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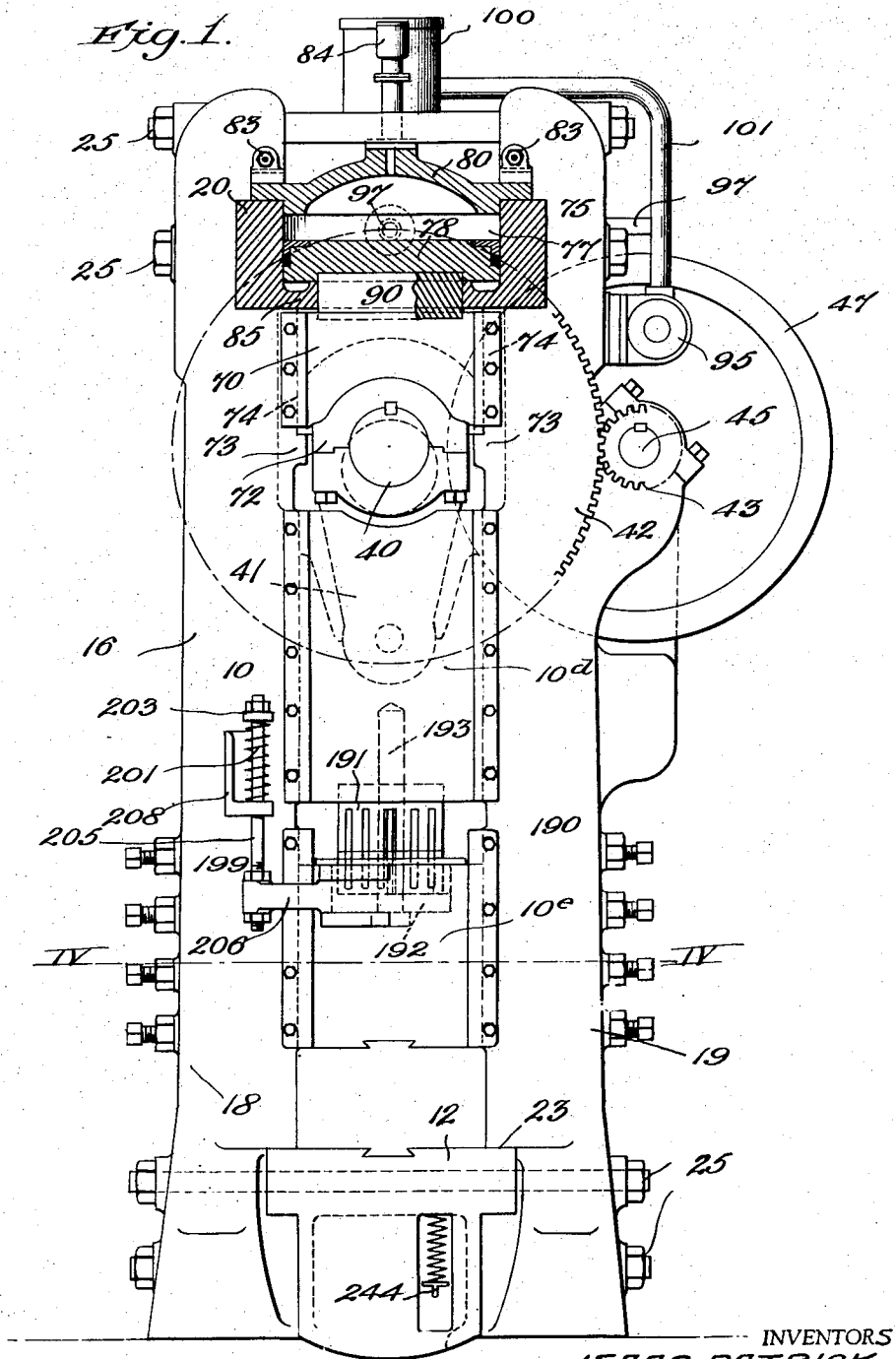
I. PATRICK ET AL

