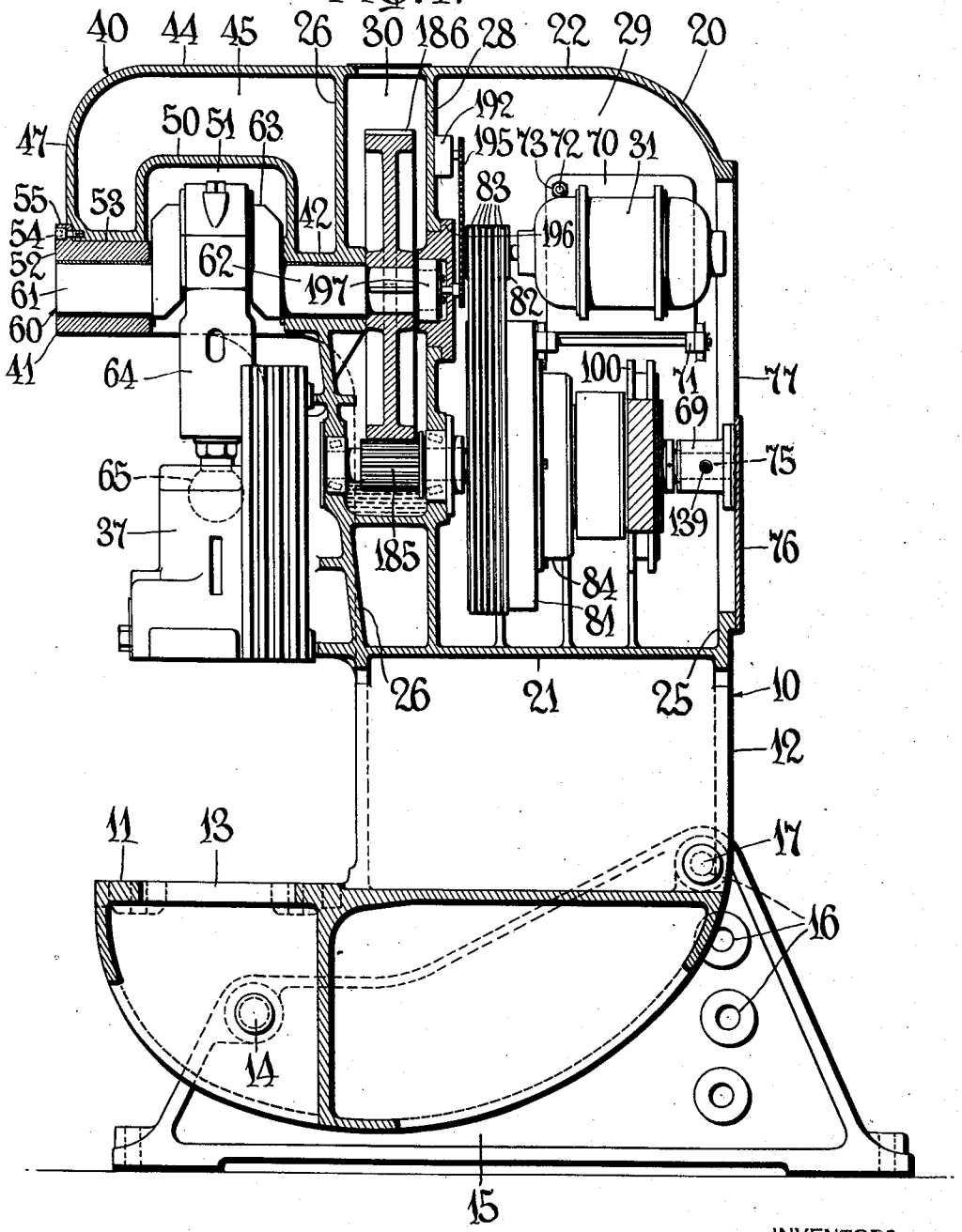
Sept. 3, 1940. G. E. MUNSCHAUER ET AL 2,213,450

PUNCH PRESS

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Fig. 1.



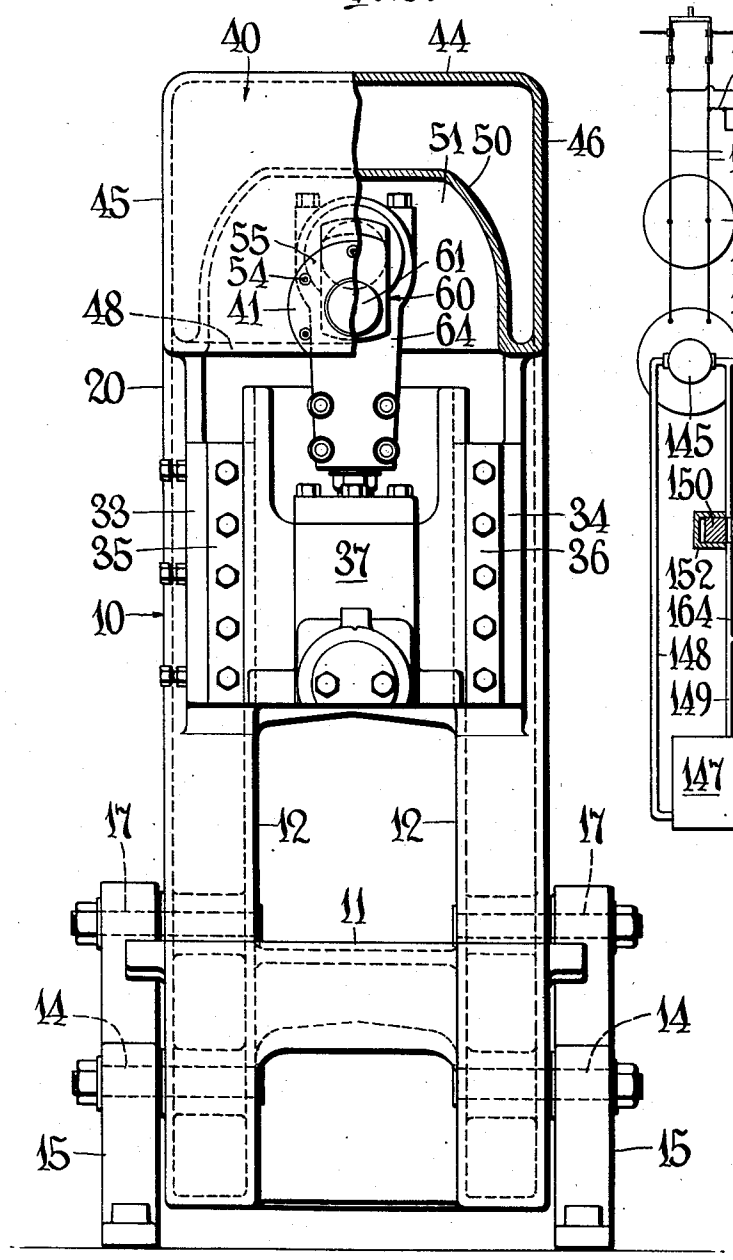
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Fig. 2.



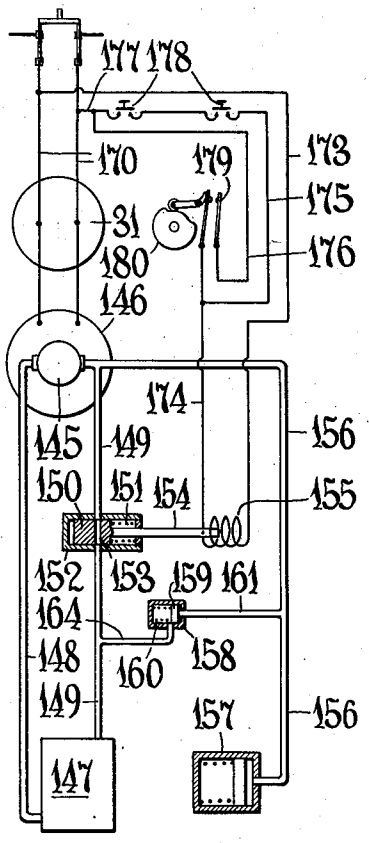


Fig. 4.

