Sept. 7, 1937. H. SINCLAIR ET AL 2,092,092

POWER PRESS TOOL OR THE LIKE

Filed Dec. 1, 1933 3 Sheets-Sheet 1

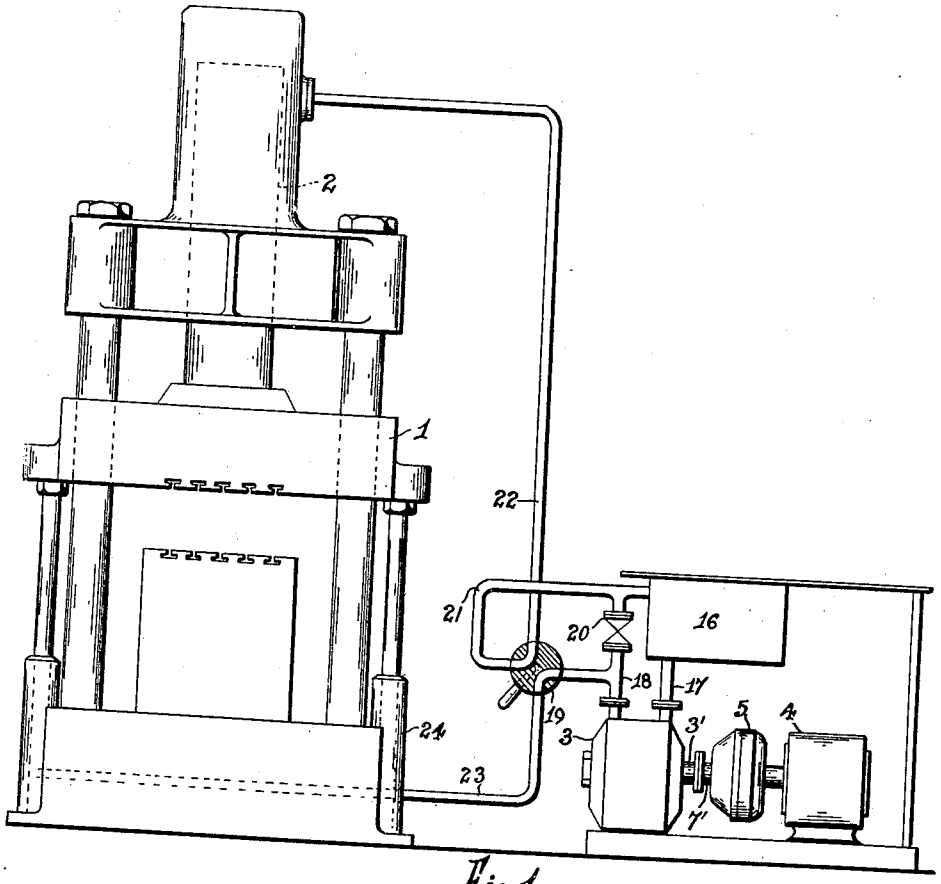


Fig. 1.

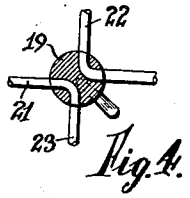


Fig. 4.

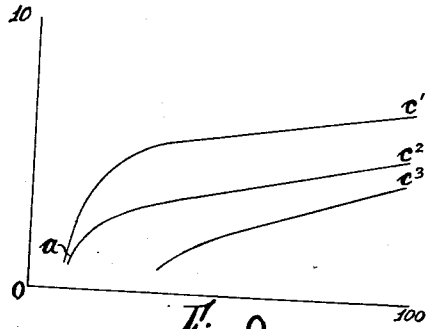


Fig. 9.

INVENTORS
Harold Sinclair
Arthur Fraser
By Dean Fairbank Hirsch & Foster
ATTORNEYS

Sept. 7, 1937.

H. SINCLAIR ET AL

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3 Sheets-Sheet 2

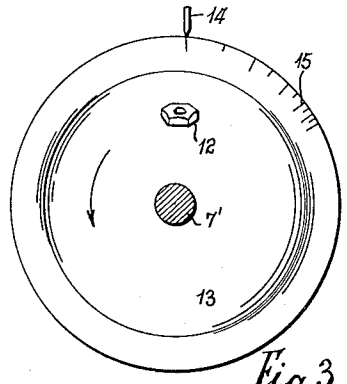


Fig. 3.

