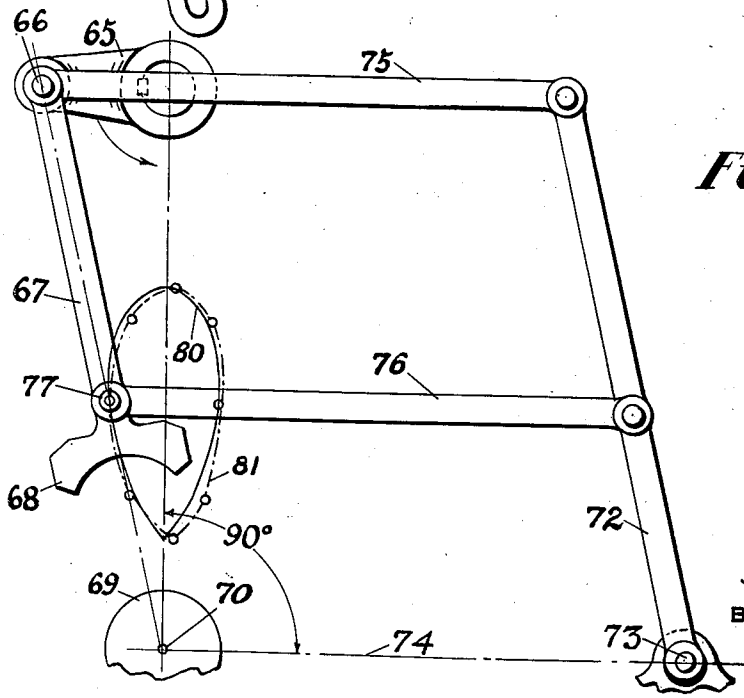


Fig. 5



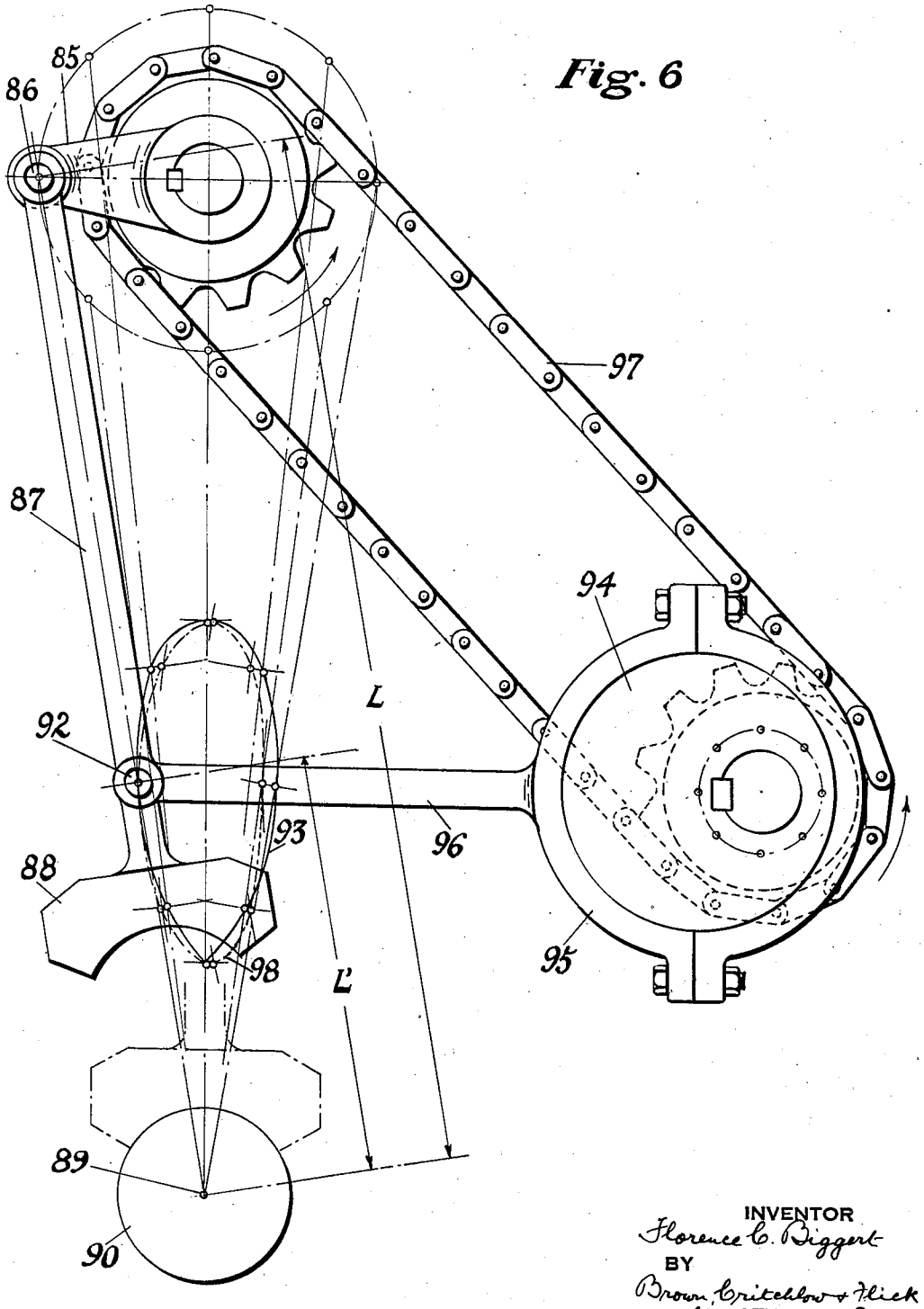
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PRESS AND DRIVE THEREFOR