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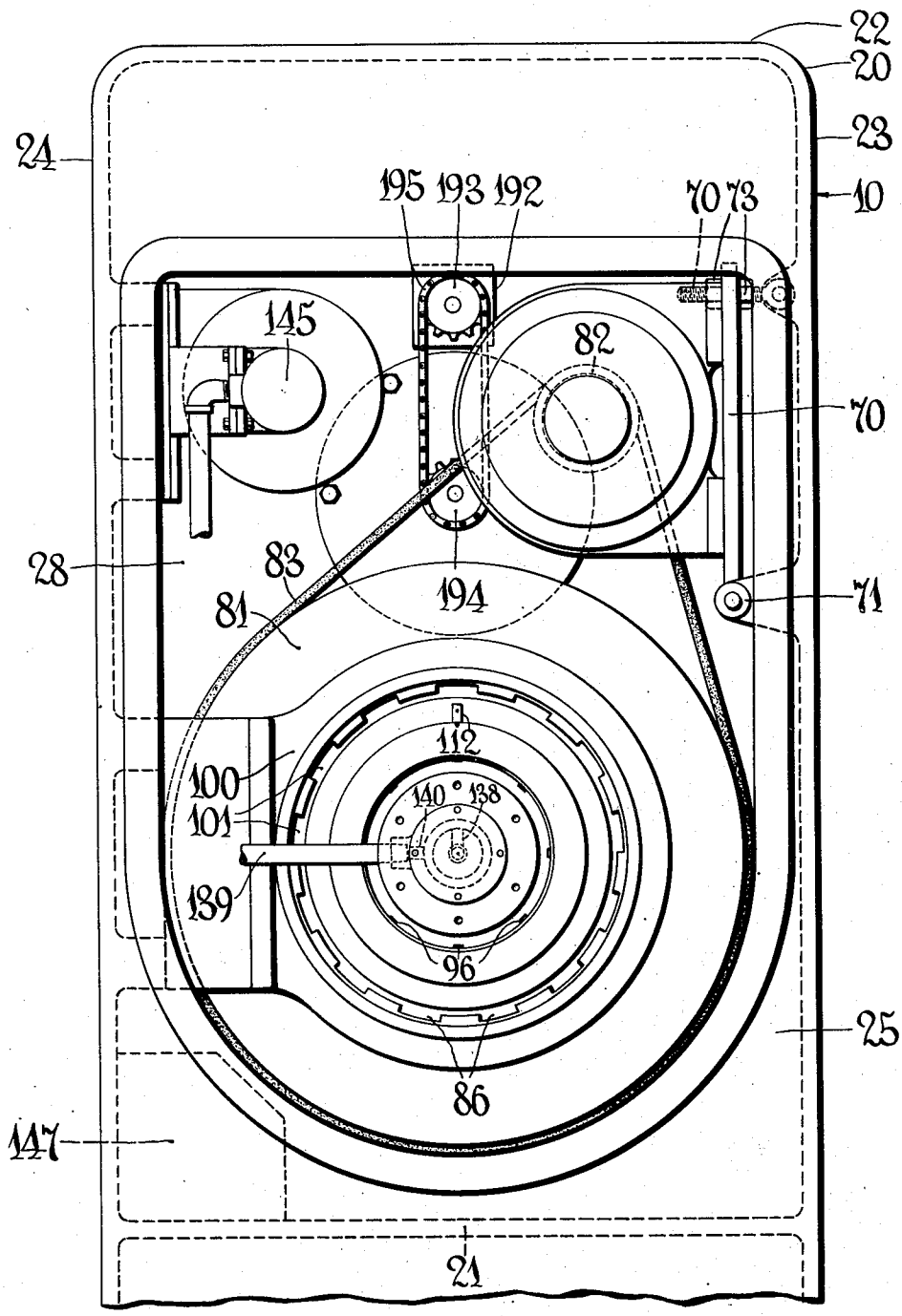


FIG. 3.

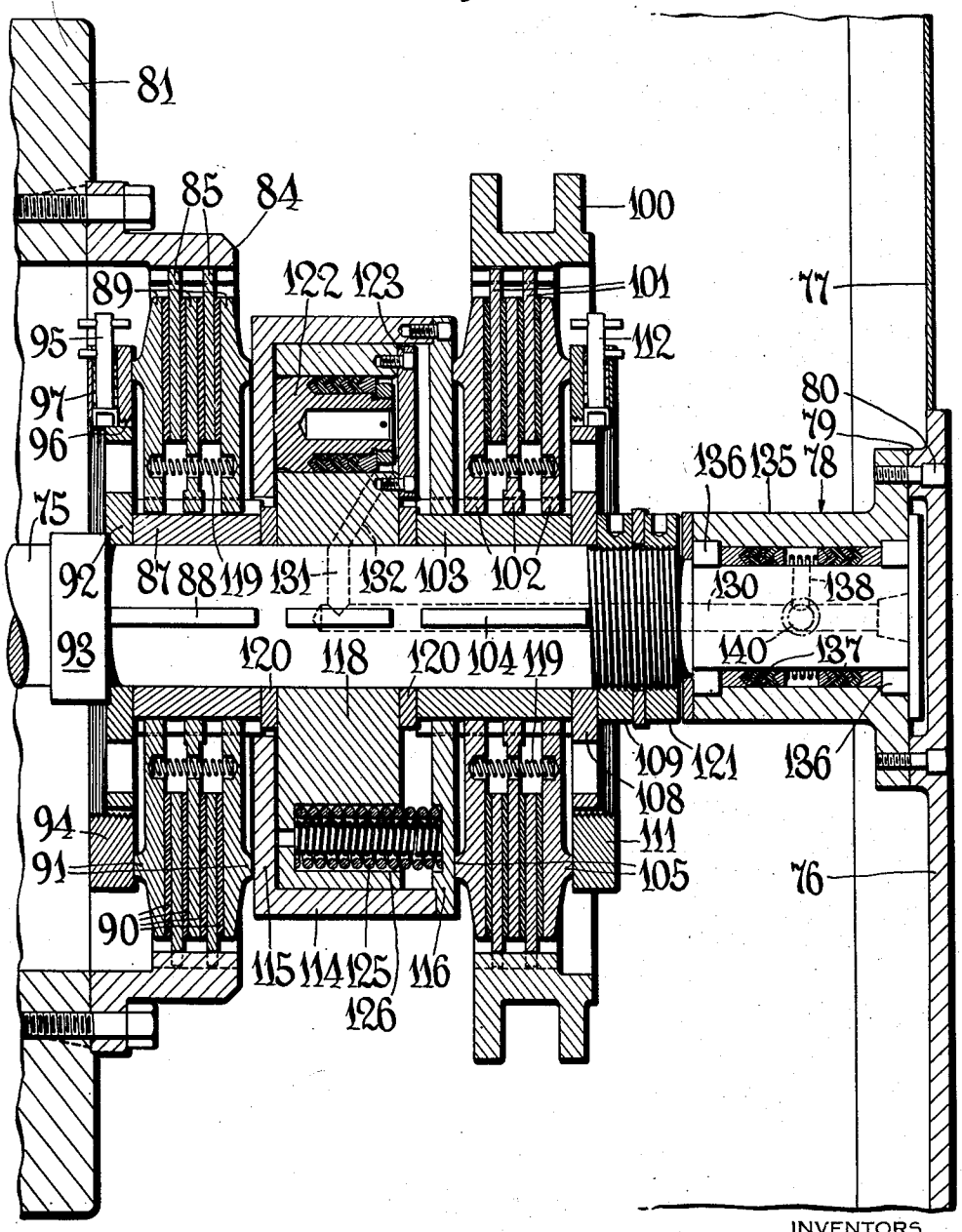
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FIG. 5.



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2,213,450

UNITED STATES PATENT OFFICE

2,213,450

PUNCH PRESS

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Application October 30, 1939, Serial No. 301,964

22 Claims. (Cl. 164—86)

This invention relates to punching and stamping machines and has particular reference to machines of the class commonly called punch presses.