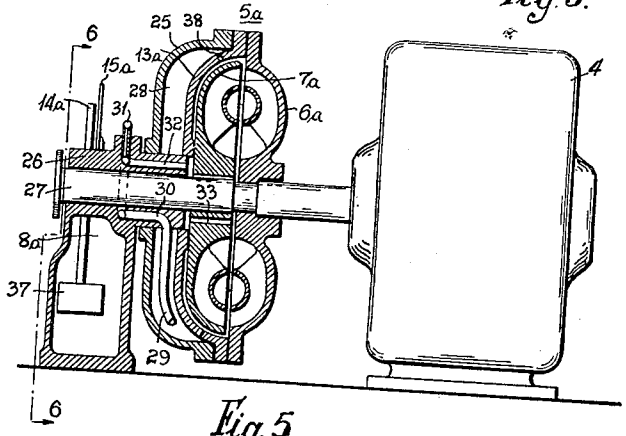


Fig. 5.

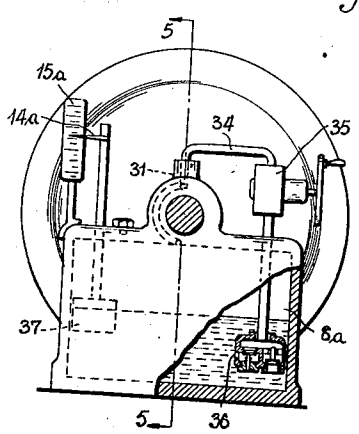


Fig. 6.

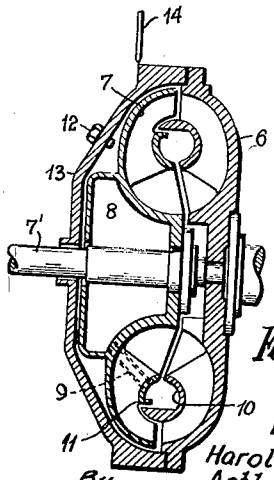


Fig. 2.

INVENTORS
Harold Sinclair
Arthur Fraser
By Dean Fairbank Hirsch & Foster
ATTORNEYS

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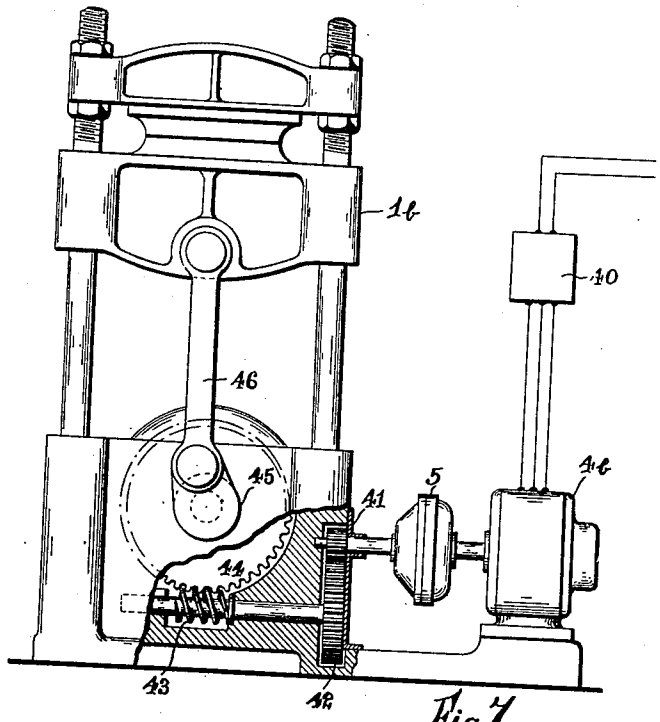


Fig. 7.

