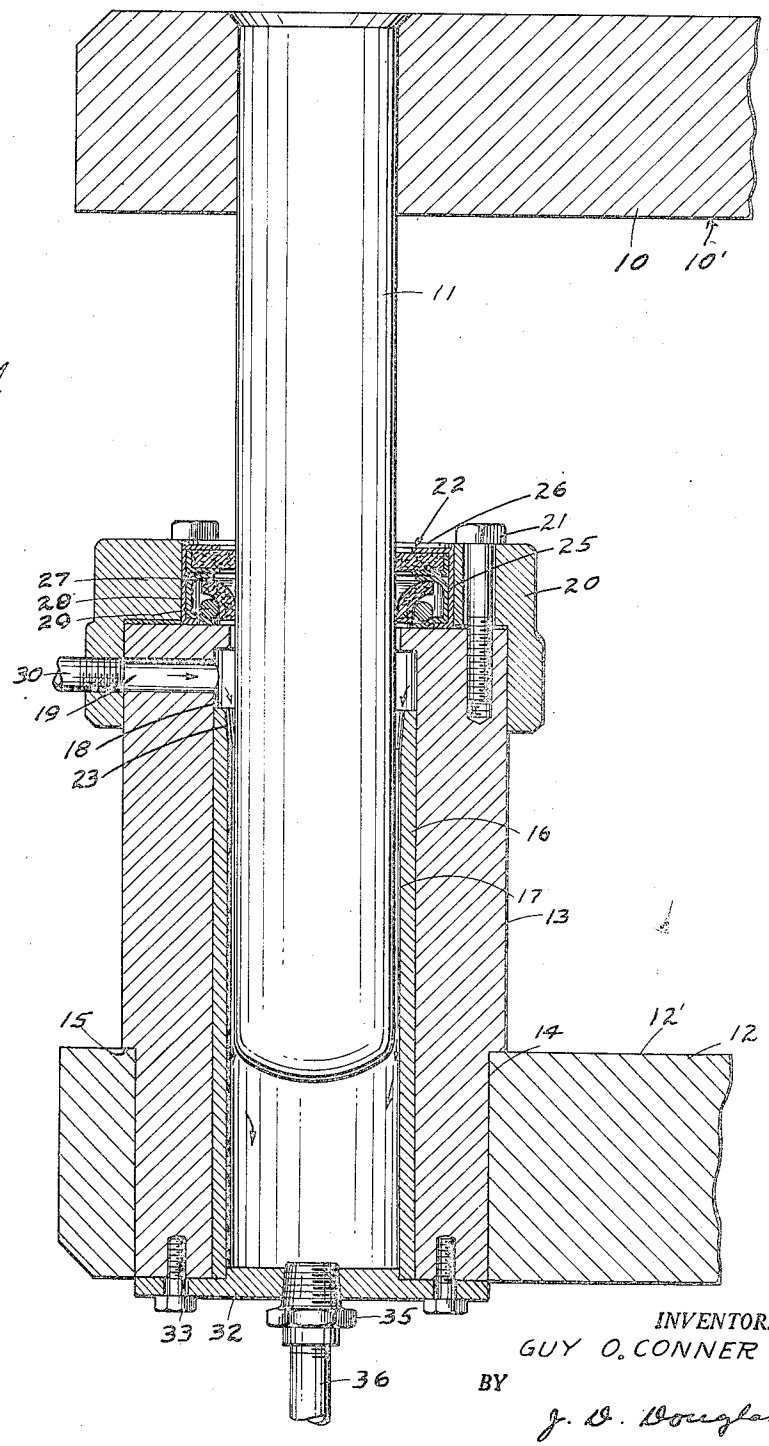
Sept. 26, 1950 G. O. CONNER 2,523,358

HYDRAULIC ANTIFRICTION DIE SET

Filed Oct. 22, 1945 4 Sheets-Sheet 1

Fig. 1



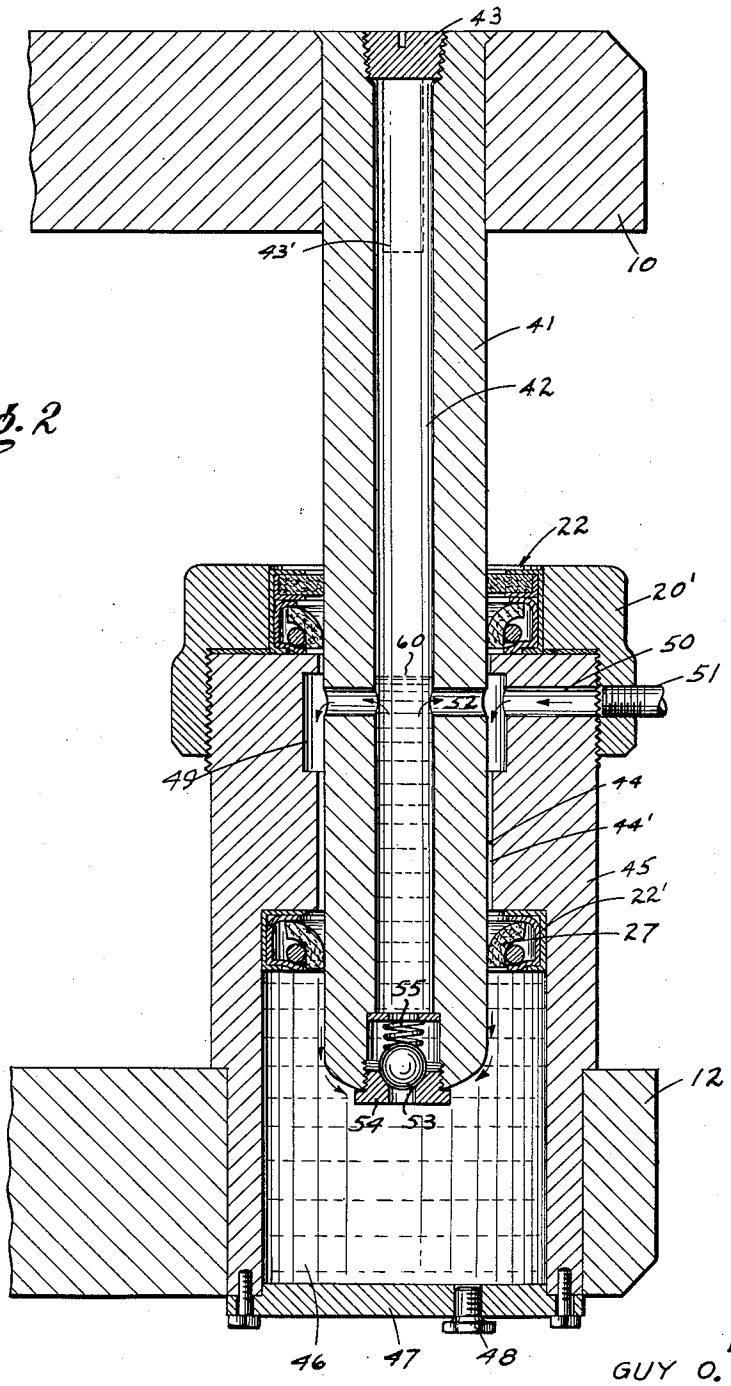