While the art with which the present invention deals is comparatively old and one in which activity has been continuous and, in fact, on an ever widening front, there has been relatively little fundamental change in the construction of presses themselves, speaking especially from the structural aspect and also with reference to the general arrangement of the operating instrumentalities of punch presses. What development has ensued has been directed chiefly to improvements in the specific construction and operation of individual elements and working units of machines of this class without substantial alteration of their cooperation or arrangement with respect to each other.

In presses of the general class into which the machine of the present invention falls, the major portion of the structural frame work of the press comprises an integral element, usually of cast iron or steel. The press of our invention has an element which corresponds in its primary function to the press frame of the prior art but in the press frame of our invention the component parts are so arranged and presented as to greatly increase the strength of the composite element and the potential stresses which may safely and efficiently be applied without undue deflection of the various stress members.

In other words, in our new punch press, the stress elements of the frame member are so shaped and arranged that the available resisting moments at all cross sections which are stressed during operation of the press are very much higher than has heretofore been the case with presses of comparable size, weight and die capacity. This signal advantage is in part attributable to the new arrangement and conformation of stress elements as such and in part to the novel arrangement of the transmission agencies between the driving motor and the reciprocating slide of the press, which novel arrangement permits a more advantageous disposition of the stress elements. In fact, it is difficult to state to which of the two factors named, the foregoing advantages of strength should be chiefly credited.

Referring to the novel arrangement of the transmission means, including the crank shaft and its connection with the slide, such arrangement affects potential strength of the frame structure in two ways. First, it permits the novel arrangement and shape of the stress elements themselves to be such as to afford the maximum internal resisting moment for given cross sectional areas; and second, it results in the external forces, which act against the stress elements and are engendered in the operation of the machine, being directed against the frame member in such manner as to minimize their resultant bending and twisting moments.

Another advantage resulting from the construction of the present invention is the very important one of increased safety of operation owing to the almost complete elimination of exposed moving parts. Further, in constructing punch presses in accordance with the teachings of the present invention, the frames of the presses have substantially uniform metal thicknesses throughout, with the result that the danger of internal strains, which occur when relatively heavy and slowly cooling sections are combined with light and rapidly cooling sections in the same casting, is virtually abolished.

The provision of a punch press possessing the foregoing attributes and one which is inherently compact, without sacrificing anything material in the way of facility of assembly and manufacture, are among the important objects of the present invention. In the machine of the present invention, a slide is caused to reciprocate by the rotation of a crank shaft which is connected to the slide by a connecting member or pitman. The crank shaft is arranged to be selectively rotated, preferably by means of an individual electric driving motor which is housed within and supported by the frame work of the machine.

The transmission and driving instrumentalities which are necessarily employed in transmitting rotative movement to the crank shaft and in accurately controlling and directing such rotative movements, both as to speed and duration, are, in the case of the present invention, arranged in a wholly novel manner and so that the deflections attending the loads and shocks to which the various structural and transmission elements are subjected are very much less than in presently known and used constructions.

Further, in the utilization of the principles of the present invention, a press of given capacity as to both die space and strength may be constructed so as to require less operating space than heretofore.

In the accompanying drawings, wherein an exemplary form of the machine of the present invention is illustrated:

Fig. 1 is a vertical cross sectional view taken

approximately on the center line of the machine and in a plane extending from the front to the rear thereof;

Fig. 2 is a front elevational view with portions of the upper part of the frame of the machine broken away;

Fig. 3 is a fragmentary rear view of the upper portion of the machine on a larger scale than Figs. 1 and 2;

Fig. 4 is a diagrammatic illustrtaion of suitable control mechanism for the machine; and

Fig. 5 is an enlarged fragmentary cross sectional view of one form of clutch and brake mechanism for the machine viewed as in Fig. 1.

In the illustrated embodiment we have shown a punch press of the inclinable type. While the principles of the present invention are susceptible of adaptation in punch presses of other types, the peculiar problems presented in the design and construction of inclinable presses, owing to the necessity for bodily moving and adjusting a large part of the framework of the press and the working parts carried thereby, frequently and during normal operation of the press, makes the present invention an even more valuable one when applied to the design and construction of inclinable presses.

For purposes of illustration of the principles of the present invention a specific punch press embodying those principles has been shown in the accompanying drawings and is described in detail herein but it is to be understood that nothing in this specification or in the drawings is to be taken as limiting the scope of application of the invention save as it is defined in the appended claims. In the drawings, like characters of reference denote like parts and the numeral **10** designates generally the principal structural element of the punch press.

The element so designated, which we shall refer to as the frame, preferably comprises a unitary iron or steel casting having a flat bed portion **11** upon which a die is adapted to be supported and secured, either directly or, as is more usual, with an intervening bolster plate. Upright structural members are arranged upon or adjacent the bed **11** for supporting the press superstructure including the various instrumentalities which cooperate to provide a relatively movable slide for supporting and actuating the upper movable element of a die for working metal or other materials. In the illustrated embodiment the upright structural members comprise a pair of columns **12** of hollow rectangular cross section, the columns rising from the opposite rear corners of the bed **11** and being spaced from each other to permit work pieces or scrap to pass rearwardly from a die secured to the bed of the press.

The columns **12** may terminate at their lower extremities in portions which curve forwardly and come up beneath the bed and merge therewith as may be seen from an inspection of Figs. 1 and 2 of the drawings. The front walls of the hollow rectangular columns substantially meet the back edge of the die-receiving portion of the bed of the press and the back walls curve downwardly and forwardly and then forwardly and upwardly to terminate substantially at the front edge of the bed of the press. The portions of the column **12** which are disposed beneath the bed **11** of the press are spaced from each other in substantially the same manner as the upright portions so that the portion of the bed **11** which extends between such column portions may be provided with a suitable opening, as at **13**, for the passage of blanks, scrap or work pieces or for the reception of spring pads, pressure plates or other die accessories. Maintaining lateral alignment of the upper and lower portions of each column also avoids twisting moments on the columns themselves and limits the stresses on the columns to those due to flexure alone.

The lower portions of the columns **12** are provided with axially aligned bearings for the reception of fulcrum or pivot shafts **14** which are supported at their outer ends in bearings provided in a pair of base members **15**. The base members **15** are each provided, preferably rearwardly of the fulcrum or pivot shaft **14**, with a plurality of openings **16** spaced along a common arc struck from the center of the pivot shaft **14**. The columns **12** are provided with axially aligned openings which are spaced from the pivot shaft **14** the same radial distance as the openings **16** whereby a pair of locking pins **17** may be passed through the openings in the columns **12** and any aligned pair of the openings **16** to secure the frame **10** of the press in either a vertical or a selected inclined position.

The press illustrated is so proportioned that in its more inclined positions the lowermost portion of the frame **10** projects below the floor line and to permit full inclination a pit is formed in the floor or foundation between the base members **15** in erecting the press.

At their upper ends the pair of columns **12** merge into and support a substantially rectangular or box-like housing portion **20** which is provided with suitable means for supporting and housing the driving and controlling instrumentalities for the crank shaft of the machine and which serves structurally as a continuation of the columns **12**. In the illustrated form the outer confines of the box-like housing portion coincide substantially with the outer confines of the pair of columns **12** and form in effect an upper continuation of the columns **12** but without the space which exists between the columns below the housing portion **20**. This relative conformation of the columns and the housing portion is preferred because of various considerations having to do with the structural efficiency of the machine and, as in the case of the association of the lower portions of the columns **12** with the bed **11**, the relative proportioning and disposition of the housing **20** and the columns **12** avoids inefficient and harmful combinations of the stresses resulting from the forces applied to these elements.

The housing portion **20** has as its components a bottom wall **21**, a top wall **22**, two side walls **23** and **24**, a rear wall **25**, and a front wall **26**, see Fig. 3. The side walls **23** and **24** and the front wall **26** extend substantially continuously from the bottom wall **21** to the top wall **22** but the rear wall **25** comprises, preferably, little more than a framing portion for receiving suitable removable closure devices whereby access may be had to the interior of the housing **20**.

A vertically extending partition **28** divides the interior of the housing **20** into compartments **29** and **30**, the former of which will usually be larger than the latter and is adapted to receive and house an electric driving motor **31** and suitable clutch and brake mechanism which will be hereinafter described in greater detail. The other compartment, **30**, houses gearing which will also be more fully described hereinafter. A signal advantage is derived from the provision of the two compartments **29** and **30** in that the compartment **30** may contain a plentiful supply of lubricant for

the gearing therein without such lubricant interfering in any way with the operation of the electric motor, the clutch and brake mechanism, and other means disposed in the compartment 29.