Filed May 4, 1937 5 Sheets-Sheet 3

Fig. 6



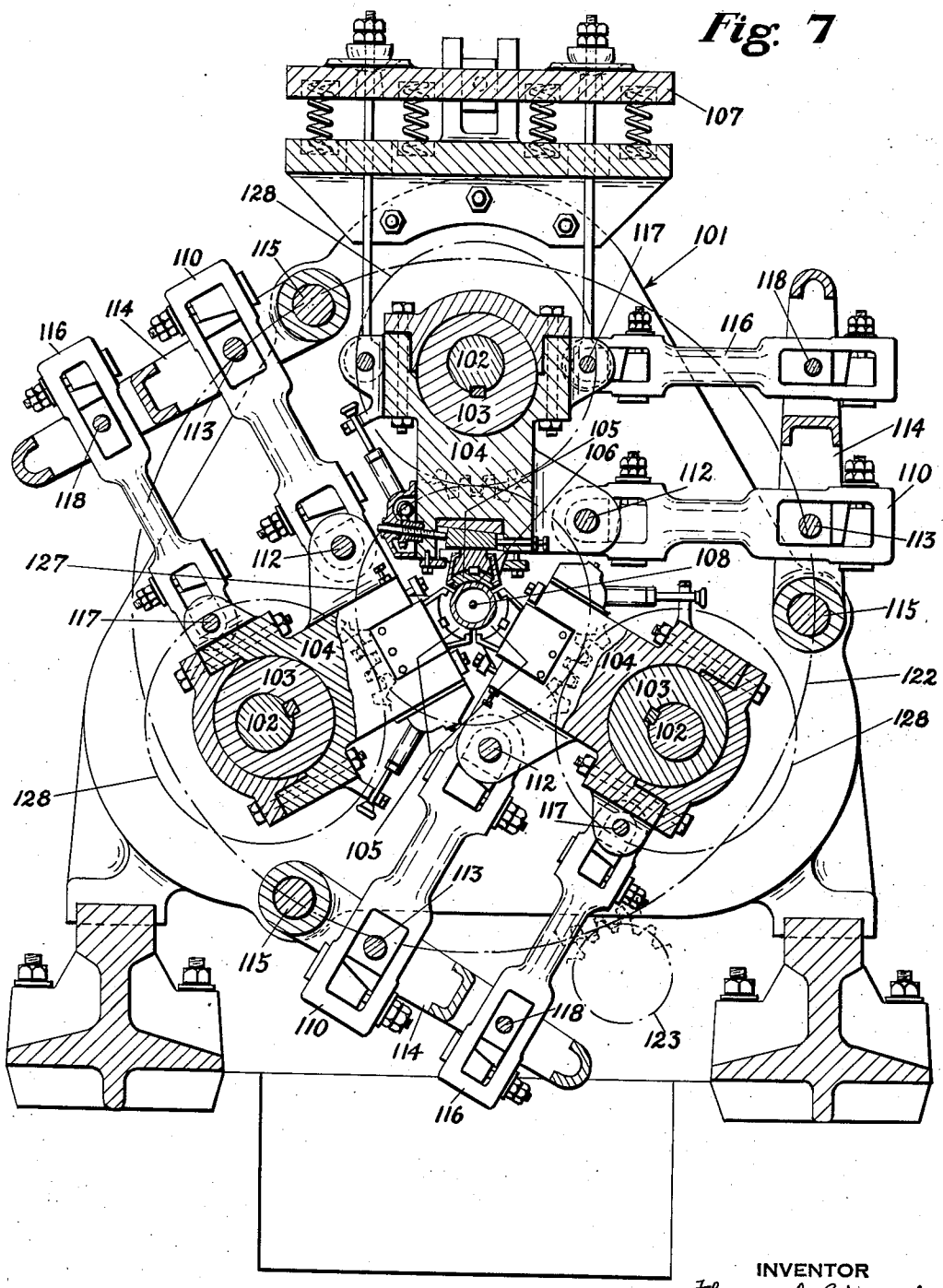
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Filed May 4, 1937 5 Sheets-Sheet 4