2,236,154

PRESS COMBINATION HAVING MEANS FOR AVOIDING JAMMING

Filed Aug. 6, 1937

4 Sheets-Sheet 1



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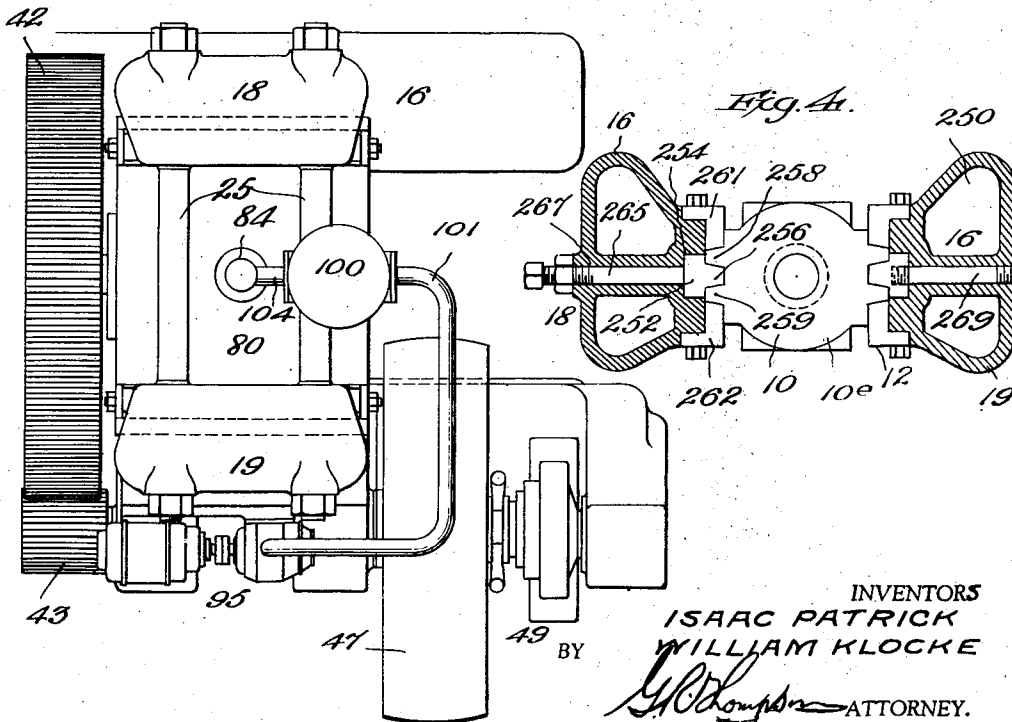
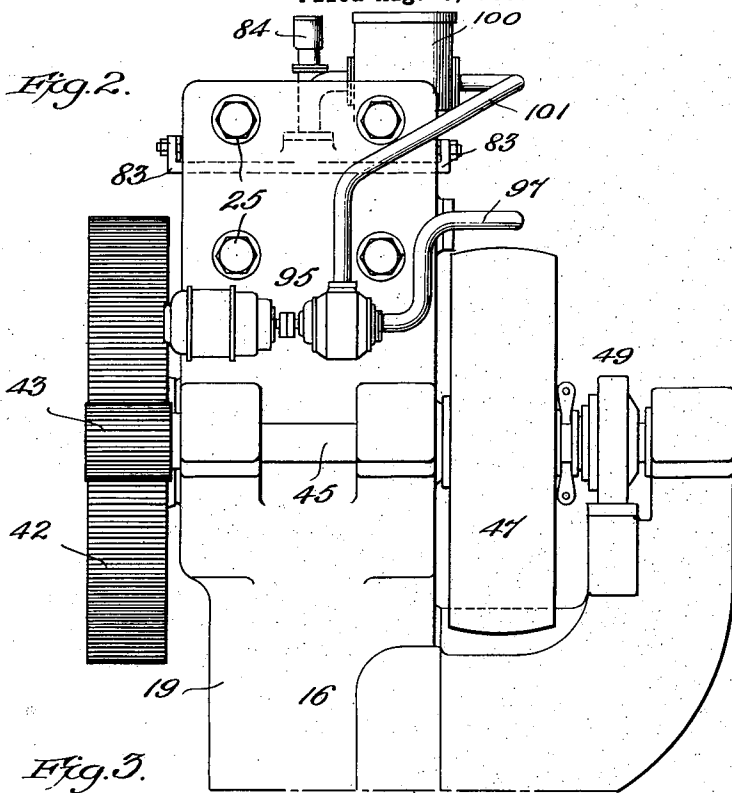
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PRESS COMBINATION HAVING MEANS FOR AVOIDING JAMMING

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4 Sheets-Sheet 2



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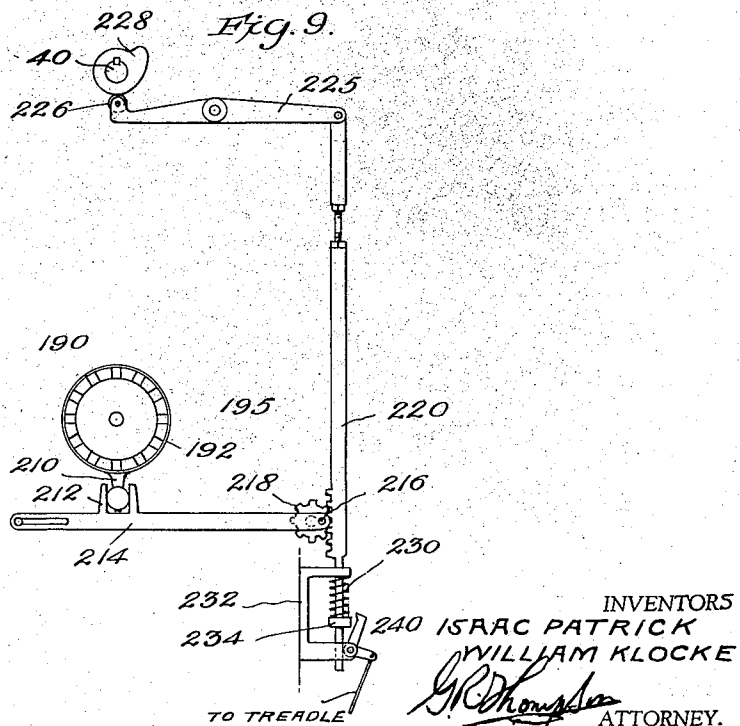
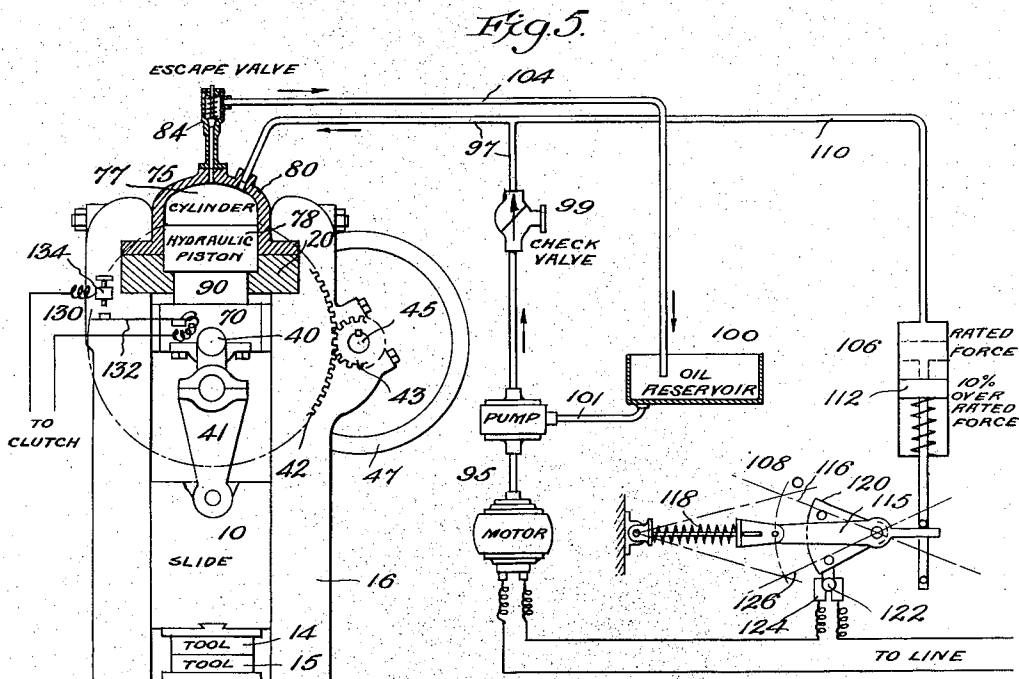
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PRESS COMBINATION HAVING MEANS FOR AVOIDING JAMMING