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Fig. 2



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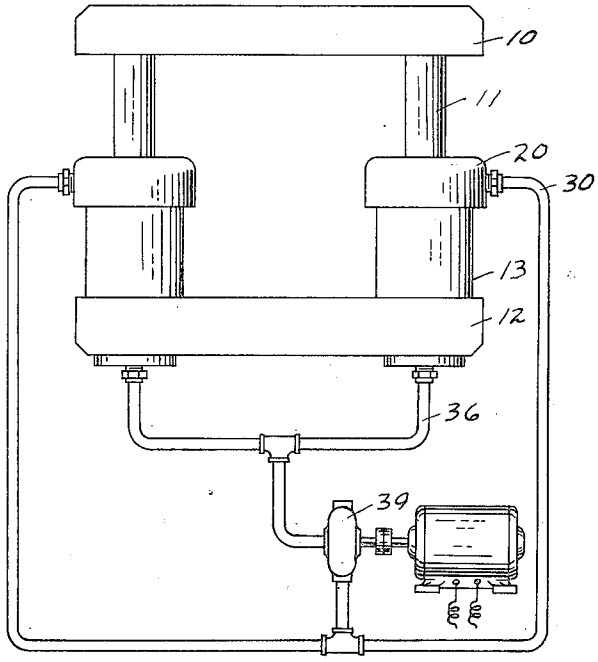


FIG. 3.