Fig. 7



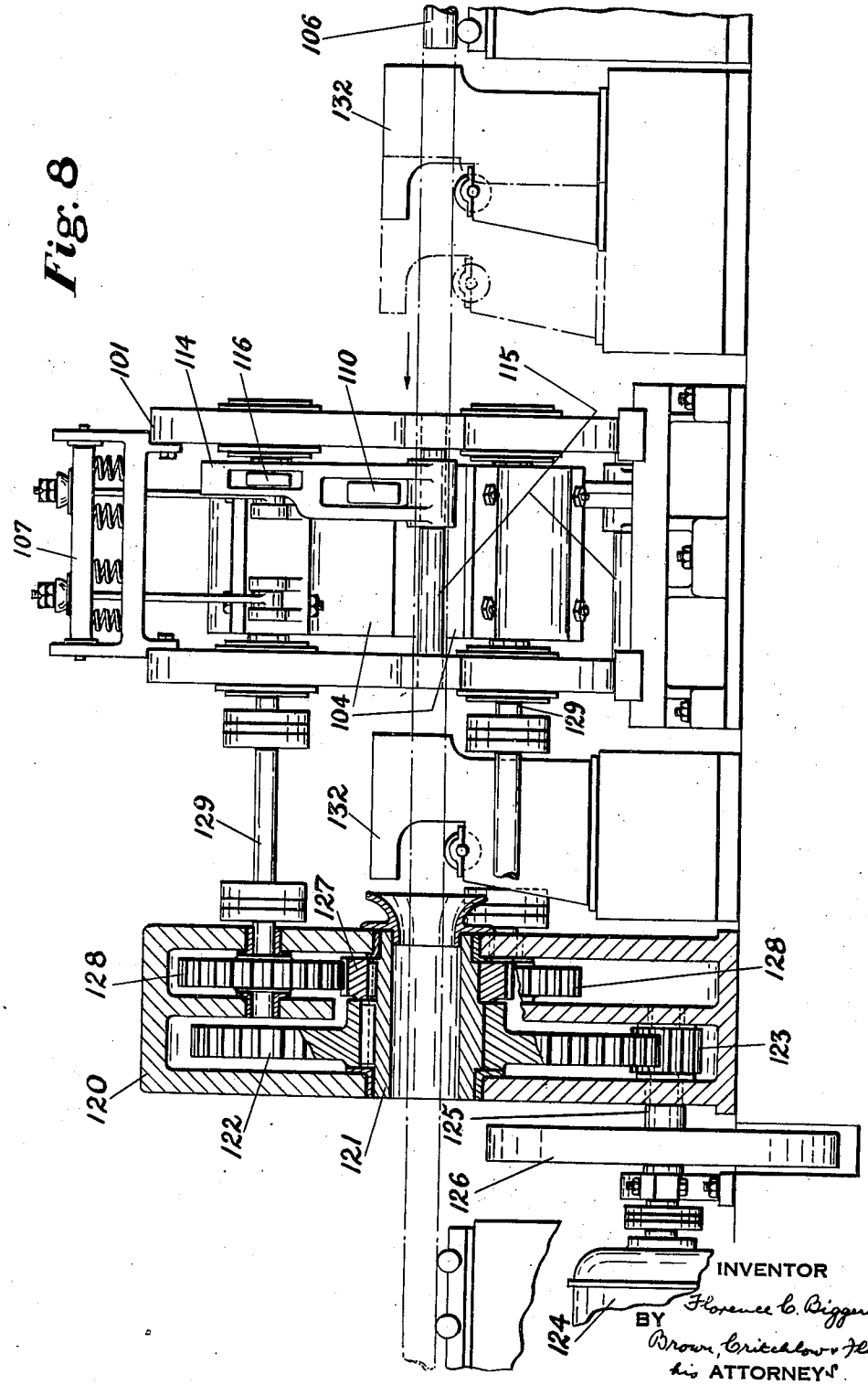
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PRESS AND DRIVE THEREFOR