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4 Sheets-Sheet 3



UNITED STATES PATENT OFFICE

2,236,154

PRESS COMBINATION HAVING MEANS FOR
AVOIDING JAMMING

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Application August 6, 1937, Serial No. 157,666

11 Claims. (Cl. 78—39)

This invention relates to mechanical presses which include means for preventing jamming or breaking when the resistance encountered by the tool-carrying parts exceeds the rated working force of the press, and provides improvements therein.

To make sharply defined and accurate forgings and other shapes it is desirable to use a mechanical press in which the reciprocatory tool-carrying part has a definite stroke, such as in a crank-press. It is also desirable to maintain a great rigidity in the press upon the impact and application of the forming-tools or dies upon the bar or billet-metal to be shaped under the very large working forces usually employed. However, the greater the rigidity of the press, the greater is the likelihood of the press jamming (or even breaking), with the practical necessity in many instances of destroying the dies or cutting the connecting-rod in order to free the press. In either case production would suffer more or less delay depending on the availability of replacement parts, and the cost would be considerable, especially if expensive dies had to be destroyed. In types of presses other than forging presses the consequences of jamming are equally serious.

The present invention provides a press combination, including a hydraulic element, which avoids jamming or breaking of the press, and which, when the tools of the press encounter a resistance which in ordinary presses would cause jamming or breaking, allows the press to complete its cycle of operation without stopping, or the press-parts to be backed off after stopping. The stopping or not stopping is a matter of the nature of the obstruction and of the design of the press-combination. The invention further provides a press combination which is self-acting to restore the parts to normal operating position or condition after operating to avoid jamming.

There are many practical limitations to overcoming the problem which has been solved by the present invention, especially in presses designed to apply a large working force. Take, for instance, a press designed to deliver a working force of 1000 tons. When it is considered that a piston of 36 inches diameter and a hydraulic pressure of 2000 pounds to the square inch is required to sustain a force of 1000 tons, it will be seen that the incorporation of a hydraulic element capable of sustaining such a force presents a problem. While piston-area may be reduced by increasing the hydraulic

pressure, there is a practical limit to the increase of pressure, so that from the standpoint of either area or pressure, there is a problem of incorporating a hydraulic element in a press capable of sustaining a force of 1000 tons.

The present invention takes into account these limitations and provides a press combination incorporating a hydraulic element, which operates to avoid jamming, is self-acting to restore the parts to normal operating position after operating to avoid jamming, as heretofore stated, and in which the hydraulic element is of a size to be readily combined with other parts of a press, without increasing the size of the press-parts over that ordinarily required for the force to be delivered, and without exceeding practical hydraulic pressures.

The present invention furthermore makes provision for certain subtleties in respect to hydraulic means. Oil (a liquid) is commonly regarded as incompressible. But there is some air occluded in the oil and this is compressible. Moreover, cylinder heads and walls, even though massive, expand appreciably at pressures of 1000 tons to the square inch and upward. Unless provision be made for such subtleties, a hydraulic element would not serve satisfactorily in a press in which it is desired to support the forming-tools rigidly during the forming operation, to obtain a positive action of the tools throughout the full working stroke of the press. The present invention therefore includes means for pre-stressing the hydraulic element with a force equal to or in excess of the rated working force of the press. By pre-stressing the hydraulic means as herein described, much of the "spring" of the slide, or other part acting against the hydraulic element, is overcome when the working force is applied by the press, the cylinder walls are expanded to a degree beyond that which would occur when a working force within the rated working force of the press is applied, and the oil and the air occluded therein is compressed to a degree beyond that which would occur when a working force within the rated working force of the press is applied.

The invention further provides a press combination incorporating a hydraulic element for avoiding jamming, in which means for maintaining constantly the pre-stressed condition of the hydraulic element and for restoring oil vented or lost from the hydraulic element are readily and practically combined with the press, in which rigid connections between the hydraulic element and pressure-maintaining and make-up

means are provided, and in which the hydraulic element may be incorporated in the reciprocatory tool-carrying slide of the press and have such rigid connections with the pressure maintaining and make-up means.

The invention further provides a press having a frame of exceptional rigidity, which may be simply or readily formed of sectional parts, which frame is readily erected, and secure when erected and used.

The invention further provides novel and useful combinations of press elements hereinafter set forth and defined in the claims.

Two embodiments of the invention are illustrated in the accompanying drawings, wherein:

Fig. 1 is a front view, partly in section, of one embodiment;

Fig. 2 is a view in elevation looking at the right-hand side of the press shown in Fig. 1.

Fig. 3 is a top plan view;

Fig. 4 is a cross section on the line IV—IV, Fig. 1.

Fig. 5 is a diagrammatic view of the embodiment of the press combination shown in Figs. 1 to 4.

Fig. 6 is a front elevation of a second embodiment of the invention;

Fig. 7 is an enlarged view, in section of the tool-carrying slide shown in Fig. 6.

Fig. 8 is a diagrammatic view of the embodiment of the press-combination shown in Figs. 6 and 7.

Fig. 9 is a diagrammatic view illustrating a means for operating the gag-connection 190 shown in Fig. 1.

In both of said embodiments, the press shown is of the type used for forging; the invention however, is applicable to other types of presses.

Referring to said drawings, numerals 10 and 12 designate the tool-carrying parts of the press on which are mounted the forming-tools 14, 15.