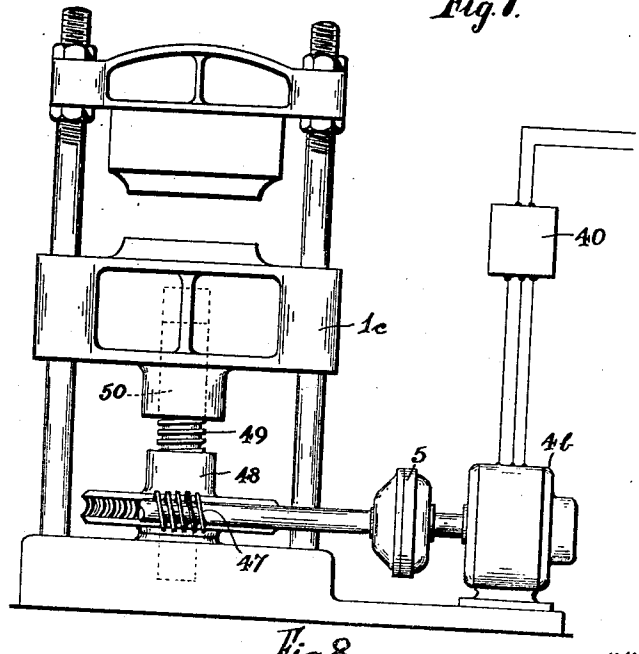


Fig. 8.

INVENTORS
Harold Sinclair
Arthur Fraser
By Dean Fairbank Hueck & Foster
ATTORNEYS

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UNITED STATES PATENT OFFICE

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POWER PRESS TOOL OR THE LIKE

Harold Sinclair, Surbiton, and Andrew Fraser, Purley, England

Application December 1, 1933, Serial No. 700,400
In Great Britain December 1, 1932

9 Claims. (Cl. 100—71)

The present invention relates to improved methods and means for operating power press tools, such as die presses, baling machines, or scrap-packing presses, or like machines, such as testing machines, which require similar drive characteristics, to which an initial driving force of relatively small magnitude is applied to cause the forming tool to approach the work, and thereafter a force of increasing magnitude, and having a predetermined maximum value, is applied to effect the forming operation.

In one known arrangement a press is actuated by a hydraulic ram, supplied with working liquid by a positive displacement pump, for example of the plunger type, driven by a suitable motor. With such an arrangement it has been found that the pump must be driven relatively slowly when the delivery pressure is approaching its maximum in order to reduce the destructive hammering of the pump valves on their seats under high pressure, and in consequence it is necessary to run the high-pressure pump slowly and to provide additional mechanism, such as an auxiliary lower-pressure fluid supply or an auxiliary small-bore ram, if it is desired to secure a relatively rapid initial movement of the tool over the part of its stroke where the driving force is low.

An object of the present invention is the provision of improved methods and means for operating power press tools or the like, which are relatively simple and nevertheless enable the desired motion of the tool to be satisfactorily performed and easily controlled.

In the method of operating power press tools or the like according to the present invention, power is transmitted from a driving motor to the driving member of the tool through a hydraulic coupling of the kinetic type, the slip in the hydraulic coupling serving automatically to reduce the speed of the tool as the resistance offered to movement of the driving member increases and to stop the tool when the resistance rises to a predetermined value, although the driving motor continues to rotate.

In one form of power press tool or the like according to the present invention, means for transmitting power from a driving motor to the tool of the press comprise a hydraulic positive displacement motor which actuates the tool, a hydraulic positive displacement pump which feeds the hydraulic motor, and a hydraulic coupling of the kinetic type through which the pump is driven and which serves to vary the pump speed automatically and inversely with respect to the resistance offered to movement of the tool.

A hydraulic coupling adapted to drive a press or the like by our improved method preferably comprises means for varying the slip characteristic thereof, and it may be provided with a scale so calibrated as to indicate the maximum pressure that the press can generate and an indicator co-operating with the scale and adapted to give a reading varying in accordance with variation made in the slip characteristic of the coupling.

The invention will be described by way of example with reference to the accompanying diagrammatic drawings, in which,

Fig. 1 is a side elevation of a moulding press,

Fig. 2 is a sectional side elevation of a part shown in Fig. 1,

Fig. 3 is an end elevation of the part shown in Fig. 2,

Fig. 4 is a diagram of a valve shown in Fig. 1, in an alternative position,

Fig. 5 is a part sectional side elevation of an alternative arrangement, taken on the line 5—5 in Fig. 6,

Fig. 6 is a part sectional end elevation of the arrangement shown in Fig. 5,

Figs. 7 and 8 are part sectional side elevations of alternative forms of press,

Fig. 9 is a graph of a typical pressure/slip characteristic curve of the type of apparatus shown in Fig. 2.