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Fig. 8



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UNITED STATES PATENT OFFICE

2,197,391

PRESS AND DRIVE THEREFOR

Florence C. Biggert, Jr., Crafton, Pa., assignor to United Engineering & Foundry Company, Pittsburgh, Pa., a corporation of Pennsylvania

Application May 4, 1937, Serial No. 140,635

4 Claims. (Cl. 153—48)

This invention relates to heavy machinery, such as presses, shears and the like and more particularly is concerned with improved mechanism for imparting force to the work-engaging parts thereof.

Heretofore, in presses, punches, shears and the like for performing a plurality of hot or cold working operations per minute, as for example on metal, the punch, die, blade or other tool is moved by a crank having a relatively short throw. Usually the crank is in the form of an eccentric which is suitably driven. The working tool is ordinarily removably mounted on a cross-head slidably carried in suitable guides, the crank being connected to the cross-head by a connecting rod which is pivotally connected to each.

Force imparting mechanism, such as just described, is often satisfactory for relatively light weight apparatus. But where the force required on the tool is high, for example, a million pounds or more, the press or other machine becomes of great size and weight. Further, the cross-head and its guides are difficult to lubricate and to cover, and the knuckle pin or other means pivotally securing the cross-head to the connecting rod has such a small movement with a short throw that it is hard to keep properly lubricated. Moreover, the force imparted to the cross-head by the connecting rod is off center relative to the work. In addition, where the parts are heavy, rapid reciprocation thereof is inefficient, power-consuming and wear producing so that the number of working cycles per minute is, ordinarily, relatively low.

Because of these and other difficulties and objections, heavy machinery of the type adapted to impart a force of, for example, one million pounds or more is ordinarily hydraulically operated. However, the number of working cycles per minute is necessarily limited in hydraulically operated equipment and as a result production efficiency often suffers greatly.

It is the general object of my invention to avoid and overcome the foregoing and other difficulties by the provision of improved mechanism for imparting force to the work-engaging parts of relatively heavy machines adapted to complete a large number of working cycles per minute.

Another object of my invention is to provide an improved mechanism for directly connecting a working tool and a crank, such mechanism having a minimum number of parts which are easily constructed, assembled and maintained and readily lubricated, and which apply the operating force in a substantially straight line to the work.

Another object of my invention is the provision of a rapidly operating, relatively heavy apparatus, and particularly a press, adapted to complete a large number of working strokes in one minute, each stroke delivering hundreds of thousands and even millions of pounds of work-producing force.

Another object of my invention is to provide an improved apparatus for rapidly and effectively straightening and sizing pipe.

Another object of my invention is the provision of improved swaging apparatus for the hot or cold working of metal.

The foregoing and other objects of my invention are achieved by the provision of apparatus including a crank, a connecting rod associated with the crank, a tool removably carried by the connecting rod adjacent its end remote from the crank, and means associated with the tool end of the connecting rod for moving it synchronously with the crank so as to position the tool for movement to and from the same point, or substantially the same point, regardless of the rotary position of the crank.