In presses, one of the tool-carrying parts is usually a stationary bed located at the lower part of the press, and the other tool-carrying part is a slide which reciprocates toward and from the bed, but the positions of the bed and slide are sometimes reversed, the press is sometimes horizontal and sometimes inclined, and sometimes the bed is reciprocated as well as the slide. The embodiments of the presses illustrated are vertical presses having a stationary bed 12 and a reciprocatory slide 10. The strains produced by the tools during the forming operation, and transmitted to the tool-carrying parts 10 and 12, are sustained by a frame 16. The element which yields so as to avoid jamming may be located between two parts of the movable slide 10 (as illustrated in Fig. 6), or between the press frame 16, and any part of the press combination through which the strains produced by the tools during the forming operation, are transmitted to the frame. In Figs. 1 to 5, the yielding element is located between a block on which the crank shaft which drives the slide is mounted, and the frame of the press. For the sake of simplicity the description which follows will ordinarily refer to a vertical type of press with stationary bed and reciprocatory slide.

The press frame 16 may also have various forms usual in presses; in a forging press designed to shape the metal with great precision, it is advantageous to have a frame which is highly rigid. To this end, in the embodiment illustrated in Figs. 1 to 5, the frame 16 is formed of two cast-steel upright sections 18 and 19 and transverse-

sections 20, 21. The transverse-section 20 is at the top of the press and corresponds to the portion usually designated as the crown of the press. The transverse-section 21 is located at the base of the press and functions as the bed of the press. Suitable interlocking means 23 between the upright or longitudinal sections 18, 19 and the transverse-sections 20, 21 are provided, as the interlocking recesses and projections which are shown in the drawings. The four sections of the frame are securely fastened together by means of tie-rods and nuts 25 running transversely of the frame and through the upright sections 18, 19.

In Fig. 6, the press frame 16 is composed of cast iron side pieces 28, 29, crown 30 and bed 31, which are securely held together by extra strong tie-rods and nuts 33.

Any of the usual or suitable mechanical means for driving or reciprocating the slide 10 may be provided in both embodiments herein illustrated. The illustrated mechanical means for driving or reciprocating the slide is a gear driven crank-shaft.

Referring to the embodiment illustrated in Figs. 1 to 5 inclusive, the slide reciprocating means comprises a crank shaft 40 and connecting rod 41, the crank shaft 40 having a gear 42 thereon which meshes with a pinion gear on a back shaft 45, and which back shaft is driven by a fly-wheel pulley 47 directly, or through a clutch 49 as may be desired.

Referring to Figs. 6 to 8, the mechanical means for driving or reciprocating the slide 10 comprises a crank shaft 50 having gears 52, 53 thereon, which latter are driven by pinions 55, 56, on a back-shaft 59, which back-shaft may be driven by a fly-wheel pulley 61 through a clutch 63. 65 designates an auxiliary fly-wheel, and 66 a connecting rod between shaft 50 and slide 10.

Again referring to Figs. 1 to 5 inclusive, the crank shaft 40 is journaled on a block 70, as indicated at 72. The block 70 is mounted between guides 73 on the sides of the frame and is confined by gibs 74.

Numeral 75 designates a hydraulic element. The construction and operation of the hydraulic element 75 is such as to exert a force sufficiently great to sustain the normal forces (opposite to the hydraulic force) exerted by the driving means on the tool-carrying parts 10 and 12, and the tools thereon, in performing the normal work of the press. For example in a press having a rated working force of 1000 tons, the hydraulic means 75 constantly and immediately acts with a force of 1000 tons plus a safe overload in opposing motion of the block 70 (or equivalently functioning parts in other embodiments). As heretofore stated, the hydraulic element 75 is pre-stressed, or constantly stressed to a degree greater than the rated working force of the press.

Most of the "spring" of the cross-piece 20 or of the slide (Figs. 6-8) is overcome when the working force is applied by the press, the cylinder walls are expanded to a degree beyond that which would occur when a working force within the rated working force of the press is applied through the tools 14, 15, and the oil and the air occluded therein is constantly compressed to a degree beyond that which would occur when a working force within the rated working force of the press is applied. The rigidity of the press under working stresses is largely increased, which

contributes importantly to the formation of precise shapes by the tools.

The hydraulic element comprises a cylinder 77 and a piston 78. The sides of the cylinder 77 are conveniently formed as a part of the cross-piece 20 of the frame, and the pressure-end of the cylinder is tightly closed by a cover 80. The cylinder-cover 80 is rigidly supported by the side pieces 18, 19 of the frame, and securely pressed against the piece 20 in which the cylinder is formed, by means of wedges 83 which are forced into grooves in the side pieces 18, 19 above a flange on the cylinder cover 80.

Numeral 84 (in both embodiments) designates an escape-valve through which the hydraulic system is opened and liquid is vented from the hydraulic element 75, when the resistance to the tools 14, 15 exceeds the rated working force of the press, as described herein.

A mechanical means is provided for sustaining the action of the force of said hydraulic means 75 (piston 78) on the block 70 (or equivalently functioning part in other embodiments) in the normal position of the latter, so that said hydraulic means 75 cannot move said block 70, in its normal position, in the direction of the action of the hydraulic force on piston 78. In the embodiment under discussion (Figs. 1-5) expansion movement of the piston 78 under the stress of liquid in the cylinder 77 is limited by a strong flange 85 on the cross-piece 20 and the cylinder is held by the wedges 83 acting against the press-frame. The slidable block 70 and the piston 78 of the hydraulic element are in stress-communication through a disk or short pillar 90. Normally the slidable block 70 rests upon the bottom of the guides 73. The guides 73 are preferably formed parallel to a line tangential to the pitch-circles of the gear 42 and pinion 43 at their point of meeting. Arranged in this way, the crank shaft 40, when the block 70 yields or moves, as hereinafter more fully explained, moves virtually on a radius having its center in the axis of the pinion shaft 45. Moving thus, the meshing of the teeth of the gear 42 and pinion 43 on the pitch-circles is only very slightly affected, so little so that little if any additional strain between the gear 42 and pinion 43 during driving, is produced, and the gear and pinion are not forced apart even under the very large driving forces transmitted from the pinion to the gear.