Referring to Figs. 1 to 4, a hydraulic press having a movable crosshead 1 is actuated by a hydraulic displacement motor in the form of a ram 2 which is supplied with working fluid by a positive displacement radial pump 3 of known type, having a driving shaft 3' which forms the driving member of the press. The pump 3 is driven by an electric motor 4, which may be of the alternating-current squirrel-cage type, through a hydraulic coupling 5 of the kinetic type. In the present example this coupling is provided with means which provide a slip characteristic especially suited to the particular operating conditions, as described in patent specification No. 1,963,720 dated June 19, 1934. The coupling 5 (Figs. 2 and 3) is provided with a vaned driving member 6 coupled to the shaft of the motor 4, and a vaned driven member 7 coupled by a shaft 7' to the pump 3, a reservoir chamber 8 connected to the driven member 7 being in communication with the working circuit by ducts 9 leading to an annular space partly enclosed by core guide members 10 and 11 formed on the driving and driven members respectively. A filling-plug 12 is screwed into a dished cover

13 which is bolted to the driving member 6 and which encloses the driven member 7 and the reservoir 8. A fixed pointer 14 co-operates with a scale 15, which may be marked in tons, on the periphery of the casing 13.

Working liquid for the press 1 is contained in a tank 16 arranged to feed a pump inlet pipe 17. A pump delivery pipe 18 is provided with two branches, one of which returns, through a by-pass control valve 20 to the tank 16, and the other of which leads to a multi-port valve 19 connecting with a return pipe 21 leading to the tank 16, a pipe 22 leading to the press ram 2, and a pipe 23 connected to two push-back rams 24.

Characteristic curves of the relationship of pressure generated by the pump 3 to slip in the hydraulic coupling, with constant speed of the driving member, are shown in Fig. 9, where the ordinate denotes pump pressure in arbitrary units and the abscissa denotes percentage slip. Curve *c1* relates to the coupling when containing a relatively large quantity of working liquid, while curve *c2*, shows the effect of reducing the liquid content somewhat. These curves are of such a nature that at light loads the slip increases almost in direct proportion with increase in torque up to the point *a*; at medium loads a given increase of torque results in a greater pro rata rise in the slip; and under heavy load conditions the effect of a rise in torque load is to cause a very rapid increase in the slip until the driven member stalls. Curve *c3* shows the relationship when the coupling has only a small liquid content.

This arrangement operates as follows.

The driving motor 4 runs continuously, and as long as the by-pass valve 20 is open, the pump 3 merely returns liquid to the tank 16. To raise the crosshead 1, the valve 19 is set in the position shown in Fig. 1, and the by-pass valve 20 is closed. Liquid under pressure is thus admitted to the push-back rams 24 which raise the crosshead, liquid above the ram 2 being returned to the tank. When the crosshead has been raised far enough, the valve 20 is opened and the valve 19 is shut. A working stroke is effected by setting the valve 19 to the position shown in Fig. 4 and shutting the valve 20. As the initial part of the working stroke requires only a relatively small force, the coupling 5 operates on the parts of its characteristic curve lying below the point *a* in Fig. 9; consequently the speed of the pump is high and the movement of the crosshead is rapid. As resistance to further movement of the crosshead increases, the slip in the coupling rises, so that the pump slows down automatically when it is required to produce a high pressure. Eventually the pump stalls automatically at the instant when the torque transmission capacity of the coupling attains the value necessary to produce a predetermined maximum force on the crosshead. When the pressure has been applied to the work for sufficient time, the by-pass valve 20 may be opened rapidly. The energy stored in the pump system is only that due to the compression of the liquid and to elastic strain of the piping and casing; the hydraulic pressure is therefore released almost instantaneously, in such a manner as to minimize risk of injury to the valve 20, since no appreciable wire-drawing of the liquid over the valve seating takes place. The valve 19 need not be operated when under high pressure.

In the above-described example the maximum force that the press develops can be varied by altering the liquid content of the coupling. When it is desired to operate the press at its maximum capacity, the coupling is turned to the position shown in Fig. 3, and filled to the level of the filling-plug 12 which is immediately screwed in. The pointer 14 now indicates on the scale 15 the maximum force that the press can develop. In order to reduce this value, the coupling is set with the pointer 14 against a figure on the scale 15 representing the reduced maximum force that the press is required to exert, and the plug 12 is removed. The liquid now drains out of the coupling until its level falls to that of the plug hole, and the plug having been replaced, the apparatus is ready for use under the new conditions.