For a better understanding of my invention reference should be had to the accompanying drawings wherein Fig. 1 is a diagrammatic view of the standard cross-head, eccentric drive heretofore employed in machinery of the general type herein considered; Fig. 2 is a diagrammatic view of a crank and work and the desired directional application of direct force; Fig. 3 is a diagrammatic view of a crank and work illustrating one manner of obtaining the direct application of force from a crank to the work in the desired direction; Fig. 4 is a diagrammatic view of a crank, a tool carried by a connecting rod, work, and one form of means for maintaining the tool end of the crank in the proper position for the direct application of force to the work; Fig. 5 is a view similar to Fig. 4 but illustrates a preferred embodiment of the invention; Fig. 6 is a view similar to Fig. 4 but illustrates another preferred embodiment of the invention; Fig. 7 is an end elevation of a press incorporating the principles of the invention; and Fig. 8 is a side elevation of the press of Fig. 7 and associated material feeding mechanisms.

Considering in greater detail the disclosure of the accompanying drawings, Fig. 1 illustrates a standard cross-head eccentric drive, such as heretofore generally employed. Particularly, this includes a drive shaft 10, an associated eccentric 11 operating to drive a pitman 12. Pivotally secured to the end of the pitman remote from the eccen-

tric, as by a knuckle pin 13, is a cross-head 14 which is slidably carried in guides 16. A tool for performing any desired work, as for example, a die 17 is removably secured to the cross-head for operation on work, such as a round metal section 18. My invention will be better understood when herein considered with a full appreciation of the standard cross-head eccentric drive, as just described.

As will be evident from Fig. 1, the die 17 moves to and from the work 18 on a line 19 passing through the same point 20, which in the work illustrated is the axis of the work. If a plurality of complementary dies, each operated by its own eccentric, are employed the point 20 is the same for all, as will be understood. This movement of the working tool to and from the same point is essential to a successful working operation, as will be recognized, for otherwise the work cannot be properly positioned relative to the dies.

Where, due to objections heretofore noted and in accordance with the principles of my invention, the cross-head and associated guides are eliminated from the mechanism, as shown in Fig. 2, the movement of the working tool to and from the same point is an essential. Specifically, in Fig. 2 the numeral 22 indicates a crank pivotally secured, as by a pin 23, to a connecting rod 24 having a working tool in the form of a die 25 directly associated therewith. Work in the form of a round metal section is shown at 27 and since it is round work engaged by a full face die its axis constitutes a point 28 to and from which the die 25 should move. In other words, when the pin 23 moves around in a circle as to points 29, 30, 31 and 32, then lines drawn through these points to the point 28 should always pass through the center of the die 25.

In Fig. 3 I have diagrammatically illustrated one manner of insuring the proper movement of the connecting rod or pitman and its associated working tool. Particularly, the numeral 35 indicates a crank to which is pivotally connected, as by a pin 36, a rod 37. The rod is formed adjacent its other end with slot 38 slidably receiving a pin 39 which defines the point to and from which the tool is moved, as for example, the center of a work-piece in the form of a round metal section 40. Now as the crank 35 is turned through points A, B, C, D, E, F, G and H any selected point on the rod, as for example point A', moves through the points B', C', D', E', F', G' and H' and defines a curved path indicated by the numeral 43.

Ordinarily in relatively heavy machinery adapted for rapid reciprocating tool movement and the application of hundreds of thousands or even millions of pounds of force, the mechanism just described is not practical, as will be evident. Hence this is not a preferred embodiment of the invention but serves to better illustrate the underlying principles of my inventive concept.

Referring now to Fig. 4 of the drawings, I have shown a mechanism including a crank 48 having a connecting rod 49 pivotally secured thereto by a pin 50. The connecting rod 49 carries a working tool, as for example a die 51, adapted to engage with a work-piece, such as a round metal section 52. The die is held for movement to and from a point 53 which, in the example given, is the center of the section 52 or more specifically the center toward which other dies complemental to the die 51 and similarly operated move. For the sake of simplicity only one die or working tool and its operating mechanism have been illustrated.