There is an important advantage in locating the hydraulic element 75 in the frame above the crank-shaft 40 and the block on which it is journaled. Considering a forging press having a rated working force of 1000 tons, the hydraulic element 75 must be stressed with a force of at least one thousand tons in order to sustain the reactions from the forming tools within the rated working force of the press, so that the press will not yield during normal operations. It is desirable to keep the hydraulic pressure as low as feasible. It is also desirable to maintain a compact structure of the press. That is, it is desirable to design the press as closely as possible in conformity with the ordinary requirements for delivering the rated working force of the press. In such a case the hydraulic element 75 would require a piston of 36 inches in diameter and a hydraulic pressure of 2000 pounds to the square inch in order to sustain a force of 1000 tons. By locating the hydraulic element above the shaft, as in the embodiment illustrated in Figs. 1-5 inclusive, an advantageous location as regards area is obtained and the location is

especially favorable in a forging press, which places the hydraulic element 75 remotely from the scale which files from the metal being shaped under the impact of the dies.

The required pressure in the hydraulic element 75, as hereinbefore explained, is constantly maintained by suitable means above a determined minimum approximating the rated working force of the press. For example, referring to Fig. 5 the cylinder of the hydraulic element 75 may be in communication with the delivery end of an intermittently operated motor-driven pump 95 through pipe 97 and a check valve 99. The intake side of the pump may be in communication with an oil reservoir 100 through pipe 101. The oil reservoir may be a sump located on the frame of the press to which oil vented from the hydraulic element 75, as hereinafter explained, through the escape valve 84, is received. Numeral 104 designates a pipe leading from the escape valve 84 to the reservoir or sump 100. The motor-driven pump 95, (also the pressure responsive device 106, etc.) is advantageously mounted on the press-frame, as shown best in Figs. 2 and 3. In this way all the piping between the pump and the hydraulic element 75 may be rigid and the greatest safety obtained with the high pressures used.

In practical operation it is desirable to maintain a force on the piston 78 somewhat in excess of the rated working force of the press. Take for example, a design in which the force acting on the piston 78 is ten percent over the rated working force of the press. The action of the motor driven pump 95 and its accessories would be to force oil into the cylinder 77 until the pressure therein created a force on the piston 78 ten percent in excess of the rated working force of the press, and then stop. When the pressure within the cylinder 77 falls to a predetermined amount (through leakage or by venting through the escape valve 84) say to a pressure at which the force on the piston 78 approximates the rated working force of the press, the motor driven pump 95 would be started so as to pump oil into the cylinder 77 until the desired or designed pressure is again established in said cylinder 77, which pressure, in the example under discussion would be that at which the force on the piston 78 is ten percent over the working force of the press. Thereupon the motor driven pump would be stopped.

The starting and stopping of the motor driven pump 95 may be automatically accomplished by any suitable means. As shown in Fig. 5, said means comprises a pressure responsive device 106 and a switch 108. In Fig 5, the pressure responsive device 106 and the switch 108 are shown in a position in which they are just about to operate to stop the operation of the motor driven pump 95. The pressure responsive device 106 is in communication with the cylinder 77 through a pipe 110 branching from the pipe 97. The pressure in the device 106 is approaching the pressure which produces a force within the hydraulic element 75 ten percent over the rated working force of the press, and has forced the piston 112 to a corresponding position. A slight increase in pressure in the cylinder 77 and in the pressure responsive device 106 will throw the switch arm 115 to the position 116 where it will be held by the spring 118. The movement of the switch arm 115 carries with it the plate 120 having the bridging contact 122 thereon, which breaks the circuit

to the electric motor through the contacts 124. The motor driven pump 95 is then stopped.

When the piston 112 of the pressure responsive device 106 reaches the dotted line position, the switch arm 115 will be shifted to its opposite position indicated by the dotted line 126 and held in this position by the spring 118. In moving to the position indicated at 126, the switch arm 115 will shift the plate 120 carrying the bridging contact 122 to close the circuit to the electric motor through the contacts 124, and thereupon start the motor-driven pump 95, and the motor-driven pump 95 will continue to run and force oil into the cylinder 77 of the hydraulic element 75 until the pressure responsive device 106 operates to shift the switch arm 115 to the position indicated by the dotted line 116, whereupon the operation of the motor driven pump 95 is again stopped.

A suitable means 130 may be provided for stopping the operation of the press when the reaction to the working force of the press exceeds the rated working force of the press (plus such overload factor as may be incorporated in the design of the hydraulic element 75). As shown in Fig. 5 the means 130 may comprise an electric circuit leading to the clutch 49 having one contact 132 on the slidable block 70, and another 134, on the side piece 16 of the frame. When the block 70 moves, a circuit is completed through the contacts 132, and 134, and the clutch is disengaged to disconnect the crank shaft 40 from the driving pulley 47. The clutch 49 may be a fluid-operated clutch such as shown and described in U. S. Patent #2,023,597, December 10, 1935, and the valve controlling the clutch may have associated therewith a solenoid (not shown) for operating said clutch controlling valve in the manner described, when the circuit is completed through the contacts 132 and 134.

Referring again to the embodiments illustrated in Figs. 6 to 8 inclusive, the hydraulic element 75 is located in the slide 10. To this end the slide comprises two parts 10^a, 10^b. One of the forming dies, as a tool 14, is mounted on the slide part 10^b, which latter acts as a support for said forming tool 14. The hydraulic element 75 comprises a cylinder 140, the side walls and head of which are formed in the slide part 10^a. Numeral 142 indicates the piston of the hydraulic element, the outer end of which bears against the slide part 10^b which supports the tool 14.

Numeral 145 designates the means for sustaining the action of the force of said hydraulic means 75 (piston 142) on the slide part 10^b in the normal position of the latter, so that said hydraulic means 75 cannot move said slide part 10^b, in its normal position, in the direction of the action of the hydraulic force on piston 142. In the present embodiment, the means 145 may comprise strong bolts or tie-rods 147 which pass through flanges on the slide parts 10^a, 10^b, which tie-rods have nuts on their ends and sustain the full force of the hydraulic pressure acting between the cylinder head and piston 142. The tie-rods however, allow the slide part 10^b to move toward the slide part 10^a when the resistance offered by the metal being shaped by the tools 14, 15 offers a resistance in excess of the rated working force of the press.

