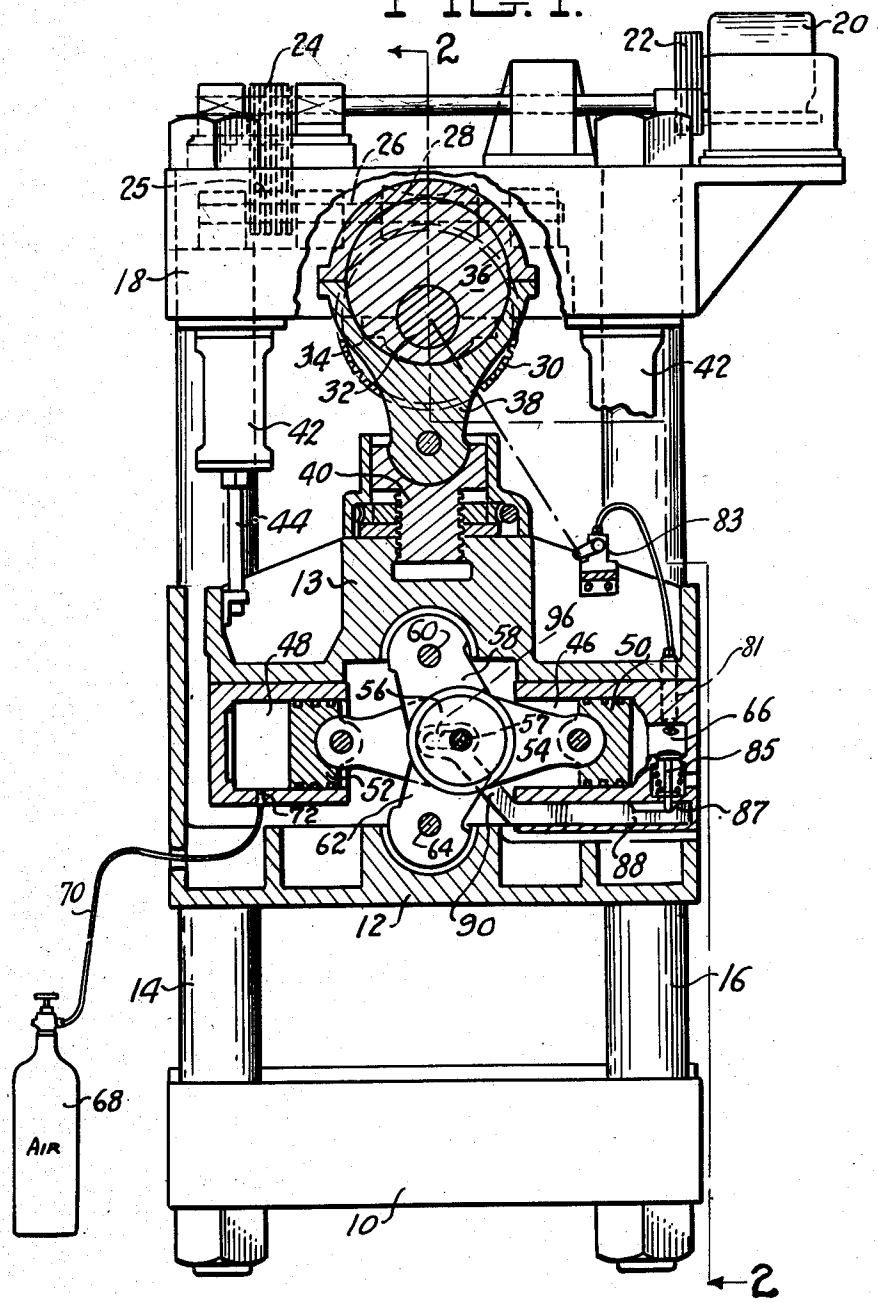
March 31, 1953 J. MULLER 2,633,094

POWER-OPERATED PRESS DEVICE

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FIG. 1.