Such adjustment is preferably made when the coupling is cold, so as to avoid errors due to expansion of the liquid.

In an alternative arrangement shown in Figs. 5 and 6 there are attached to the driving member 6*a* a dished cover 13*a* enclosing the driven member 7*a* and an outer cover 25, these two covers being sealed by glands against a fixed manifold 26 surrounding the driven shaft 27. Small ports 38 in the cover 13*a* permit liquid to pass into a chamber 28 enclosed between the covers 13*a* and 25 and accommodating a fixed scoop tube 29 the lower end of which opens tangentially in a direction facing the direction of motion of adjacent parts of the covers 13*a* and 25, and the upper end of which communicates by a passage 30 in the manifold 26 with a port 31. The port 31 also communicates with the working circuit of the coupling by an inlet passage 32 in the manifold 26 and a passage 33 in the hub of the driven member 7*a*. The port 31 communicates by a pipe 34 and a hand operated reversible gear pump 35 with a foot valve 36 submerged in liquid contained in a reservoir 8*a*, the foot valve serving to keep the pump 35 primed. A float 37 is connected with a pointer 14*a* which co-operates with a fixed scale 15*a* which may be calibrated in tons.

This coupling, which is somewhat similar to one of the examples described in patent specification No. 1,859,607 dated May 24, 1932, operates as follows. While the driving member is rotating, liquid is discharged continuously from the working circuit by the ports 38 into the chamber 28 from which it is scooped by the tube 29. The liquid thus removed flows through the passages 30, 32 and 33 back to the working circuit, a continuous circulation thus being maintained. If it is desired to reduce the maximum force of the press, the pump 35 is operated to draw liquid delivered by the scoop tube through the port 31 and into the reservoir 8*a* until the pointer 14*a* indicates the desired value on the scale 15*a*. To increase the maximum force of the press, the pump 35 is operated in the reverse direction so as to draw liquid from the reservoir 8*a* and feed it through the passages 32 and 33 into the coupling working circuit.

In Fig. 7 is shown a simple form of mechanical gear driven press. A reversible electric motor 4*b* having a controller 40 is connected to a worm 43 through speed-reducing gearing 41, 42, (the gear 41 forming the driving member of the tool) and a hydraulic coupling 5, which is preferably of the type shown in Fig. 2. The worm 43 meshes with a worm wheel 44 keyed to a crank shaft on each end of which is a crank 45 connected by a connecting-rod 46 to a slidable crosshead 1*b*.

In operating this press, a working stroke is performed by running the motor at full speed in the direction necessary to raise the crosshead, and the driven member of the hydraulic coupling stalls automatically when a predetermined force is ap-

plied by the press. The return stroke is effected by reversing the motor 4b.

In the alternative form of mechanical geared press shown in Fig. 8, the driven member of the hydraulic coupling 5 is connected to a worm 47 meshing with a wheel 48 keyed to a screwed shaft 49 which engages an internally threaded portion 50 of the crosshead 1c.

Where a group of hydraulic presses are required to perform similar operating cycles, a single pressure-generating unit comprising a hydraulic coupling and a high-pressure pump may be employed to serve the several presses in rotation.

We claim:

1. A power press tool comprising a tool member, a motor driven shaft adapted to rotate continuously, a rotatable tool driving member, and a hydraulic coupling having a vaned impeller element drivably connected with said shaft, and a vaned runner element drivably connected with said tool driving member and disposed adjacent to said impeller so as to form therewith an annular working circuit for coupling liquid, said liquid permitting continuous slipping retardation of said runner element to increasing extents under increasing loads, and said hydraulic coupling being of such a size that, when the resistance offered to movement of the tool member rises to a predetermined value, said slip reaches 100%, and movement of said driving member ceases, although said shaft continues to rotate.

2. A power press tool comprising a tool member, a driving motor adapted to rotate continuously, a rotatable tool driving member, and a hydraulic coupling having a vaned impeller element drivably connected with said motor and a vaned runner element drivably connected with said tool driving member and disposed adjacent to said impeller element so as to form therewith an annular working circuit for coupling liquid, said liquid permitting continuous slipping retardation of said runner element to increasing extents under increasing loads, and said hydraulic coupling being of such a size that, when the liquid content of the coupling is substantially at a maximum and while said driving motor continues to rotate, the slip in the coupling will rise to 100 per cent upon the resistance offered by a work-piece to movement of the tool member rising to the maximum value that the tool member is adapted to withstand.