The cylinder 140 of the hydraulic element is in communication with the escape valve 84 through a duct 150, which escape valve opens when the resistance offered by the tools 14, 15 exceeds the force exerted by the compressed liquid in the cylinder 40, venting liquid through

a duct 153, which vented liquid is advantageously received in a reservoir 155 on the slide part 10^a.

The mechanical means for maintaining the required pressure in the hydraulic element 75, in the embodiment under discussion, may comprise a variable delivery motor-driven pump 160, in which the volume of liquid delivered is governed by the pressure. There are a number of these variable delivery pumps on the market. The pump illustrated is a "Racine" pump manufactured by Racine Tool & Machine Co. of Racine, Wisconsin. The pump is in communication, on its compression side, with the cylinder 140 of the hydraulic element 75 through a pipe or duct 162, and on its intake side communicates with the reservoir 155 through a pipe or duct 164. 166 designates a pressure responsive device which is in communication with the cylinder 140 of the hydraulic element 75 through a pipe or conduit 168 which branches from the pipe or conduit 162. The pressure responsive device 166 comprises a piston 170 against one side of which a spring 172 acts. When the pressure in the cylinder 140 of the hydraulic element 75, and in the ducts from the compression side of the pump 160, increases, the piston 170 of the pressure responsive device 166 rises against the pressure of the spring 172. As the piston 170 rises, the axis of the barrel 175 of the pump approaches the axis of the rotor-drum 177. The pressure of the spring 172 may be set so as to control the movement of the piston 170 that the axis of the barrel 175 of the pump will coincide with the axis of the rotor-drum 177 when the pressure within the cylinder 140 of the pressure responsive device 175 reaches, or remains at, such a pressure as to produce a force within the hydraulic element 75 equal to the rated working force of the press, plus such excess as is determined or desired to maintain in the hydraulic element 75. The motor driven pump 160 therefore may be run constantly; when the pressure within the hydraulic element 75 is such as to produce the desired force, the pump ceases to deliver oil to the hydraulic element; and when the pressure of the liquid within the hydraulic element 75 falls, (by reason of leakage or by reason of opening of the escape valve 84 to vent liquid) the pump is immediately operative to deliver oil to the cylinder of the hydraulic device 75, which delivery continues until pressure within the hydraulic element 75 is such as to provide the desired or determined force. During the normal operation of the press, the hydraulic element 75 is always stressed with a force equal to the rated working force of the press plus such overload as that at which the hydraulic element 75 is designed to yield against the reactions on the tools 14 and 15.

A suitable means 130 may be provided for stopping the operation of the press when the hydraulic element 75 yields, as previously described. The means may be similar to that shown and described with reference to the embodiment illustrated in Figs. 1 to 5 inclusive and include an electrical circuit having a contact 180 on the slide part 10^a and another contact 181 on the slide part 10^b, which contacts are open in the normal position of the parts, and are closed when the hydraulic element 75 yields, whereupon the clutch 63 is operated to disengage the slide 10 from the driving means, as previously described in reference to Figs. 1 to 5 inclusive.

The motor driven pump 160 is advantageously mounted on the part 10^a of the slide 10, and

thereby the pipes connecting the pump and hydraulic element 75 be rigid.

In the embodiment illustrated in Figs. 1-5 inclusive, the slide 10 may comprise two parts, 10^d, 10^e, having between them a gag connection 190. The gag connection 190 comprises two castellated blocks 191, 192. One of the castellated blocks, as the castellated block 192 is rotatable with relation to the other, and the two slide parts 10^d and 10^e are connected by a bolt 193 long enough to allow the castellated blocks 191, 192 to abut end to end, as shown in Fig. 1. A means 195 is provided for turning the castellated part 192 a sufficient amount to bring the notches of the part 192 opposite the projections 197, of the part 191, so that the projections 197 may enter the said recesses, and the part 10^d of the slide reciprocate without moving the part 10^e of the slide, when it is desired to have the press skip one or more strokes without stopping the driving mechanism. The weight of the slide part 10^e may be counter-balanced in the upper position of the slide by suitable means 199, which as shown in Fig. 1, may comprise a spring 201 in position between a nut 203 on a rod 205 fastened to a bracket-arm 206 on the slide part 10^e, and a bracket 208 fixed on the press frame 16. At the back of the press there is a duplication (not shown) of the parts 201 to 208. The turning of the part 192 of the gag connection 190 is effected by suitable means, which may be as follows: The part 192 has an arm 210 thereon (Fig. 9) which is engaged by a fork 212 on a shift-bar 214. One end of the bar 214 may be pivoted to an eccentric pin 216 on a pinion 218 which engages a rack-bar 220. The rack-bar 220 is connected at one end to a pivoted lever 225, which latter lever has a roller 226 on the opposite end which engages a cam 228 on the crank shaft 40. The roller 226 is held against the cam 228 by a spring 230 acting between a bracket 232 on the press frame 16 and a shoulder 234 on the rack bar 220. A dog 240, connected to a treadle 244 is provided for engaging the shoulder 234 when the rack bar 220 is raised by the action of cam 228 on lever 225.

In the normal operation of the press, the part 192 of the gag connection 190 is turned at the upper portion of each stroke, to bring the recess of the castellated part 192 opposite the projections of the castellated part 191. Unless the treadle 244 is actuated, as soon as the roller 226 runs off of the high point of the cam 228 (which takes place in the upper part of the working stroke) the castellated part is turned back again to bring the projections of the two castellated portions 191, 192 into end to end abutment. When the tool on the slide part 10^e strikes the work, the force of the driving mechanism transmitted to the slide part 10^d is transmitted through the gag connection 190 to the slide part 10^e, and the said slide part 10^e is rigidly forced downward against the resistance offered against the tools 14 and 15 by the metal being shaped.