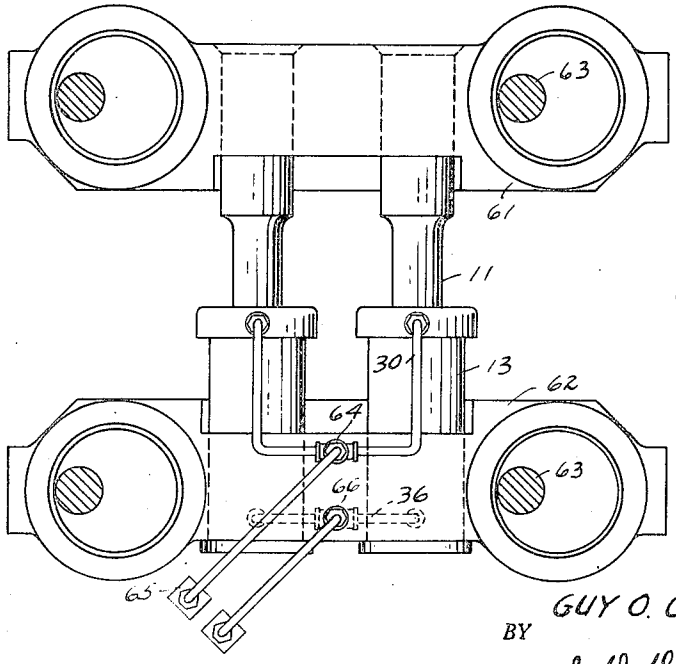


FIG. 4.

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HYDRAULIC ANTIFRICTION DIE SET

Filed Oct. 22, 1945 4 Sheets-Sheet 4

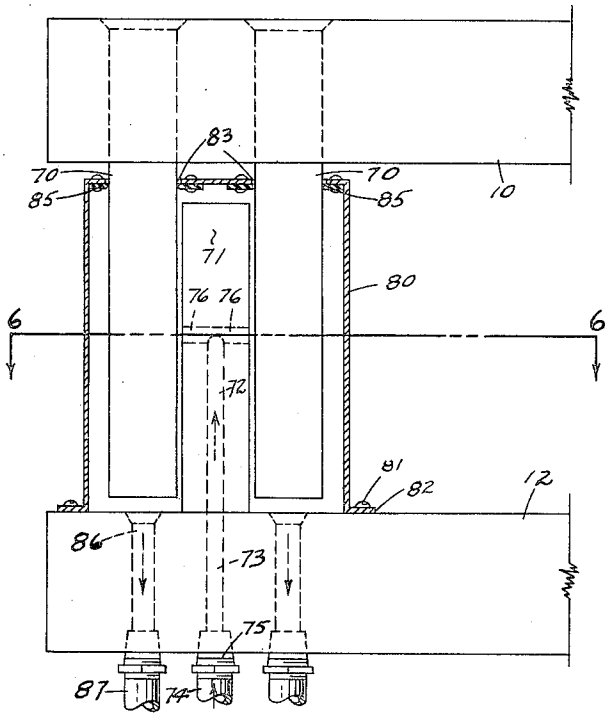


FIG. 5.

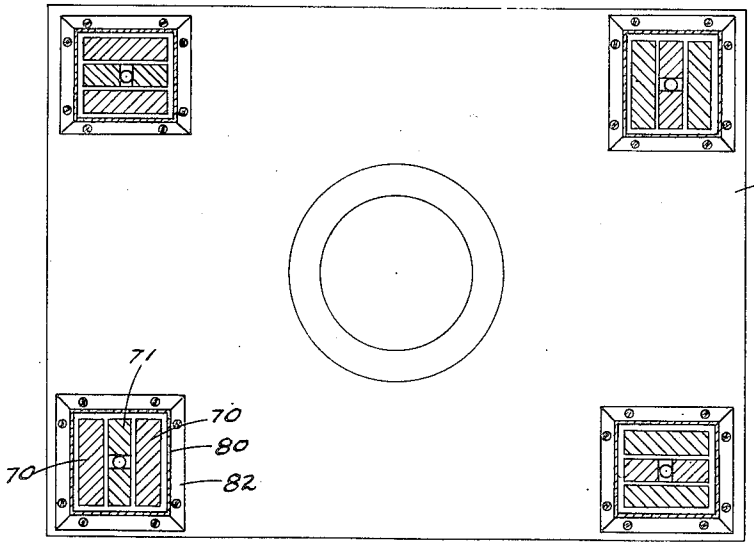


FIG. 6.