3. In a power press tool, a tool member, a hydraulic positive displacement motor for actuating the tool member, a hydraulic positive displacement pump for feeding said motor, and including a pump driving shaft, a driving motor, and a hydraulic coupling having a vaned impeller element drivably connected to said driving motor and a vaned runner element juxtaposed to said impeller element and fixed to said pump driving shaft, said elements together forming an annular working circuit for coupling liquid, said liquid permitting the runner element to continuously slip in respect to the impeller element, the extent of slipping increasing under increasing loads, said hydraulic coupling being of such a size that, when the liquid content of the coupling is substantially at a maximum, and while said driving motor continues to run, the slip in the coupling will rise to 100 per cent upon the resistance offered by a workpiece to movement of the tool member rising to the maximum value that the tool member is adapted to withstand.

4. In a power press tool, a tool member, a hydraulic positive displacement motor which actuates the tool member, a hydraulic positive displacement pump which feeds said motor and which has a driving shaft, a motor-driven shaft, a hydraulic coupling having a vaned impeller element fixed to said motor-driven shaft, and a vaned runner element juxtaposed to said impeller element and fixed to said pump driving shaft, said elements together forming an angular working circuit for coupling liquid, said liquid permitting the runner element to continuously slip in respect to the impeller element, the extent of slipping increasing under increasing loads, means for varying the liquid content of said coupling circuit to vary the maximum load which will cause 100% slipping, and a by-pass valve disposed on the delivery side of said pump and operable to release the pressure acting on said hydraulic motor.

5. A power press tool comprising a tool member, a driving motor adapted to run continuously, a rotatable driving member which serves to actuate the tool member, a hydraulic slippable coupling having a vaned impeller element drivably connected with said motor and a vaned runner element drivably connected with said tool driving member, said coupling elements being juxtaposed to form an annular working circuit for coupling liquid, said liquid permitting the runner element to continuously slip in respect to the impeller element, the extent of slipping increasing under increasing loads, means for varying the slip characteristic of said coupling to vary the maximum load which will cause 100% slipping, an indicator responsive to operation of said slip-varying means, and a scale with which said indicator cooperates, said scale being so calibrated as to register the force exerted by the tool member when said driving member stalls at the end of a press stroke.

6. A power press tool comprising a tool member, a reversible driving motor, a rotatable driving member which serves to actuate the tool member, and a hydraulic slippable coupling having a vaned impeller element drivably connected with said motor and a vaned runner element drivably connected with said tool driving member, said elements being juxtaposed to form an annular working circuit for coupling liquid, said liquid permitting continuous slipping retardation of said runner element to increasing extents under increasing loads, and said hydraulic coupling being of such a size as to permit said driving member to stall upon the resistance offered to movement of the tool member rising to a predetermined value, although said motor continues to rotate, and the return stroke of the press being effected by reversing said motor.

7. A power press tool comprising a tool member, a rotatable driving member which serves to actuate the tool member, a reversible electric motor and a hydraulic slippable coupling of the kinetic type connected between said driving member and said motor, said coupling being of such a size as to permit said driving member to stall although the driving motor continues to rotate and permitting said motor to start up in the reverse direction under a light load at the beginning of an opening movement of the press.

8. A power press tool comprising a tool member, a motor driven shaft adapted to rotate continuously, a rotatable tool driving member, and a hydraulic slippable coupling having a vaned impeller drivably connected with said shaft and a vaned runner drivably connected with said tool driving member and forming with said impeller

an annular working circuit for coupling liquid, said coupling being of such a size that, when said motor driven shaft is rotating and the liquid content of said coupling is at its maximum, while the resistance to motion of said tool member rises from not less than 70% of its maximum value to its maximum value, the slip in said coupling increases, in substantially linear relationship with said resistance, from not more than 50% to 100%.

9. The method of controlling the maximum pressure applied to a work piece in a power press, which includes driving the tool member by a hydraulic coupling of the kinetic type, which coupling is driven by a driving motor shaft adapted to rotate continuously and to apply a pressure in excess of said maximum, and varying the liquid content of the coupling to such an amount that the slip in the coupling will reach 100% when said maximum pressure is reached and said driving motor shaft continues to rotate.

HAROLD SINCLAIR.
ANDREW FRASER.