If, however, it is desired to have the slide skip one or more strokes, without stopping the running of the driving mechanism, the operator presses the treadle 244. When the high point of the cam 228 turns the lever 225 and lifts the rack-bar 220, the dog 240 turns to a position where it engages the underside of the shoulder 234. As the crank shaft 40 continues to turn, the rack bar 220 is held by the dog 240 in the position to which it was raised by the high point of the cam 228. In this position the castellated

part 192 is held in a position where the recesses thereof are opposite the projections of the castellated part 191, and as the slide part 10^d moves downward under the action of the crank 40 and connecting rod 41, the die part 10^e is held in its raised position by the counter-balancing means 199, the die part 10^d moving through a reciprocation without imparting corresponding movement to the slide part 10^e because the projections of the castellated part 191 slide idly in the recesses in the castellated part 192. Movement of the slide part 10^d with immobility of the die part 10^e continues until the treadle 244 is allowed to rise, as by removal of the operator's foot therefrom.

By the use of the gag-clutch, as previously described, in a forging press of the size and rated working force described (or on that order) important advantages are obtained. The inertia of the upper slide-part 10^d and of the driving parts and connections does not have to be overcome in stopping and starting the forging operation. These parts can run continuously. A forging-operation can be skipped merely by shifting the castellated part 192 to bring the projections thereon into line with the recesses in the part 191, as previously described. The mass of the counterbalanced slide part 10^e is the only addition to the masses already in motion, when the forging operation is resumed. By said means, the strain on the driving parts is much less than in the case where the starting and stopping is done through a clutch on the pulley shaft, the horsepower to drive the press may be reduced, and fast forging operations obtained. Fast operation is a prime factor in forging and is often necessary in order to strike a piece of metal before too much cooling has occurred.

To obtain exceptional accuracy of shape or size of a metal part shaped or formed between the tools of the press, means 250 are provided for guiding the slide 10 (or as in Fig. 1, the part 10^e of the slide) with extreme accuracy. The guiding means 250 are shown in Fig. 4. The guiding means 250 comprises blocks 252 which are fitted accurately into grooves 254 on each of the side frames 18, 19 and the press. Each of the blocks 252 is provided with a rib 256 having tapered sides which fits against the tapered sides of two pairs of ribs 258, 259 on the slide part 10^e. The outside faces of the ribs 258, 259 contact with the correspondingly tapered sides of two pairs of gibs 261, 262 fastened on the frame portions 18, 19. Threaded pins 265 are provided which engage threads 267 on the side pieces 18, 19 of the frame and pass through the said side pieces in the frame to abut against the backs of the blocks 252 which are provided with the ribs 256. By screwing the pins 265 inward the blocks 252 are pressed inward, and the pins 265 provide a means for obtaining an extremely close fit of the ribs 256 against the adjacent sides of the ribs 258, 259. Other pins 269, threaded into the blocks 252, with nuts at the outer ends, serve to hold the blocks 252 firmly against the ends of the pins 265. Adjustment of gibs 261, 262 provides a means of obtaining an extremely close fit between the gibs and the outer sides of the ribs 258, 259.

Résumé of operation

If and when the tools 14, 15, on the tool-carrying parts 10 and 12 meet a resistance exceeding the rated working force of the press applied by the driving mechanism (as for example when a

billet or bar which is acted on by the tools is cooled to such an extent that the resistance offered by the metal being shaped, to the continued movement of the slide 10 becomes so great that in a press, without means for preventing jamming, the driving mechanism would exert such a force on the stalled tools as to either jam the press, or to break the bed or crown, the slidable block 70, Figs. 1 to 5 inclusive, acting through the disk 90 and piston 78, or, the slide part 10^b Figs. 6 to 8 inclusive acting through the piston 142, increases the pressure of the liquid in the cylinder of the hydraulic element 75, which increase of pressure within the hydraulic element 75 opens the escape valve 84, thereby opening the hydraulic system to vent liquid through the escape valve, and allows the block 70, or the slide part 10^b to yield. In this way the driving mechanism may continue to run even though the tools 14 and 15 are stalled. The movement of the slidable block 70 Figs. 1 to 5, or of the slide part 10^b, Figs. 6 to 8, in the manner aforesaid, may be sufficient to enable the crank 40 Figs. 1 to 5, or the crank 50, Figs. 6 to 8, to pass through the dead center, thereby avoiding jamming or breaking of the press. The design of the hydraulic element 75 may be such as to only allow such a limited amount of movement of the block 70 or slide part 10^b as to make it desirable to stop the press before the dead center position of the crank 40 or crank 50 is reached. Accordingly, after the block 70 has risen a predetermined amount, or the slide part 10^a has moved a predetermined amount with relation to the slide part 10^b, the clutch 49, Figs. 1 to 5 or clutch 63, Figs. 6 to 8 may be operated to disengage the slide reciprocating parts from the driving means through contacts 132, 134, Figs. 1-5, or 180, 181 Figs. 6 to 8, in the manner previously described. Thereafter the direction of the rotation of the crank shaft may be reversed, the tools 14, 15 backed off from the obstruction, and the obstruction removed.

After the crank 40, Figs. 1 to 5, or crank 50, Figs. 6 to 8 has either passed through its dead-center position, or been backed-off from its dead center position, following an obstruction to the movement of the tools 14, 15 as heretofore explained, the hydraulic element 75 is automatically restored to a stressed condition wherein the force exerted or immediately exorable thereby equals the rated working force of the press plus such excess as may be determined. In the embodiment Figs. 1 to 5 this is accomplished through the motor driven pump 95, pressure-responsive device 106 and switch 108 in the manner previously described. That is, with the pressure in the hydraulic element 75 developing a force equal to the rated working force of the press plus say a ten percent overload, the piston 112 of the pressure responsive device 106 has shifted the switch arm 115 of the plate 120 to the position shown by the dotted lines 116, in which position the circuit to the motor driven pump 95 is open through the contacts 122, 124. When the pressure in the hydraulic device 75 falls a predetermined amount, either through venting of liquid through the escape valve 84, or through leakage, the piston 112 of the pressure responsive device will move a predetermined amount (see dotted line position, Fig. 5), and when it has moved this predetermined amount the switch arm 115 will be moved against the action of the spring 118 to the position shown by the dotted line 126, the switch arm 115 moving the plate 120, and the bridging contact 122 thereon with it so as to

complete the circuit to the motor driven pump 95 through the contacts 122, 124. The motor driven pump will continue to operate until a pressure is restored in the hydraulic element 75 which produces a predetermined force in the said hydraulic element 75 as heretofore stated, at which time the pressure responsive device 106 operates to break the circuit to the motor driven pump 95 in the manner already described.