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UNITED STATES PATENT OFFICE

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HYDRAULIC ANTIFRICTION DIE SET

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Application October 22, 1945, Serial No. 623,758

12 Claims. (Cl. 164—118)

1

This invention relates to improvements in die sets and heads for punch presses or the like and more particularly to an improvement in means for maintaining alignment between the heads and/or die set parts as well as the dies during punching or forming operations.

As is known to those versed in the art, a punch press usually includes a head which is movable relative to a base or bolster, which head and base carry dies and are effective to move the dies toward and from each other and perform forming or cutting operations on a material disposed therebetween. The accuracy of the forming or cutting effected by the dies is determined by the ability of the press to hold the dies in proper alignment with each other.

Heretofore it has been customary to provide so-called die sets for use in presses to maintain the desired alignment of the dies. In general, the die sets comprised separate plates or shoes carried by the head and bolster of the press respectively, and which plates are adapted to have mounted thereon the dies per se. It has also been common to provide pillars or posts usually known as leader pins that are rigidly secured in one of the plates and which extend toward and are reciprocable in bushings of guides carried by the other plate; the purpose being to maintain alignment of the plates and the dies carried thereby.

The accuracy of the alignment of the die parts during operation is largely determined by the fit of the leader pins in the bushings. If a loose fit is provided between the bushings and leader pins, there is more opportunity for the plates to move laterally and for the dies to thus be carried out of alignment with each other. If attempts are made to decrease the tolerance or reduce this loose fit, the leader pins and guides are apt to get hot and bind or seize, especially during high speed operation. As a matter of experience, at high speed operation, ordinary die sets have been known to get hot and seize in a few seconds time.

The importance of providing means for maintaining more exact alignment of the dies can be better appreciated by taking into consideration that the bolster and head of a press are normally massive devices, and in order to permit effective operation, a clearance of between .002 and .005 inch must be provided between the working slides of the press. When it is further understood that the stock being worked on may be between .002 and .005 inch thick, it

2

will be seen that the tolerances or clearances necessary to the successful operation of the press are so large as to make it difficult, if not impractical, to operate on thin stock without the aid of die sets. This is especially true where a high speed operation is contemplated.

This deficiency is corrected somewhat by the use of the ordinary die set, since here the tolerance or clearance between the pins and the bushing may be cut down to .001 inch per inch of diameter of the pin. That is with a die set having leader pins one inch in diameter, the total clearance may be .001 inch or a clearance on diametrically opposite sides of the pin of .0005 inch. However, it has been found that in operating on thin stock .002 inch thick the clearance between the cutting edge of the dies should not, for best results, exceed 10 per cent of the stock thickness. Therefore, it appears that with .002 inch thickness stock, for best results the total clearance between the leader pins and bushings should not be over .0002 inch while there is actually .001 inch or five times as much clearance as is desirable. The result is that the dies are capable of greater lateral movement than their clearance and the cutting edges are often actually riding on each other. This causes the cutting edges to be dulled and results in a shorter die life than would be possible if the dies could be kept in more perfect alignment.

One method and means for increasing the accuracy of the alignment of the dies and reducing the clearance between the leader pins and bushings is proposed in my copending application for "Die Set," Serial No. 519,284, now Patent No. 2,422,774 dated June 24, 1947. That application contemplates the use of anti-friction elements that may be of the rolling type, interposed under loaded conditions between the walls of the posts and the walls of the sockets.

The present invention contemplates providing the desired reduction of the tolerance and/or clearance by providing an improved support for the cooperating guiding members which includes utilizing a liquid film such as oil. The liquid oil film is interposed between the cooperating guiding members under pressure and holds them against lateral displacement relative to each other with a minimum of frictional losses. The oil may be cooled if desired thus assisting in preventing heating of the leader pins and their cooperating guides.

In the drawings I have illustrated an embodiment of my invention wherein:

Fig. 1 is a vertical sectional view of a leader pin and a bushing with certain parts shown in elevation and with a portion of a die set shown attached thereto;

Fig. 2 is a similar view of another modification of the invention;

Fig. 3 is a diagrammatic view illustrating my invention;

Fig. 4 is another diagrammatic view showing the invention as applied to a high speed press of my invention;

Fig. 5 is a fragmentary elevation of another embodiment of my invention with certain parts shown in section,

Fig. 6 is a sectional view on a reduced scale taken from a plane indicated by the line 6 of Fig. 5 of a complete die set of my invention.