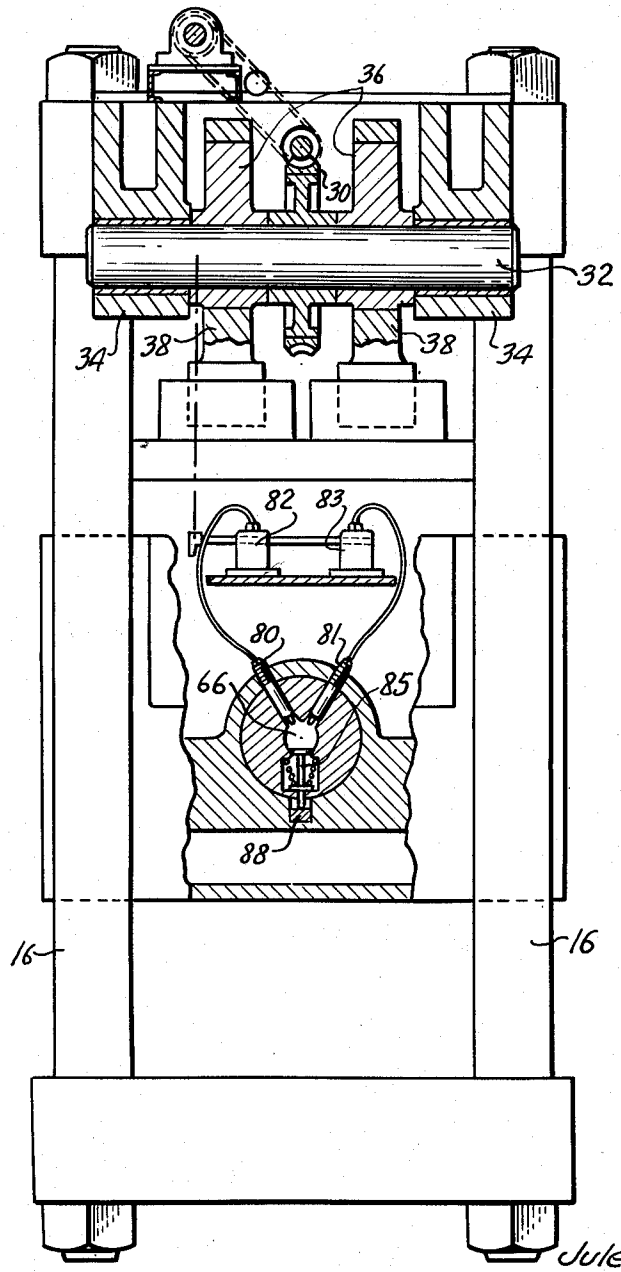
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FIG. 2.



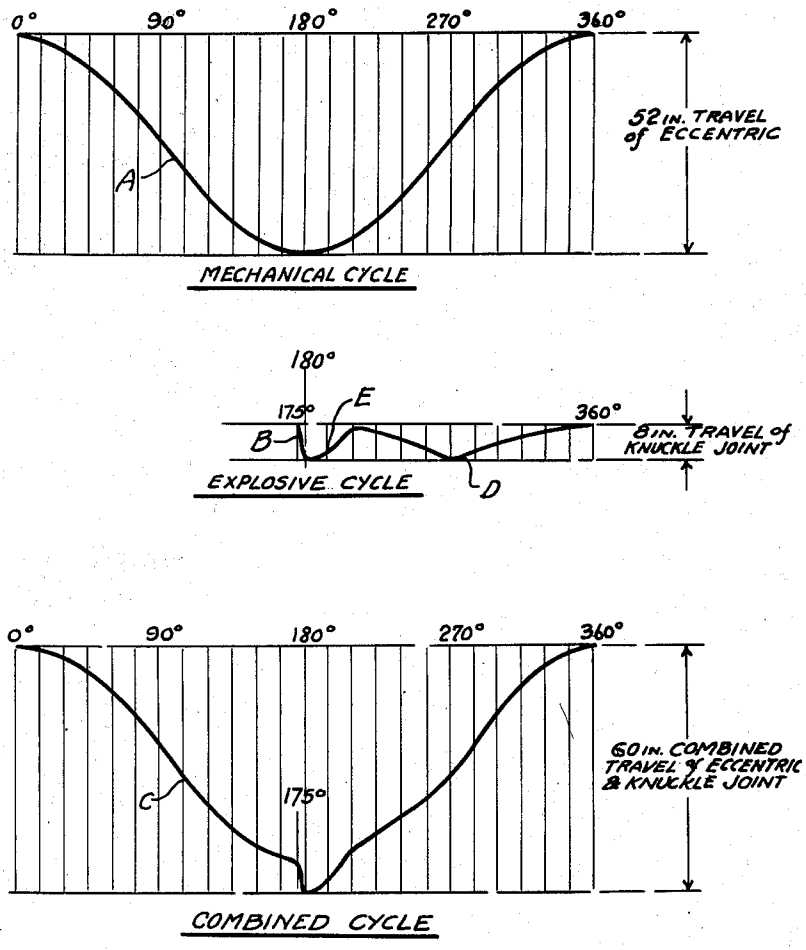
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FIG. 3