The front wall 26 of the housing 20 is provided on its outer or front face, and usually adjacent the lower portion thereof, with a pair of integrally formed and laterally spaced projections 33 and 34 for receiving a pair of adjustably and removably associated gibs 35 and 36 which are adapted to retain and guide a slide member or ram 37 for vertical reciprocation against the front of the housing 20. The slide member 37 is provided with suitable means for securely engaging the upper or movable element of a die. The adjustable and removable gib construction and the details of the slide are conventional and well known and since they do not directly and specifically form a part of the present invention, their details will not be further particularized herein.

Adjacent the upper portion of the outer or front face of the front wall 26 of the frame 10 there is an integrally formed projecting portion 40 which provides a pair of spaced coaxial bearings 41 and 42 whose axes extend from front to rear of the punch press. The rear bearing 42 may in fact be said to be supported jointly in the front wall 26 of the housing 20 and in a portion of the projection 40.

The projection 40 comprises a hollow casing having a top wall 44, side walls 45 and 46, a front wall 47, and a bottom wall 48. The rear wall of the hollow casing which comprises the projection 40 is identical with the upper portion of the front wall 26 of the housing 20. The bottom wall 48 of the projection 40 is provided with an upwardly directed approximately central formation 50 which provides a recess 51 in such bottom wall adapted to receive and provide clearance for the crank portion of a crank shaft. The walls of the upward formation 50 are spaced at all points from the interior of the top, side, front and rear walls which form the outer casing of the projection 40 so that, with reference to upward bending moments directed against the projection, considered as a cantilever beam supported upon the housing portion 22, spaced but rigidly constrained tension and compression members are provided.

The spacing of these wall portions and also the spacing of the corresponding wall portions of the casing portion 20 and the columns 12 is so proportioned throughout as to afford substantially uniform strength. While the breadth of the entire frame is substantially uniform throughout, the depth of the cross sections, considered as beams, bears an approximate proportion to the magnitude of the moment of the external forces as such moments are increased at points more remote from the point of application of the force.

While the various portions of the frame have been shown as substantially closed hollow box sections, it will be clear that suitable provision must be made for supporting and removing cores in the course of casting the frame. This is preferably accomplished by locating core prints at points which coincide with relatively little stressed portions of the frame structure, such portions lying close to the neutral fibre of the frame, considering the various cross sections thereof as beam sections. The holes left by the core prints may, after removal of the cores, be permanently closed by welding plates in or over the openings, which would be the case in the press illustrated in the drawings, or the holes may be closed by removable plates or even left open. In any event the disposition of the holes is such as not to materially lessen the strength of the frame.

Adjacent the bottom of the projection 40 and at opposite sides of the recess 51, front and rear, are the bearings 41 and 42 respectively, previously referred to. It will be noted from an inspection of Fig. 1 that each of the bearings 41 and 42 is of substantial length and is supported and directly backed at each of its ends by either an inner or an outer wall portion of the projection 40. It will be further noted that each such backing wall portion extends directly vertically to the point where it merges with one of the spaced top wall portions and the rigidity and efficiency of this arrangement will be apparent.

The front bearing 41 includes a cylindrical bearing block 52 which is removably associated with the lower forward portion of the projection 40. This end may be accomplished by providing an arcuate or circular opening or recess 53 in the projection 40. The cylindrical bearing block may conveniently be held against accidental removal by screws 54 which pass through an annular flange 55 formed on the cylindrical bearing block and engage in the projection 40. This construction of the front bearing 41 permits ready removal or assembly of the bearing block 52 in the process of erecting or dismantling a punch press.

A crank shaft 60 for effecting reciprocation of the slide 37 has journal portions 61 and 62 which are supported in the bearings 41 and 42 respectively and intermediate such journal portions the crank shaft is provided with a crank 63, the crank pin of which engages rotatably with one end of a connecting member or pitman 64. The other end of the connecting member 64 is engaged with the slide 37 by means of a ball and socket joint designated generally 65 and which permits the connecting member 64 to incline freely with respect to the slide 37 as the opposite end of the connecting member is caused to revolve with the crank pin.

The details of the connecting member and of its connection with the crank 63 and the slide 37 respectively are not new excepting in that the plane of rotation of the crank 63 is at right angles to the plane of rotation of cranks as conventionally found in machines of the kind under consideration and consequently the axis of the crank shaft runs from front to rear of the machine generally and of the slide in particular.

Referring now to the means for rotating the crank shaft 60 and for controlling its rotation, special attention is directed to Fig. 1 where the electric driving motor 31 is shown disposed in the housing 20 with its rotor shaft extending in a direction parallel to the extent of the crank shaft 60. In the present instance, the motor is mounted against the inner face of the side wall 23 and if desired the mounting of the motor may be such as to permit bodily adjustment of the motor to effect adjustment of the tension in a driving belt or chain associated therewith.

Such an arrangement is shown in Fig. 3 where a plate 70, to which the motor 31 is secured, is hinged to the wall 23 as at 71. The edge of the plate 70 which is opposite the hinged mounting 71 is movable toward and away from the wall 23 to alter the radial disposition of the motor shaft and adjusted position thereof is secured by means of a screw 72 which is pivotally anchored to the wall 23 and projects

through an opening in the plate 70 where it is secured by means of opposed adjusting nuts 73.

Also disposed in the housing 20 is a countershaft 75 which is journaled in the front wall 26 of the housing, in the partition 28, and also in an element which forms a part of the closure for the rear wall 25. For smooth, accurate and frictionless operation tapered roller bearings are provided in the front wall 26 and the partition 28 for the reception of the journal portions of the countershaft 75.

Referring to the end of the shaft 75 which it has been stated is journaled in the closure means associated with the rear wall 25, attention is directed chiefly to Figs. 1 and 5. The opening in the rear wall 25 which has been hereinbefore described is provided with a composite closure comprising a lower member 76 of relatively rigid construction and an upper member 77 which need not be of such rigid construction since its only function is to close the upper portion of the opening. The lower member 76 is arranged to support a bearing for the end of the shaft 75 and, referring to Fig. 5, such bearing is shown at 78 as being secured to a boss 79 formed on the closure member 76 by means of screws 80. The bearing 78 performs the further function of providing distributing means for a hydraulic system in a manner which will hereinafter appear.

The countershaft 75 is provided for the purpose of transmitting rotary motion from the motor 31 to the crank shaft 60 and, more particularly, for rendering ready and effective the accurate control of such transmission of motion. The countershaft 75 serves further to support a flywheel 81, the function of which in a machine of the class under consideration is so well known as not to require mention. The flywheel is rotatably mounted upon the countershaft 75 and is in alignment with a pulley 82 which is fixed to the shaft of the motor 31 for driving engagement therewith through the medium of a plurality of belts 83.

To the side of the flywheel 81 there is rigidly secured an annular clutch element 84 which is internally splined for driving engagement with a pair of driving clutch discs 85 as appears at 86 in Fig. 3. A cooperating clutch element in the form of an externally splined collar 87 is fixed to the countershaft 75 as by the key 88 which appears in Fig. 5 and a plurality of driven clutch discs 89, in the present instance three, are internally splined for driving engagement with the collar 87. It will be noted that the driving and driven clutch discs 85 and 89, respectively, are alternately arranged in a conventional manner and if desired friction discs 90, secured to either the driving or the driven clutch discs, may be interposed.

The end discs in the series so formed, in the present instance the two outer discs 89, are preferably provided with annular projections 91 which provide thrust faces for applying an axial compressive force against the series of clutch discs to establish driving engagement between the flywheel 81 and the countershaft 75. On one side, the left hand side as seen in Fig. 5, the series of clutch discs is provided with a relatively rigid abutment which comprises a collar or disc 92 which is disposed upon the countershaft 75 against a shoulder which is formed by an enlargement 93 of the countershaft 75. The collar 92 is externally threaded for engagement with an internally threaded collar or disc 94 which bears directly against the annular projection 91 of the left hand clutch disc 89. Adjustment of the abutment so formed is afforded by reason of the screw thread engagement between the collars 92 and 94 and adjusted position thereof is maintained by a pin 95 which enters one of a number of circumferentially spaced notches 96 disposed about the periphery of the collar 92. The pin 95 is carried in an opening in the collar 94 and is adapted to be manually withdrawn from engagement with a notch 96 against the resistance of a coil spring 97 which is disposed thereabout when it is desired to adjust the position of the abutment formed by the collars 92 and 94.