The desired movement of the die 51 is obtained by a cam 56 which is turned at the same angular speed as the crank 48, as by the provision of an endless chain 57. A link 58 pivotally connected to the rod 49, as by a pin 59, carries a cam follower 60 which is held in engagement with the cam by a compression spring 61. The cam 56 is so shaped that the pin 59 defines a path 62 in the rotation of the crank 48 which path is identical to the path 43 of Fig. 3 where the crank 48 and crank 35 are identical and the distance between the pins 50 and 59 is the same as that between pin 36 and point A of Fig. 3. In other words, the center of the die 51 lies always on a line passing through the pin 50 and the point 53 regardless of the position of the crank 48.

Although mechanism of the type just described provides a perfect positioning motion for the rod 49 and for the die 51 nevertheless in relatively heavy rapidly reciprocating machinery the use of the cam and associated mechanism is often not practical as will be recognized by those skilled in the art. Accordingly, I have shown in Fig. 5 a mechanism better adapted for the application of heavy force on a working tool and completing a relatively large number of working cycles per minute.

Particularly referring to Fig. 5 of the drawings the numeral 65 indicates a crank pivotally secured as by a pin 66 to a rod 67 carrying a working tool, as for example, a die 68 which is adapted for movement to and from a work piece, such as a round metal section 69 having a center point 70 toward and from which the die is moved regardless of the position of the crank 65. I control the position of the rod 67 and the die 68 by a system of linkage which includes a lever 72 which is pivotally connected as at 73 upon a line 74 extending through the point 70. The lever 72 is connected by parallel links 75 and 76 to the pin 66 and to a pin 77, respectively, so that a parallelogram is formed by the rod 67, the lever 72 and the links 75 and 76.

Now assuming that the dimensions of the parts of Fig. 5 are similar to those of Figs. 3 and 4, then the pin 77 if moved in exactly the right manner by the linkage would define a curved path 80 shown in full lines which is identical to the curved paths 43 and 62 of Figs. 3 and 4, respectively. However the linkage just described does not move the pin 77 in exactly this path but instead actually moves it in a path indicated by the dotted line 81. While in Fig. 5 the path 81 actually taken by the pin 77 does not coincide with the desired theoretical path 80, it should be remembered that in actual practice only a part of the path 81 is actually used in performing the work. Usually this is not more than about a 50° crank angle on each side of dead center, and the remainder of the stroke provides clearance to give time for feeding the material worked. By slightly changing the location of the point 73 or the pin 77 or both, the effective part of path 81 may be made to substantially coincide with path 80. It will be understood in this connection that the showing in Fig. 5 is actually an exaggerated condition wherein the throw of the crank 65 is much greater in proportion to the rest of the apparatus than is the case in an actual construction. Specifically in an actual machine the throw of the crank, ordinarily an eccentric, is from a fraction of an inch up to several inches and the length of the connecting rod or pitman

is ordinarily several feet or more. I have found therefore that in actual constructions the theoretical error between the working portions of paths 80 and 81 is less than the machining tolerances and is therefore negligible.

Like Fig. 5, the apparatus shown in Fig. 6 on somewhat larger scale constitutes a preferred embodiment of my invention. In this figure of the drawings the numeral 85 indicates a crank pivotally connected as by a pin 86 with a rod 87. A working tool, usually such as a die 88, is carried at the end of the rod 87 and is mounted for movement to and from a point 89 which in the embodiment of the invention illustrated constitutes the center of a round work-piece 90. In order that the die 88 moves to and from the point 89 regardless of the position of the crank 85 a pin 92 secured to the rod 87 should travel in a curved path 93 which like paths 43 and 62 heretofore described is theoretically and actually the correct path.

In order to move the pin 92 in the path 93, or more particularly in a practical equivalent thereof, I provide an eccentric 94 which is surrounded by a strap 95 of a pitman 96 which is pivotally secured at its other end to the pin 92. The eccentric 94 is driven at the same angular speed as the crank 85, as for example by the provision of a connecting chain 97. The radius of the eccentricity of the eccentric 94 is in direct ratio to the length of the crank 85. More particularly, I have found that this ratio is substantially identical to the ratio between the dimension L marked in the drawings and the dimension L'. Actually when an eccentric, such as 94, is employed to control the position of the pin 92 the path defined by the pin is indicated by the numeral 98 and as seen from the drawing this path does not exactly overlie the theoretically proper path 93. However the dimensions in the drawings have been exaggerated to illustrate the principle involved and in actual practice the throw of the crank 85 is much less relative to the length of the rod 87 so that the paths 98 and 93 substantially overlie each other in the actual work performing portions thereof within a few thousandths of an inch which is close as could be obtained if actual theoretical movement were desired due to machining tolerances and fits.