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UNITED STATES PATENT OFFICE

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POWER-OPERATED PRESS DEVICE

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6 Claims. (Cl. 113—38)

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This invention relates to presses for forging, extruding or drawing metals and similar machines and is particularly directed to a novel method and apparatus for operating the drawing, extruding or forging slide through the working portion of its stroke.

Conventional mechanical presses for the forming of metals by forging, extruding or drawing operate by developing the maximum pressure against the metal at the bottom of the stroke, whereas it is desirable and important to develop the highest pressure at the initial contact between the forming die and the metal to cause the initial crystal slippage and to maintain the slippage during the working portion of the press stroke.

The primary object of the invention is to provide a novel method and apparatus for operating the slide of a forging, extruding or drawing press by means of which energy for the working portion of the stroke is derived in part from an extraneous source of power, and in part from the usual power source that raises and lowers the slide through the working portion of the stroke, in such a manner that the force against the metal to be worked is raised to substantially the peak pressure at the time of initial contact between the metal and forming die.

Another object of the invention is to provide a method and apparatus of this character in which an explosive medium is used to provide the additional power.

Still another object of the invention is to provide a device of this character in which an explosive medium is used in a power cylinder having a piston connected to a toggle in the slide operating linkage, the toggle being adapted to pass over center against the action of a bounce or restoring cylinder.

Still another object of the invention is to provide a device for operating the slide of a forging, extruding or drawing press through the working portion of its stroke which comprises, means to derive energy from an explosive medium in a power cylinder and to impart such energy to the slide of the press, the arrangement being such that the power derived from an explosive medium is automatically timed with respect to the movement of the remainder of the press parts and the power piston is automatically restored to the position in which its operation commences.

Other objects and advantages of the invention will become apparent from the following description of a preferred embodiment, reference being had to the accompanying drawings in which:

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Fig. 1 is a central vertical section of a press embodying the present invention, portions of the press being shown in full lines; Fig. 2 is a section on line 2—2 of Fig. 1 with parts broken away; and Fig. 3 is a timing diagram indicating a preferred sequence of events in the operation of the press.

Referring to the drawings, the press structure may take any suitable form but the present invention is particularly applicable to large presses. The dies between which the metal is actually formed are omitted but as in normal practice one of the die parts is to be carried by a bed 10 and disposed in the path of movement of a mating die member carried by a slide 12, the slide being gibbed for reciprocation in the press frame and between tie-rods 14 and 16. The crown of the press is indicated at 18 and carries a slide driving motor 20 which is connected by means of a belt 22 and gear set 24—25 to a shaft 26. A worm 28 on shaft 26 drives a pinion 30 disposed on a crank-shaft 32 which is journalled in a front-to-back position in the press crown in suitable bearing blocks 34. Eccentrics 36 carried by the crank shaft 32 are surrounded by connecting rods 38, the rods being diametrically divided in the usual manner for assembly. At their lower ends the connecting rods 38 are in operating connection with slide 12 through adjustable screw connections 40.