Before describing the means for acting upon the other end of the series of clutch discs to establish driving engagement between the flywheel 81 and the countershaft 75 reference will be had to a somewhat similarly arranged and cooperating brake assembly for preventing rotary movement of the countershaft 75 whenever the clutch mechanism just described is in a disengaged state. The brake mechanism comprises a rigid annular ring 100 which may conveniently be formed as an integral part of the frame 10 of the press. The ring 100 has an internally splined opening which corresponds in function to the internally splined opening of the clutch element 84 and likewise provides locking engagement with a pair of externally splined brake discs 101. Disposed alternately between the discs 101 are internally splined brake discs 102 which engage an externally splined collar 103 which is secured to the countershaft as by the key 104.

As in the case of the clutch mechanism, the end clutch discs 102 are provided with outwardly directed annular projections 105 which provide thrust faces for engagement by means which clamp across the series of brake discs to frictionally lock the countershaft 75 to the rigidly stationary frame portion 100 and thereby prevent rotary movement of the countershaft when such clamping means are operative. In the present embodiment abutment means, which are relatively stationary with respect to the countershaft 75, are provided for engagement with the series of discs at one side of the discs. Such abutment means are similar in construction to the abutment means which are associated with the clutch discs 85 and 89 and are preferably disposed at the right hand side of the series of brake discs as viewed in Fig. 5, that is, on the side of the brake discs which is remote from the clutch mechanism previously described.

The abutment for the brake discs comprises a collar 108 which is disposed upon the countershaft 75 against a securing collar 109 which is threaded to the shaft. The collar 108 is externally threaded to receive an internally threaded collar 111 which bears directly against the annular projection 105 of the right hand brake disc 102. Adjustment of the abutment is effected as in the case of the clutch mechanism, by means of the screw thread engagement between the collars 108 and 111 and adjustment is maintained in a similar manner by means of a yieldably releasable pin 112 which may be engaged with any one of a series of notches provided about the periphery of the inner collar 108.

The clutch mechanism and the brake mechanism are spaced along the countershaft 75 to permit the interposition of clutch and brake operating means and in the present instance such means are combined in a single movable member, preferably in the form of a cylinder or drum 114 having closed ends 115 and 116. The drum

114 is disposed about a circular member 118 whose periphery bears against the inner peripheral wall of the drum 114 and the member 118 is fixed to the countershaft 75 whereby the drum 114 is positioned for axial sliding movement along the countershaft 75 and between the clutch and brake mechanism.

The drum 114 is also fixed for rotation with the countershaft 75 by reason of the fact that the axial opening in the end member 116 thereof is formed to engage the splined periphery of the collar 103, although the drum 114 is arranged to have free axial movement with respect to the collars 87 and 103. Axial movement of the drum 114 is limited in both directions by abutment of the ends 115 and 116 of the drum with the inwardly directed annular projections 91 and 105 of the clutch and brake mechanism respectively.

The axial dimension of the drum and the distance between the inner annular projections 91 and 105 of the clutch and brake mechanism are so proportioned that relatively little movement of the drum brings it from a position where the end wall 115 is disposed against the projection 91 of the clutch mechanism to a position where the end wall 116 is disposed against the projection 105 of the brake mechanism and in these opposite positions the clutch and brake mechanisms are respectively rendered operative.

The movement of the drum 114 from one of its extreme positions to another is quickly and forcibly effected and, by means which will presently be described, the drum serves to bear against either the discs of the clutch mechanism or the discs of the brake mechanism in such manner as to press the discs against their associated abutment and cause the shaft to be frictionally locked to the flywheel 81 or the stationary ring 100 as the case may be.

Owing to the shortness and the rapidity of the movement of the drum 114 it might be said that as a practical matter the disengagement of either the clutch or the brake is accompanied by a simultaneous engagement of the other. In order that frictional engagement between the several discs of either the clutch or brake mechanism may be broken quickly upon movement of the drum 114 to disengaging position, coil springs 119 are provided for engaging the inner sides of the opposite end discs to spread the discs when pressure is removed from them.

Means for causing the drum 114 to be moved as indicated above and for causing pressure to be exerted thereagainst sufficient to maintain driving and braking engagement of the clutch and brake discs respectively for predetermined periods of time will now be described. It may be noted first, however, that the circular member 118 is securely held against axial movement upon the countershaft 75. This may be accomplished by providing collars 120 which occupy the entire space between the circular member 118 and the collars 87 and 103. It will be noted that the outer ends of the collars 87 and 103 abut the collars 92 and 108 respectively and that when the threaded collar 109 is tightened on the shaft 75 the entire series of collars, together with the circular member 118, is clamped firmly between the enlargement 93 of the shaft 75 and the threaded collar 109. A locking collar 121 for the collar 109 may be employed.

By reason of this arrangement of the several collars all axial forces which result from operation of the clutch and brake mechanisms are balanced out within the combined mechanism and there is no resultant thrust of the countershaft 75 against the faces of its bearings in the frame of the machine. All of the reactions engendered by the thrust of the clutching and braking actions take the form of direct axial stress in the portion of the countershaft 75 which lies between the enlargement 93 and the collar 109.

The circular member 118 has spaced thereabout a plurality of cylindrical openings for the reception of pistons 122. While the number of openings may be varied to suit requirements, the form of clutch and brake mechanism illustrated in the accompanying drawings contemplates the provision of three such openings spaced equidistant from each other and at the same distance from the axis of the member 118. The openings extend parallel to the axis of the countershaft 75 and they are all closed at one end as by the cap 123 shown in Fig. 5 to provide fluid chambers between the closed ends of the opening and the ends of the associated pistons 122.

The opposite ends of the several pistons 122 are adapted, when fluid pressure is introduced into the fluid chambers referred to, to bear against the interior of the end closure member 115 of the drum 114. Resilient means are provided for normally urging the drum 114 toward the brake mechanism and such means are conveniently found in springs 125 which are disposed in openings 126 formed in the circular member 118, the openings being preferably of the same number as the pistons 122 and spaced about the member 118 in staggered relation with respect to the pistons 122.

The outer ends of the springs 125 bear against the inner wall of the end closure member 116 of the drum 114 and since the circular member 118 is fixed against axial movement with respect to the shaft 75 the tendency of the springs is to urge the drum to the right as seen in Fig. 5, with the end closure portion 116 thereof against the projecting annular portion 105 of the inner brake disc 102. The pressure of the springs 125 normally produces sufficient force to brake the drive shaft and to frictionally lock it in a stopped position. When this is the case the left hand clutch discs 89 and 90 are spread apart by the springs 119 and rotary movement of the flywheel is not transmitted to the countershaft 75 by the clutch mechanism.

For operating the press when desired, means are provided for exerting a predetermined fluid pressure in the fluid chambers of the circular member 118 and this pressure is sufficient to overcome the combined resilient urge of the springs 125 and consequently the pistons move to the left in their chambers as seen in Fig. 5. The left hand ends of the pistons bear against the inner wall of the end closure member 115 of the drum 114 and move the drum into position where the member 115 of the drum acts against the series of clutch discs 85 and 89 to produce frictional clutching action and consequent driving connection between the flywheel 81 and the countershaft 75.

For introducing fluid into the fluid chambers mentioned above the countershaft 75 is provided with an axial bore 130 and passages 131 radiating therefrom. The radiating passages 131 have continuations 132 formed in the circular member 118, one set of passages 131, 132 leading to each of the cylindrical openings in the circular

member adjacent the right hand end thereof as viewed in Fig. 5.