For a complete understanding of my invention as practically applied to a relatively heavy machine adapted to perform a large number of working cycles per minute with each one of the working cycles imparting a force of hundreds of thousandths of pounds or more to the work, reference should be had to Fig. 7. In this figure the numeral 101 indicates generally the housing of a press which housing journals driven shafts 102 each of which carries an eccentric 103. Surrounding each eccentric 103 is a pitman 104 which removably carries at its end remote from the eccentric a working die 105. The dies 105 are complemental to each other and in the embodiment of my invention illustrated are three in number. They are adapted to engage with a portion of the length of a pipe 106 to size and straighten it. The uppermost pitman 104 is counterbalanced and held against the eccentric bearing by a spring blanket 107.

Each pitman 104 is held in the proper working position for movement to and from the point 108 regardless of the position of its eccentric 103 by a system of parallel linkage similar to that particularly disclosed in Fig. 5 and heretofore described. In the embodiment of the invention shown this includes a link 110 which is pivotally secured as by a pin 112 to the side of the pitman. The link 110 is pivotally secured by a pin 113 to a link 114 mounted for rocking movement on a pin 115 carried by the housing 101. Completing the parallel linkage system is a link 116 which is pivotally secured as at 117 and 118 to the pitman 104 and to the link 114, respectively. The shafts 102 are rotated at the same angular speed by suitable mechanism which may take the form illustrated in Fig. 8 wherein a centrally apertured housing 120 rotatably receives a hollow hub 121 through which the pipe 106 is passed. Fixed to the hub 121 is a bull gear 122 which is driven by a gear 123 connected to a motor 124 by a shaft 125 carrying a flywheel 126. The hub 121 likewise carries a gear 127 which engages with gears 128 connected to spindles 129 which are removably secured to the shafts 102.

Positioned on each side of the press 101, as seen in Fig. 8, are chuck mechanisms 132 for advancing and rotating the pipe. The chuck mechanism 132 at the entering side of the press is mounted so that it can be adjustably positioned closer to or farther from the press 101, as exemplified by the dotted line showing thereof, so that the pipe is moved into the press in the desired manner regardless of its exact length and diameter and the amount of work done in the press. Each of the chuck mechanisms 132 is adapted to positively grip the pipe and feed it forward a given amount when the dies 105 of the press are open. During the forward feeding movement of the pipe it is turned through any desired arc, as for example 60 degrees, so that the line of the joinder of the dies when again closed comes at a different point on the pipe than in the last closing of the dies. In actual practice the pipe is turned through an arc slightly less than 60 degrees due to the rotation of the pipe caused by the operation of the press as hereinafter described. The chuck mechanisms release their grip upon the pipe before the dies 105 engage it and the chuck mechanisms are moved back to their initial position to be ready for another forward feeding movement of the pipe when the dies 105 again release it.

The mechanisms 132 have not been illustrated in detail inasmuch as they are known per se to the man skilled in the art, as, for example, in Patent No. 1,287,791.

A novel feature of a press constructed as just described is that in the engagement of the complementary dies with the pipe 106 there is a turning of the pipe about its own axis and through a relatively short arc during the working operation. This is due to the fact as will be evident from the foregoing description that each die 105 engages with the pipe to one side of the dead center position illustrated in the drawing. As the eccentrics 103 move toward the dead center the pipe engaged by the dies turns slightly with the dies to the dead center position illustrated in the drawings and as the pitman 104 moves on past the dead center the pipe is carried slightly past dead center until the dies move away from the pipe. In the actual press illustrated the dies 105 engage with the pipe when each eccentric 103 is approximately 40 degrees from dead center position. During the initial working movement of the dies the pipe is elastically compressed and further movement of the dies toward the point 108 effects plastic compressing or flow of the pipe metal up to

the dead center position of the pitman 104. As the pitman moves past the dead center position and starts away from the pipe, the pipe elastically recovers an amount dependent upon the character of the metal of the pipe and after the elastic recovery is complete each die leaves the pipe. It should be understood in this connection that the figures given are illustrative of one particular working operation and that within the principles of my invention the actual working operation can be varied as desired.