It should be expressly understood that the parts so far described may be varied in their construction and form no part of the present invention except that they serve to reciprocate the slide through the non-working portion of its stroke, that is, advance the slide to die closing position and restore it after the drawing operation has been performed. While the sinusoidal movement derived from eccentrics 36 is satisfactory for certain operations, a slide driving mechanism including a plurality of toggles may serve better in other instances where a dwell is required in the stroke.

Slide 12 is divided into upper and lower sections, the lower section being gibbed in the frame as previously stated and the upper section being mounted for slidable reciprocation in the lower section. The upper slide section is designated 13 and suitable counterbalance cylinders 42 are provided adjacent the crown of the press to assist in raising the weight of the slide parts. The pistons in the counterbalance cylinders 42 are connected to the upper slide part 13 by means of rods 44.

One of the slide parts, preferably the upper part 13, is formed with opposed power and bounce

cylinders, the power cylinder being designated 46 and the bounce cylinder being designated 48. A power piston 50 reciprocates in the power cylinder 46 while a bounce piston 52 reciprocates in the bounce cylinder 48. The two pistons are connected to each other by a link or connecting-rod 54 which is connected at each end to the power and bounce pistons by suitable wrist pin connections and intermediate its ends is connected to a central pivot 56 of a toggle link comprising an upper arm 58 pivotally connected as at 60 to the upper slide part 13 and a lower link 62 pivotally connected as at 64 to the lower slide part 12. It will thus be seen that as the connecting rod 54 moves laterally the toggle, comprising arms 58 and 62, is straightened causing a lowering of the slide part 12 with respect to the slide part 13.

In the normal position, during idle or non-working movements of the press, the power piston is disposed at the right of its cylinder thus forming one wall of a combustion chamber 66. The power piston is held in a definite position by air pressure in bounce cylinder 48, the pressure being introduced, for example, from a source 68 by means of a pipe 70 and a piston controlled port 72 in the bounce cylinder. The source 68 carries air at a relatively low pressure, in the order of 40 pounds per square inch, sufficient to hold the pistons in their non-working position and to maintain the lower slide part 12 contracted with respect to the upper slide part 13. In the normal or non-working position of the parts, then, the toggle link 58—62 is broken; that is, its arms lie at an angle to each other.

Any suitable motive force may be used to drive the power piston 50 outwardly in the power cylinder 46. However, it is preferred that the additional energy be derived from the timed explosion of a material such as will decompose spontaneously in the power cylinder without the requirement that air at high pressure and temperature be contained in the power cylinder or without the requirement of ignition by a spark or otherwise. A fuel of this character may comprise hydrogen peroxide injected in the presence of an agent capable of causing rapid and spontaneous decomposition such as hydrazine or ethyl alcohol. Both the peroxide and its decomposing agent are liquids capable of being handled separately with complete safety but form a spontaneously explosive mixture when brought together.

The fuel constituents are injected into the power cylinder 46 by means of separate injection nozzles 80 and 81 supplied by separate fuel pumps 82 and 83. The pumps and nozzles follow the known practice of similar pumps and nozzles in the familiar compression engines and it is only necessary to modify this equipment by changing the material used for the hydrogen peroxide pumps, since this material must be stored and conveyed in suitable metallic containers. Stainless steel, however, is suitable for the pump and nozzle parts and, in fact, is a preferred metal.

A single valve 85 is provided opening into the combustion chamber 66 and the valve serves as a controllable exhaust and venting valve held open during a large portion of the stroke as will be hereinafter apparent. The single valve thus permits venting of the power cylinder and combustion chamber during that portion of the stroke of piston 50 which would normally be referred to as a compression stroke. The valve

is closed slightly before the piston reaches its position of full insertion in the power cylinder 46.

Valve 85 is operated in any suitable manner, as by a cam 87 carried at the end of a reciprocating slide 88 which is connected by means of an arm extension 90 to a pin 57 on central pivot point 56 of the toggle link 58—62. The valve is thus timed in its opening by movement of the toggle link. A lost motion connection comprising pin 57 extending from the pivot 56 and working in a slot 96 of the arm extension 90 operates to bring cam 87 under the stem of valve 85 when the power piston 50 has completed slightly more than half of its power stroke so that the toggle link 58—62 has been straightened and broken slightly in the opposite direction when the valve 85 begins to be opened by cam 87. The valve 85 is held open by cam 87 during the remainder of the working stroke of piston 50 and the return of this piston through nearly all of its return stroke, being closed only when pin 57 is engaged by the end of slot 96. This occurs when piston 50 is nearly at the extreme inner end of its stroke.