Means for connecting the axial bore 130 with a source of fluid pressure are associated with the bearing 78 for the countershaft and in the preferred form the bearing 78 includes a hollow cylindrical member 135 having anti-friction bearings 136, which may be of the tapered roller bearing type, mounted in its opposite ends and disposed about the countershaft in such manner as to leave an annular space defined by the exterior of the countershaft 75, the interior of the cylindrical member 135, and the anti-friction bearings 136. The space so defined is provided at each end, that is, against each of the bearings 136, with suitable packing as indicated at 137 in Fig. 5. Intermediate the packing the countershaft has a radial bore 138 extending between the axial bore 130 and the remaining space about the countershaft 75 between the packings 137.

A fluid conduit 139 leads to the cylindrical member 135, see Fig. 3, and a passage 140 is formed in the cylindrical member to communicate between the conduit 139 and the space inside the cylindrical member. It will be clear from the foregoing that the conduit 139 is in constant and free fluid communication with the fluid chambers adjacent the pistons 122 in the circular member 118 through the passage 140, the radial passage 138, the axial bore 130, and the passages 131 and 132.

We turn now to a description of the combined manual and automatic means for controlling the flow of fluid to the clutch and brake operating mechanism. Fig. 4 is a schematic view showing the electrical circuits and fluid conduits which cooperate to effect such control and the numeral 145 designates a fluid pump which may be provided with an individual electrical driving motor 146. The pump 145 and the motor 146 therefor appear in their assembled positions in Fig. 3.

Suitable fluid circuits are associated with the pump 145 so that the pump and motor may operate continuously when the press is in use, electrically controlled by-pass valves being provided for rendering the fluid pressure generated by the pump operative to engage the clutch mechanism or inoperative, in which case the spring means 125 engage the brake mechanism. When the press is in use but not executing a punching stroke, that is, when the driving motor for the press is rotating but the clutch mechanism is not engaged, the pump 145 withdraws fluid from a reservoir 147 through a conduit 148 and returns the fluid so withdrawn directly to the reservoir through the conduit 149, this being the path of least resistance to fluid flow.

A valve 150 is interposed in the conduit 149 and a spring 151, which is confined in a valve casing 152 with the valve 150, normally retains the valve in the position illustrated in Fig. 4 whereby fluid in the conduit 149 may flow freely through the passage 153 in the valve 150. An armature or core 154 is connected to the valve 150 and an electro-magnet or solenoid 155 is arranged so that energization of the windings thereof attracts the core 154 and moves the valve into a position where it prevents direct flow of fluid in the conduit 149. When direct flow of fluid back to the reservoir is prevented in this manner the fluid from the output side of the pump 145 flows in a branch conduit 156 which leads directly to the fluid chambers of the clutch and brake operating mechanism. That is to say, it connects with the conduit 139, previously described in connection with the construction of the countershaft bearing 78. The fluid chambers of the circular member 118 are represented by the schematic element 157 of Fig. 4.

A pressure relief device is shown at 158 in Fig. 4 and this device may comprise a chamber having a floating piston 159 normally urged to a predetermined position by a spring 160. A conduit 161 extends from an intermediate point along the conduit 156 to the chamber of the device 158. When the pressure in the working chambers of the clutch and brake mechanism, shown at 157 in Fig. 4, exceeds a predetermined amount the piston 159 of the device 158 is moved, against the resistance of the spring 160, to a position where it uncovers a port 163 and the port 163 has connection with the conduit 149 by means of a conduit 164.

It will be clear from the foregoing that when the electro-magnet 155 is energized passage of fluid through the conduit 149 is prevented and that consequently the continuing operation of the pump 145 builds up pressure in the conduit 156 and the fluid chambers 157 of the clutch operating mechanism until such pressure reaches a predetermined degree whereupon further increase in pressure is prevented by by-passage of fluid from the conduit 156 to the reservoir 147 through the conduit 161, the device 158, the conduit 164, and the conduit 149.

When the electro-magnet 155 is de-energized the spring 151 moves the valve 150 to its illustrated position whereupon flow through the conduit 149 is re-established. The output of the pump 145 is then returned directly to the reservoir 147 and, further, the action of the spring elements 125 of the clutch operating mechanism causes the drum 114 to be moved to the right as seen in Fig. 5 with the result that the fluid in the working chambers referred to as 157, in the schematic showing of Fig. 4, is expressed therefrom and returned to the reservoir through the conduits 156 (138) and 149.

Suitable electrical circuits are provided for energizing the electro-magnet 155 and such circuits are arranged for operation by a combination of manual and automatic means. It is desired that operation of the press be manually initiated and that operation thereof continue until the manual operating pressure or force is released, with the qualification that after the manual operating force is released it is desired that the press, if a certain portion of a stroke has been executed, continue the ensuing stroke and stop only when it reaches the end of a complete stroke, usually with the slide of the press in its uppermost position.

The energy for activating the electro-magnet may be derived, as in the present instance, from the circuit which activates the motor 146 of the pump 145. Such circuit is shown at 170 and is controlled by a switch 171. Actually, the circuit 170 will usually be combined with the circuit for the main driving motor 31 of the machine in such manner that manipulation of a single switch closes and opens the circuits of both of the motors 31 and 146 and such arrangement is schemataically indicated in Fig. 4 where the main driving motor of the machine is designated 31.

One of the terminals of the electro-magnet 155 is connected directly to one side of the main circuit 170 by a conductor 173 and the other side of the electro-magnet has a conductor 174 which diverges into conductors 175 and 176 which extend in shunt relation to each other, then again

converge as at 177 and connect with the other side of the main circuit 170. One of the shunt circuits 175 is provided with spaced manually operable push-button switches 178. The push buttons of the switches 178 are arranged at the front of the press and in such manner that an operator, in having one hand on each of the push buttons, cannot have either hand in a position where it is likely to be injured. The switches 178 are of a type which is in circuit closing position only as long as the push button is held depressed by the operator, removal of manual pressure from the push button resulting immediately in the opening of the circuit controlled thereby.

The shunt circuit 176 which extends about the push-button switches 178 is provided with a rotary limit switch having normally spaced contacts 179 and a circuit-closing cam 180. The cam 180 is rotated at the same speed as the crank shaft of the press and, after a cycle of operation of the press has been begun by depression of the push buttons of the switches 178 by the operator, and after such operation has proceeded for a predetermined portion of its cycle, the cam has rotated to a point where the raised portion thereof closes the switch by moving one of the spaced contacts 179 against the other. After this point has been reached the operator may release the push buttons of the switches 178 since the electro-magnetic circuit will remain closed through the shunt circuit 175. When the end of an operating cycle is reached the cam, which travels at the same angular speed as the crank shaft, reaches a position where it releases the contact 179 which resiliently opens the circuit 176 and results, as will be apparent from the foregoing, in substantially simultaneously disconnecting the clutch mechanism and setting the brake mechanism.

The portion of the countershaft 75 which extends through the chamber 30 has fixed thereto a pinion 185 for engagement with a gear 186 which is fixed to the crank shaft 60. An opening is also provided at the top of the chamber 30 to permit introduction of the gear 186 and a suitable cover 190 may be provided therefor.

The casing of the rotary limit switch which includes the contacts 179 and the cam 180 for controlling the contacts is shown in outline at 192 in Figs. 1 and 3. A sprocket 193 is provided on the shaft of the limit switch which controls the movements of the cam 180 which is disposed within the casing 192. A corresponding sprocket 194 is provided upon a reduced extension of the crank shaft which extends through the partition 28 into the chamber portion 29 and a chain 195 connects the sprockets. To facilitate assembly the partition 28 is provided with a removable plate 196 which is adapted to receive and provide bearing for the crank shaft 60 at its rear end. An anti-friction bearing 197 is preferably disposed between the journal portion of the crank shaft 60 at this point and the shaft supporting portion of the removable plate 196. By this construction it will be noted that the crank shaft has substantial bearing support directly on each side of the crank portion thereof and also directly on each side of the drive-gear-supporting portion thereof.