In the embodiment, Figs. 6 to 8 inclusive the parts are restored to normal operating position, following the venting of liquid through the escape valve 84, by the following means. As heretofore stated, the motor driven pump 160 runs continuously. When liquid is vented through the escape valve 84 (or when liquid is lost from the hydraulic element 75 through leakage) the pressure drops, and this drop of pressure also occurs in the pressure responsive device 166. The spring 172 thereupon moves the piston 170, and the movement of the piston 170 moves the barrel 175 of the pump so that its axis is eccentric to the axis of the rotor-drum 177 to a greater or less degree depending on the drop of pressure in the hydraulic element 75. When the axis of the barrel 175 becomes eccentric to the axis of the rotor drum 177, the pump begins to force liquid into the cylinder of the hydraulic element 75, and continues to force liquid into the cylinder of the hydraulic element 75 until a pressure is built up therein which produces a force equal to the rated working force of the press, plus a determined overload, at which time the increased pressure operating on the pressure responsive device 166 moves the piston 170 against the spring 172 to a position where the axis of the barrel 175 of pump 160 becomes concentric with the axis of the rotor-drum 177, at which time delivery of liquid to the hydraulic element 75 by the pump 160 ceases. The pump then continues to run without delivering liquid to the hydraulic element 75, being ready at anytime upon a fall of pressure in the hydraulic element 75 to resume delivery of fluid thereto.

The press embodiment shown in Figs. 1-5 and 9, may be operated to skip one or more strokes, without stopping the driving mechanism, through the means and by the operation hereinbefore described, which means include the treadle 244 and gag connection 190.

The invention may receive other embodiments than those herein specifically illustrated and described.

What is claimed is:

1. A press comprising a frame, tool-carrying parts, one a reciprocating slide, mechanical means for reciprocating said slide, and means for preventing the jamming or breaking of the press when the resistance encountered by the tool-carrying parts approximates the rated working force of the press, said means comprising a hydraulic element arranged to sustain the working force applied by said reciprocating means, means for normally maintaining said hydraulic element under a minimum stress approximating the rated working force of the press so that the press normally operates with the rigidity of its frame, including mechanical means for connecting and holding the parts of said hydraulic element so that they cannot be moved apart by hydraulic force therein, and means opening said hydraulic system to vent at reduced pressure liquid from said hydraulic element when the resistance encountered by the tool-carrying parts and transmitted to said hydraulic element approximates

the rated working force of the press and the force under which said hydraulic element is stressed.

2. A press comprising a frame, tool-carrying
5 parts, one a reciprocating slide, mechanical means for reciprocating said slide, and means for preventing the jamming or breaking of the press when the resistance encountered by the tool-carrying parts approximates the rated working
10 force of the press, said means comprising a hydraulic element arranged to sustain the working force applied by said reciprocating means, means for normally maintaining said hydraulic element under a minimum stress approximating
15 the rated working force of the press so that the press normally operates with the rigidity of its frame, including mechanical means for connecting and holding the parts of said hydraulic element so that they cannot be moved apart by hydraulic force therein, and means opening said hydraulic system to vent at reduced pressure liquid
20 from said hydraulic element when the resistance encountered by the tool-carrying parts and transmitted to said hydraulic element approximates the rated working force of the press and
25 the force under which said hydraulic element is stressed, and a motor-driven make-up pump for replenishing liquid incidently lost or vented from said hydraulic element.

3. A press according to claim 1, wherein said hydraulic element is positioned between parts of said slide.

4. A press according to claim 2, wherein said hydraulic element is positioned between parts of
35 said slide, and said make-up pump is mounted on said slide.

5. A press according to claim 1, wherein said slide reciprocating means further comprises a crank-shaft, and further comprising a slidable
40 block carrying said crankshaft, said hydraulic element being positioned between said slidable-block and the press-frame.

6. A press according to claim 1, wherein said reciprocating means further comprises a crank-shaft, a driving gear thereon and a driving pinion,
45 and further comprising a slidable block carrying said crank-shaft and driving gear, said hydraulic element being positioned between said slidable-block and the press-frame, and said pinion being mounted on said frame and meshing
50 with said driving-pinion in a line joining the centers of the gear and pinion which is perpendicular to the direction in which said block slides when said hydraulic element yields.

7. A press according to claim 2, further comprising a hydrostat responsive to pressure within said hydraulic element and means operated by said hydrostat for starting and stopping said motor at differences of pressure corresponding to
5 the rated working force of the press and a predetermined surplus.

8. A press according to claim 2, wherein said make-up pump is of the variable-delivery type, with zero delivery at a pressure within said hydraulic element which stresses the latter with a force approximating the rated working force of the press.

9. A press according to claim 1, wherein said frame comprises side-pieces and transverse-
15 pieces adjacent the ends of said side-pieces, interlocking joints between said side pieces and transverse pieces, and tie-rods passing through said side-pieces and holding said transverse-pieces and side-pieces interlocked, said hydraulic
20 element having its cylinder formed in one of said transverse-pieces.

10. A press according to claim 1, wherein said slide reciprocating means further comprises a crank-shaft, and further comprising a slidable
25 block carrying said crankshaft, and wherein said frame comprises side pieces and transverse-pieces adjacent the ends of said side pieces, interlocking joints between said side pieces and transverse pieces, and tie-rods passing through
30 said side pieces and holding said transverse-pieces and side pieces interlocked, said hydraulic element being positioned between said slidable block and one of said transverse-pieces of the frame.

11. A press comprising a frame, tool-carrying parts, one a reciprocating slide, means for reciprocating said slide, and a hydraulic element situated in the line of strain between one of the tool-carrying parts and the press frame, mechanical means for connecting and holding the parts of the hydraulic element so that they cannot be moved apart by hydraulic force therein,
40 and means for prestressing said hydraulic element at a pressure which imparts to said hydraulic element a force on the order of the rated working force of the press, and means for opening said hydraulic system to vent at reduced pressure liquid from said hydraulic element when the resistance encountered by the tool-carrying parts
50 exceeds the rated working force of the press.

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