The fuel pumps 82 and 83 are driven by any suitable connection to the crank shaft 32 and a small eccentric or pitman connection to this shaft will furnish ample power for the pump drive.

As previously noted, bounce cylinder 48 contains air under relatively low pressure introduced through piston control port 72. When port 72 is covered by the bounce piston 50 the air in cylinder 48 is trapped and is greatly increased in pressure by continued movement of bounce piston 52. This air then is increased in pressure and the energy stored therein may be utilized to return the power piston to its initial position. The action of the bounce cylinder does not take place until after the slide has been withdrawn from the work by movement of the eccentrics 36 and connecting-rods 38.

The operation of the mechanism may best be understood by referring to the timing diagram shown in Fig. 3.

The inner and outer slide parts 12 and 13 move down together by reason of the energy imparted from the driving motor 20 to the eccentric 36 through the gear train and shafting in the press crown. This motion is sinusoidal and is indicated by the sine curve A. As the slide parts near the bottom of the stroke, fuel is injected into power cylinder 46 through the two nozzles 80 and 81 if the energy is to be derived from the decomposition of hydrogen peroxide as above stated. Nozzles 80 and 81 act in response to a pressure wave from their respective pumps 82 and 83, the pumps being driven from and thus timed by the shaft 32 which carries the eccentrics 36.

Energy expended in the power cylinder 46 drives the power piston 50 outwardly of this cylinder and since the piston is connected to the center pivot of toggle link 58—62 the two slide portions 12 and 13 commence a differential movement, slide part 12 moving more rapidly than slide part 13. The motion of slide part 12 alone may be represented by a curve B. The first portion of this curve is relatively steep as it represents the high velocity and rapid straightening of the toggle link. The curve is essentially sinusoidal, but its rate of descent is somewhat more rapid than its later ascending rate, as the ascent is impeded by the action of bounce cylinder 48. It will be seen that the power applied

against the work during the straightening of the toggle link is the sum of the energy applied by the press driving motor and the energy developed in the power cylinder. This force is essentially at a maximum as soon as the explosion takes place in the power cylinder.

It will be seen that the peak of the curve B representing the motion of slide part 12 corresponds to the peak of the curve A representing the motion of eccentric 36. Thus the maximum closing of the dies of the press is reached when the eccentric is at bottom center and the toggle link is straight. These events are timed to occur together.

The piston 50 continues to drive the toggle link to the left beyond its center position and at a predetermined point in this continued operation, bounce piston 52 closes port 72 and the pressure in bounce cylinder 48 commences to increase. Somewhat later in the stroke, at point E on the curve, exhaust valve 85 is opened by cam 87, the cam being drawn under the valve by slide 88 connected in turn to actuating arm extension 90. The valve 85 remains open until nearly the end of the cycle as later described.

The retraction of the lower slide part 12, and thus the opening of the forming dies, is caused in part by the breaking of the toggle link to the left in Fig. 1 and in part by the upward movement of both slide parts 12 and 13 by eccentric 36. Since the two motions are in the same direction, they are added together in curve C which represents the movement of the lower face of slide part 12. The upward movement by eccentric 36 continues, but lower slide part 12 is later moved through a second downward movement indicated at D by the expansion of air compressed in bounce cylinder 48. This expansion takes place during a time when valve 85 is open so that the resistance to movement is only that caused by friction and the weight of the lower slide part. There is no second closing of the die part by the second straightening of the toggle since this action takes place at a time when eccentric 36 has raised the entire slide assembly beyond the point where it is possible for the dies to close.

Expansion of air in the bounce cylinder thus moves the power piston to its initial position. As the toggle link nears its initial position the end of slot 96 contacts pin 57 and moves cam 87 from under the stem of valve 85 so that the valve closes. Continued air pressure from source 68 holds the parts in the initial position, ready for another operating stroke.