We claim:

1. In a punch press, a frame member comprising a substantially rectangular casing portion having front, side and top walls, a reciprocable slide and means at the outside of the front wall of said casing portion for supporting and guiding the same, a crank shaft for reciprocating said slide, said frame member having a die-receiving bed disposed below said slide and spaced from said casing portion and connecting means extending between said casing portion and said bed, said frame member also having a forward extension at its front wall above said slide supporting and guiding means and comprising side, top and bottom walls, the top and side walls of said extension forming forward extensions of the top and side walls of said casing portion and the bottom wall of said extension being formed to receive and provide bearings for said crank shaft, said last mentioned top and bottom walls cooperating to provide spaced stress-receiving structural elements.

2. In a punch press, a frame member comprising a substantially rectangular casing portion having front, rear and side walls, a reciprocable slide and means at the outside of the front wall of said casing portion for supporting and guiding the same, said frame member having a die-receiving bed disposed below said slide and a forward extension at its front wall and above said slide, a bearing element provided at the forward portion of said extension and an aligned coaxial bearing element in the front wall of said casing portion, a crank shaft journaled in said bearings and having a crank therebetween for connection with said slide to actuate the latter, transmission means in said casing portion for actuating said crank shaft, said crank shaft extending through said front wall to the interior of said casing portion for engagement with said transmission means.

3. In a punch press, a frame member comprising a hollow substantially rectangular casing portion, a reciprocable slide and means at the outside of the front wall of said casing portion for supporting and guiding the same, said frame member having a die-receiving bed disposed below said slide and a forward extension at its front wall and above said slide, a bearing element provided at the forward portion of said extension and an aligned coaxial bearing element spaced rearwardly of the first bearing element, a crank shaft journaled in said bearings and having a crank therebetween for connection with said slide to reciprocate the latter, transmission means in said casing portion for actuating said crank shaft, said crank shaft having a rear portion extending through said front wall to the interior of said casing portion for engagement with said transmission means.

4. In a punch press, a frame member comprising a substantially rectangular casing portion having front, side and top walls, a reciprocable slide and means at the outside of the front wall of said casing portion for supporting and guiding the same, said frame member having a die-receiving bed disposed below said slide and a forward extension at its front wall and above said slide, said forward extension comprising side, top and bottom walls with said side and top walls forming forward extensions of the side and top walls of said casing portion, a bearing element associated with the bottom wall of said forward extension adjacent the forward portion thereof and a second bearing element spaced rearwardly of said first bearing element and in axial alignment therewith, a crank shaft journaled in said bearing elements and having a crank therebetween, and transmission means housed in said

casing portion for actuating said crank shaft, said crank shaft extending through said front wall into said casing portion for engagement with said transmission means.

5. In a punch press, a frame member comprising a substantially rectangular casing portion having front, side and top walls, a reciprocable slide and means at the outside of the front wall of said casing portion for supporting and guiding the same, a crank shaft for reciprocating said slide, said frame member having a die-receiving bed below said slide and spaced from said casing portion and connecting means extending between said casing portion and said bed, said connecting means including a pair of spaced vertically extending column portions of hollow substantially rectangular cross section, each of said column portions being disposed with its outer side wall forming substantially a downward continuation of a side wall of said casing portion, said frame member also having a forward extension at its front wall above said slide supporting and guiding means and comprising side, top and bottom walls, the top and side walls of said extension forming forward continuations of the top and side walls of said casing portion and the bottom wall of said extension being formed to receive and provide bearings for said crank shaft.

6. In a punch press, a frame member comprising a substantially rectangular casing portion having front, side and top walls, a reciprocable slide and means at the outside of the front wall of said casing portion for supporting and guiding the same, a crank shaft for reciprocating said slide, said frame member having a die-receiving bed disposed below said slide, said frame member also having a forward extension at its front wall above said slide supporting and guiding means and comprising a hollow substantially rectangular element having spaced top and bottom walls and spaced side walls, said bottom wall being formed to receive and support said crank shaft.

7. In a punch press, a frame member comprising a substantially rectangular casing portion having front, side and top walls, a reciprocable slide and means at the outside of the front wall of said casing portion for supporting and guiding the same, and a crank shaft for reciprocating said slide, said frame member having a die-receiving bed disposed below said slide, said frame member also having a forward extension at its front wall above said slide supporting and guiding means and comprising a hollow substantially rectangular element having spaced top and bottom walls and spaced side walls, said bottom wall being formed to receive and support said crank shaft and the top and side walls of said forward extension being arranged to form substantially forward continuations of the top and side walls respectively of said casing portion.

8. In a punch press, a frame member comprising a main frame portion, a reciprocable slide and means at the front of said main frame portion for supporting and guiding the slide, and a crank shaft having a crank for reciprocating said slide, said frame member having a die-receiving bed disposed below said slide, said main frame portion having a forward extension at its front side above said slide supporting and guiding means and comprising a hollow substantially rectangular element having spaced top and bottom walls and spaced side walls, a recess in said bottom wall for receiving and housing the crank portion of said crank shaft, a bearing disposed at the forward portion of said bottom wall and adjacent said recess and a second bearing coaxial therewith and disposed at the rear portion of said bottom wall adjacent said recess and adjacent the main frame portion, said crank shaft being adapted to be journaled in said bearings.

9. In a punch press, a frame member comprising a casing portion, a slide and means at the front of said casing portion for supporting and guiding said slide, said frame member having a die-receiving bed disposed below said slide and a forward projection at the front of the casing portion of said frame member and above said slide, a crank shaft journaled in said forward projection with a portion thereof extending rearwardly into the interior of said casing portion, a countershaft journaled within said casing portion with its axis extending parallel to the axis of the crank shaft and drive means engaging between said crank shaft and said countershaft, means for imparting rotary motion to said countershaft, and clutch means associated with said countershaft between said last mentioned means and said crank shaft driving means for effecting connection and disconnection between said means for selectively imparting rotary motion to said crank shaft.

10. In a punch press, a frame member comprising a casing portion, a slide and means at the front of said casing portion for supporting and guiding said slide, said frame member having a die-receiving bed disposed below said slide and a forward projection at the front of the casing portion of said frame member and above said slide, a crank shaft journaled in said forward projection with a portion thereof extending rearwardly into the interior of said casing portion, a countershaft journaled within said casing portion and spaced below and in parallel relation with respect to said crank shaft, means in said casing portion for establishing permanent driving engagement between said crank shaft and said countershaft, an electric driving motor disposed in said casing portion above said countershaft with its rotor shaft extending parallel thereto, a flywheel normally mounted for free rotation on said countershaft, transmission means connecting said motor and said flywheel, and clutch means actuable to engage and disengage said flywheel and said countershaft for joint rotation and relative rotation respectively.

11. In a punch press, a frame member comprising a casing portion, a slide and means at the front of said casing portion for supporting and guiding said slide, said frame member having a die-receiving bed disposed below said slide and a forward projection at the front of the casing portion of said frame member and above said slide, a lateral partition forming forward and rear compartments in the interior of said casing portion, a crank shaft journaled in said forward projection with a portion thereof extending rearwardly into the forward compartment of said casing portion, a countershaft journaled in said casing portion and having a portion thereof disposed in said forward compartment and another portion thereof disposed in said rear compartment, a driving connection between said countershaft and said crank shaft in said forward compartment, and means engageable with said countershaft in said rear compartment for effecting rotation thereof.

12. In a punch press, a frame member comprising a casing portion, a slide and means at

the front of said casing portion for supporting and guiding said slide, said frame member having a die-receiving bed disposed below said slide and a forward projection at the front of the casing portion of said frame member and above said slide, a lateral partition forming forward and rear compartments in the interior of said casing portion, a crank shaft journaled in said forward projection with a portion thereof extending rearwardly into the forward compartment of the casing portion, a countershaft extending parallel to said crank shaft and journaled in said casing portion with a portion thereof disposed in said forward compartment and a portion thereof disposed in said rear compartment, a permanent driving connection between said countershaft and said crank shaft in said forward compartment, drive means in said rear compartment adapted to rotate substantially continuously, and clutch means between said drive means and said countershaft for selectively establishing driving engagement therebetween.