I have found in actual practice with apparatus constructed as just described that the dies 105 are moved almost exactly toward and from the point 108 so that the theoretically correct and the actual paths of movement substantially coincide and any difference is much less than that illustrated in Fig. 5. For example, in the mechanism illustrated, the work operated on has been represented as a fourteen inch pipe so that the length of the pitman 104 is roughly five feet from the center of the shaft 102 to the bottom of the die and the distance from the pin 115 to the center of the pitman 104 is roughly eight feet. Hence with a total stroke of approximately 1½ inches by the eccentric 103 the difference between the theoretically proper path of movement of each die 105 and the actual path of movement is negligible.

In the actual operation of the apparatus just described pipe from about three inches to about fifteen inches in diameter and up to fifty feet long is straightened and sized in a rapid and efficient manner. Between about eighty and about one hundred fifty pipes, each fifty feet long, can be sized and straightened in an hour. The apparatus is adapted to complete up to or over fifty working cycles a minute and each die is capable of exerting seven million pounds pressure for a duration of approximately two-tenths of a second. The pipe is moved step by step through the press with each step being controlled by the working stroke of the feeder but being in the neighborhood of from about one to about three feet.

While the principles of my invention have been broadly explained, they have been illustrated as employed in conjunction with a pipe sizing and straightening apparatus. It should be understood, however, that the specific example given is merely illustrative of one concrete embodiment of my invention and that the principles thereof can be employed in the construction of any relatively heavy machinery wherein the size and weight of the parts are important or limiting and wherein relative heavy working force must be imparted to a tool, and particularly to a plurality of similarly operated tools, a number of times a minute.

From the foregoing it will be recognized that the objects of my invention have been achieved by the provision of improved mechanism for imparting relatively heavy force to a working tool or tools a plurality of times a minute. The size of the mechanism is considerably reduced over known mechanism and the parts are adapted to directly apply the working force in a straight line to the material worked. Lubrication of the working parts is not difficult and the apparatus is adapted to complete a relatively large number of working cycles per minute.

In the specification and claims the terms "crank" and "eccentric" are intended to be used alternatively as are the terms "connecting rod" and "pitman."

While in accordance with the patent statutes, I have disclosed the principles of my invention and illustrated a single complete embodiment of the application thereof, it should be understood that my invention is not limited thereby or thereto but is defined in the appended claims.

I claim:

1. Apparatus for straightening and sizing pipe comprising a press, complementary dies, a pitman mounting each die, an eccentric for driving each pitman, and a system of parallel linkage associated with each pitman and controlling the position of the die carried thereby for movement to and from the pipe, each pitman and associated system of parallel linkage being constructed and arranged so that a line drawn through the axis of the pitman will at every degree of rotation of the eccentric pass through or substantially through the axis of the pipe.

2. Apparatus for swaging an elongated member comprising a plurality of complemental dies adapted to engage a member, and means for reciprocating the dies toward and from the axis of the elongated member and for simultaneously oscillating the dies about the said axis of the member, said means being constructed and arranged to turn the member slightly about substantially its longitudinal axis during the working position of the working stroke of the dies.

3. Apparatus for swaging an elongated member comprising a plurality of complemental dies adapted to engage a member, a plurality of cranks mounting and reciprocating the dies toward and from substantially the axis of the elongated member to swage it, and means associated with the cranks to turn the dies and the member slightly about substantially the longitudinal axis of the member during the working stroke of the dies.

4. Apparatus for swaging a longitudinal member comprising a press, complementary dies, a pitman mounting each die, an eccentric for driving each pitman, and a system of parallel linkage associated with each pitman and controlling the position of the die carried thereby for movement to and from the member, each pitman and associated system of parallel linkage being constructed and arranged so that a line drawn through the axis of the pitman will during the working portion of the die stroke pass through or substantially through the axis of the member.

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