While the invention has been described in connection with a particular form and disposition of the operating parts and in connection with a specific fuel system it should be appreciated that numerous modifications and changes may be made not only in the press parts themselves but in the method of its operation and fuels or explosive medium used without departing from the invention as defined in the appended claims.

What I claim is:

1. In a metal forming press, a die-carrying slide movable toward and away from work to impart a predetermined shape thereto, power means for imparting said movements to the slide, said slide having upper and lower parts movable toward and away from each other in the plane of movements of the slide, a toggle connection between said slide parts operable when straightened to separate said slide parts, a pair of opposing cylinders carried by one of said slide parts, a piston in each cylinder, a cross connection between said pistons moving one from the other and connected to said toggle connection to cause successive straightening and breaking movements thereof when the pistons are reciprocated, means for creating an explosion in one of said cylinders at a predetermined point in a work-shaping stroke of the slide and to impart a sudden straightening movement of said toggle connection to move said slide parts away from each other, said other piston acting during said toggle straightening movements to compress a bounce charge in its cylinder which then returns the pistons and toggle connection to normal positions, and means automatically operable to relieve the explosive pressure in the first cylinder when the pistons have moved a predetermined distance under the explosive action.

2. In a press of the class described, a die-carrying slide, said slide having upper and lower parts relatively movable in the plane of the slide movements, power means operable to impart predetermined successive inward work-shaping and outward retracting movements to that one of said slide parts on which said die is carried, toggle means connecting said upper and lower slide sections and operable when straightened to cause a predetermined relative separation of said slide parts, a cylinder carried by one section, a piston in said cylinder connected to said toggle means and movable by explosive action in the cylinder to cause a sudden start of the toggle means to move one slide part outward from the other, means operable at a predetermined point in the work-shaping stroke of the slide to introduce into said cylinder separate fuel constituents which when combined effect an explosion, and means operable at a predetermined point in a work-shaping cycle to return the toggle to broken position and the piston to initial position.

3. In a press of the class described, a die-carrying slide, said slide having an upper power section and a lower die-carrying section relatively movable in the plane of the slide movements, power means operable to impart predetermined successive inward work-shaping and outward retracting movements to said upper power slide section, toggle means connecting said slide sections and operable when straightened to cause a predetermined relative separation of the sections, a first power cylinder carried by one slide section, a piston in said cylinder connected to said toggle means and movable by explosive action in the cylinder to cause a sudden start of the toggle means to move one slide section outward from the other, means operable at a predetermined point in the work-shaping stroke of the slide to introduce into said cylinder separate fuel constituents which when combined effect an explosion, a second cylinder carried by one of said sections, a piston operating in said second cylinder and connected to said toggle means, said second piston being operable upon a straightening movement of the toggle means to compress a bounce fluid in its cylinder, and means to render said bounce fluid active to return the toggle means and the first piston to normal positions after a straightening operation of the toggle means.

4. In a press of the class described, a pair of opposing die-carrying members with one member slidable toward and away from the other, one of said members including at its work-shaping

side a section for carrying the die of such member and movable inward and outward relative to its carrying member in the plane of relative sliding movements of said members, toggle means connecting said section to its carrying member and being normally broken to hold the connected parts in retracted relation, power means for imparting predetermined inward and outward strokes to said slidable carrying member, a cylinder carried by said member, a piston in said cylinder normally at the inner end of its stroke in the cylinder, a connection between said piston and said toggle, means automatically operable at a predetermined point in a work-drawing cycle of the press to introduce into said cylinder separate fuel constituents which when combined effect an explosion to actuate the piston and said connection to straighten the toggle and force said section outward from its carrying member to assist in a drawing operation, and means automatically operable to return the toggle and piston to normal positions when the drawing operation is completed.

5. A combination as called for in claim 4, together with means operable at approximately the end of a toggle straightening movement of the first piston to relieve the pressure in its cylinder.

6. A combination as called for in claim 4, together with a relief valve in said first cylinder, and means connecting said toggle means and relief valve and automatically operable to open the relief valve when the toggle means reaches its straightened position.

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