13. In a punch press. a frame member comprising a casing portion, a slide and means at the front of said casing portion for supporting and guiding said slide, said frame member having a die-receiving bed disposed below said slide and a forward projection at the front of the casing portion of said frame member and above said slide, a crank shaft journaled in said forward projection and having a portion thereof extending into the interior of said casing portion, a countershaft extending parallel to said crank shaft and journaled in said casing portion, a permanent driving connection between said countershaft and said crank shaft in the interior of said casing portion, drive means in said casing portion adapted to rotate substantially continuously, and clutch means between said drive means and said countershaft for selectively establishing driving engagement therebetween.

14. In a punch press, a frame member comprising a casing portion, a slide and means at the front of said casing portion for supporting and guiding said slide, said frame member having a die-receiving bed disposed below said slide and a forward projection at the front of the casing portion of said frame member and above said slide, a lateral partition forming forward and rear compartments in the interior of said casing portion, a crank shaft jorrnaled in said forward projection with a portion thereof extending rearwardly into the forward compartment of the casing portion, a countershaft extending parallel to said crank shaft and journaled in said casing portion with a portion thereof disposed in said forward compartment and a portion thereof disposed in said rear compartment, a permanent driving connection between said countershaft and said crank shaft in said forward compartment, a flywheel mounted upon said countershaft in said rear compartment and normally free to rotate with respect thereto, drive means engageable with said flywheel for imparting substantially continuous rotary movement thereto, and releasable means for locking said flywheel to said countershaft for imparting rotary movement to the latter.

15. In a punch press, a frame member comprising a casing portion, a slide and means at the front of said casing portion for supporting and guiding said slide, said frame member having a die-receiving bed disposed below said slide and a forward projection at the front of the casing portion of said frame member and above said slide, a crank shaft journaled in said forward projection with a portion thereof extending rearwardly into the interior of the casing portion, a countershaft journaled in said casing portion and extending parallel to said crank shaft, a permanent driving connection between said countershaft and said crank shaft in the interior of said casing, a flywheel mounted upon said countershaft and normally free to rotate with respect thereto, drive means engageable with said flywheel for imparting substantially continuous rotary movement thereto, and releasable means for locking said flywheel to said countershaft for imparting rotary movement to the latter.

16. In a punch press, a frame member comprising a hollow casing portion, a reciprocable slide and means at the outside of the front wall of said casing portion for supporting and guiding the same, said frame member having a die-receiving bed disposed below said slide and a forward extension at its front wall and above said slide, a bearing element provided at the forward portion of said extension and an aligned coaxial bearing element spaced rearwardly of the first bearing element, a crank shaft journaled in said bearings and having a crank therebetween for connection with said slide to reciprocate the latter, said first bearing element being removably associated with said extension to facilitate assembly and disassembly of said crank shaft, transmission means in said casing portion for actuating said crank shaft, said crank shaft having a rear portion extending through said front wall to the interior of said casing portion for engagement with said transmission means.

17. In a punch press, a frame member comprising a hollow casing portion, a slide and means at the front of said casing portion for supporting and guiding said slide, said frame member having a die-receiving bed disposed below said slide and a forward projection at the front of the casing portion of said frame member and above said slide, a lateral partition forming forward and rear compartments in the interior of said casing portion, a crank shaft journaled in said forward projection with a portion thereof extending rearwardly into the forward compartment of said casing portion, bearing means associated with said partition for receiving and supporting the rear terminal portion of said crank shaft, a countershaft journaled in said casing portion and having a portion thereof disposed in said forward compartment and another portion thereof disposed in said rear compartment, a driving connection between said countershaft and said crank shaft in said forward compartment, and means engageable with said countershaft in said rear compartment for effecting rotation thereof.

18. In a punch press, a frame member comprising a hollow casing portion, a reciprocable slide and means at the outside of the front wall of said casing portion for supporting and guiding the same, said frame member having a die-receiving bed disposed below said slide and a forward extension at its front wall and above said slide, a bearing element provided at the forward portion of said extension and an aligned coaxial bearing element spaced rearwardly of the first bearing element, a crank shaft journaled in said bearings and having a crank therebetween for connection with the slide to reciprocate the latter, transmission means in said casing portion for actuating said crank shaft, said crank shaft hav-

ing a rear portion extending through said front wall to the interior of said casing portion for engagement with said transmission means, and a bearing spaced rearwardly of said front wall within said casing, the rear terminal portion of said crank shaft being journaled in said last-mentioned bearing.

19. In a punch press, a frame member comprising a hollow casing portion, a lateral partition forming forward and rear compartments in the interior of said casing portion, a reciprocable slide and means at the outside of the front wall of the casing portion for supporting and guiding the same, said frame member having a die-receiving bed disposed below said slide and a forward extension at its front wall and above said slide, a bearing element provided at the forward portion of said extension and an aligned coaxial bearing element spaced rearwardly of the first bearing element, a crank shaft journaled in said bearings and having a crank therebetween for connection with the slide to reciprocate the latter, said crank shaft having a portion thereof extending rearwardly into the forward compartment of the casing portion, bearing means associated with said partition for receiving and supporting the rear terminal portion of said crank shaft, a countershaft journaled in said casing portion and having a portion thereof disposed in said forward compartment and another portion thereof disposed in said rear compartment, a driving connection between said countershaft and said crank shaft in said forward compartment, and means engageable with said countershaft in said rear compartment for effecting rotation thereof.

20. In a punch press, a frame member comprising a hollow casing portion, a slide and means at the front of said casing portion for supporting and guiding said slide, said frame member having a die-receiving bed disposed below said slide and a forward projection at the front of the casing portion of said frame member and above said slide, a lateral partition forming forward and rear compartments in the interior of said casing portion, a crank shaft journaled in said forward projection with a portion thereof extending rearwardly into the forward compartment of the casing portion, a countershaft extending parallel to said crankshaft and having a portion thereof disposed in said forward compartment and another portion thereof disposed in said rear compartment, aligned coaxial bearings formed in the front and rear walls of said casing portion and in said partition, said countershaft being journaled at its front and rear ends and intermediate thereof in the bearings in the front and rear of the casing and in the partition respectively, a driving connection between said countershaft and said crank shaft in said forward compartment, and means in said rear compartment for engagement with said countershaft to rotate the same.

21. In a punch press, a frame member comprising a hollow casing portion, a reciprocable slide and means at the outside of the front wall of said casing portion for supporting and guiding the same, said frame member having a die-receiving bed disposed below said slide and a forward extension at its front wall and above said slide, a lateral partition forming forward and rear compartments in the interior of said casing portion, a crank shaft journaled in said forward projection with a portion thereof extending rearwardly into the forward compartment of said casing portion, bearing means associated with said partition for receiving and supporting the rear terminal portion of said crank shaft, a countershaft extending parallel to said crank shaft and having a portion thereof disposed in said forward compartment and another portion thereof disposed in said rear compartment, aligned coaxial bearings formed in the front and rear walls of said casing portion and in said partition, said countershaft being journaled at its front and rear ends and intermediate thereof in the bearings in the front and rear of the casing and in the partition respectively, a driving connection between said countershaft and said crank shaft in said forward compartment, and means in said rear compartment for engagement with said countershaft to rotate the same.

22. In a punch press, a frame member comprising a hollow casing portion, a lateral partition forming forward and rear compartments in the interior of said casing portion, a reciprocable slide and means at the outside of the front wall of said casing portion for supporting and guiding the same, said frame member having a die-receiving bed disposed below said slide and a forward extension at its front wall and above said slide, a bearing element provided at the forward portion of said extension and an aligned coaxial bearing element spaced rearwardly of the first bearing element, a crank shaft journaled in said bearings and having a crank therebetween for connection with the slide to reciprocate the latter, transmission means in said casing portion for actuating said crank shaft, said crank shaft extending rearwardly into the forward compartment of the casing portion, bearing means associated with said partition for receiving and supporting the rear terminal portion of said crank shaft, the aforesaid transmission means comprising a countershaft extending parallel to said crank shaft and having a portion thereof disposed in said forward compartment and another portion thereof disposed in said rear compartment, alingned coaxial bearings formed in the front and rear walls of said casing portion and in said partition, said countershaft being journaled at its front and rear ends and intermediate thereof in the bearings in the front and rear of the casing and in the partition respectively, a driving connection between said countershaft and said chank shaft in said forward compartment, and means in said rear compartment for engagement with said countershaft to rotate the same.

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