Referring now to the drawings, throughout which like parts are shown by like reference characters, and particularly to Fig. 1, there is illustrated at 10 an upper plate or shoe adapted to be secured to the traveling head or slide of the press. Secured in the upper plate 10, is a downwardly extending leader pin 11 which is cylindrical in form and provided with a smooth exterior surface. A lower plate 12 is provided which may be secured to the bolster of the press and carries a guide for the leader pin which guide is secured in an aperture in the plate. The guide is in the form of a cylindrical sleeve 13 which is provided with a reduced portion 14 having a driven fit in the bore or aperture of the plate 12. A shoulder 15 on the sleeve engages with the upper surface of the plate 12. These parts are not of necessity cylindrical, but could be made square or of other shape if desired.

The cylinder 13 is provided with a sleeve 16 of alloy material such as silver, aluminum or copper and lead disposed in the guide and having a bore 17 in alignment with the post 11 and in which the post is adapted to reciprocate. The bore 17 is slightly larger than the post 11, this dimension being exaggerated in the figures for the purpose of explanation. In actual practice the clearance could be varied but is preferably kept relatively small, a clearance of .0005 per inch of diameter being satisfactory. The upper end of the sleeve is honed at 23 to provide a slight bell mouth. The upper end of the cylinder is provided with an annular chamber 18 which communicates exteriorly of the cylinder by a duct 19. The top of the cylinder is sealed around the post by a cap 20 which is held on the cylinder by screws 21 that extend through the cap into threaded openings in the top of the cylinder. The cap is provided with a packing gland, illustrated generally at 22, which seals the top of the cylinder where the post 11 enters the cylinder and prevents leakage of fluid, as will hereinafter be described, from the cylinder upwardly around the post. It may comprise an outer shell 25 carried by the cap 20 in the opening 26. A packing member 27 is disposed in a retaining ring 28 and held against the post 11 by a split ring or spring 29. The member 27 may be of rubber, leather or other suitable material. Although a specific type of packing gland is shown, it will be appreciated that this is merely for the purpose of illustration and that other types could be substituted with equal facility as long as they prevent leakage of liquid around the post 11.

A conduit 30 is threaded through the flange of the cap 20 into the duct 19 which opens into the annular chamber 18.

The bottom of the cylinder is closed by a plate 32 which may be secured thereto in any suitable manner such as by studs 33. An outlet is provided in which a coupling 35 is disposed which connects to an outlet conduit 36.

The opposite faces 10' and 12' of the upper and lower plates 10 and 12, respectively, are adapted to have secured thereto the usual die parts. There may be one or more of the posts and cylinder combinations as shown in Fig. 1 for each die set.

In operation a fluid such as oil is forced through the pipe 30 and duct 19 into the chamber 18 at the top of the cylinder. This fluid then passes downward through the space between the leader pin and sleeve around the post 11 into the lower part of the chamber 18 below the post 11. The fluid may escape from this chamber through the conduit 36 back to the pressure unit. The pressure unit may be a motor driven pump 39 (Fig. 3) supplying the fluid, which may be oil, under relatively high pressure.

The oil is kept constantly circulating during operation of the device and results in a high pressure resistance film of fluid between the post 11 and the wall 17 which holds the post firmly centered and limits lateral movement thereof. At the same time, the oil serves as a lubricant and is highly anti-friction in nature thus reducing the power needed to reciprocate the die set parts and maintaining extremely accurate alignment therebetween. The packing gland 22 prevents escape of the fluid around the entering portion of the post 11. The oil may be circulated through a cooling unit if desired to maintain the desired temperature thereof.

Fig. 2 is similar in operation to that just described. In this instance, however, the external pump may be eliminated and the film of oil maintained by a pumping action which is inherent in the construction shown.

As shown in the drawings the leader pin or post 41 is provided with an axial bore 42 extending throughout the length of the post, the upper end being closed by a threaded plug 43. It may be desirable in some instances to provide even greater space than is provided by the bore 42 without reducing the wall strength, in which instance the plug 43 would be removed and an auxiliary expansion chamber attached thereto. The chamber represented by the bore 42 may also be reduced in area if desired by providing an extension on the plug 43 as indicated by the dotted lines at 43'.

The bore 42 extends axially downward through the post 41 opening through the bottom thereof. The cylinder 45, in this instance, is also secured in the plate 12 in a manner similar to that described for the previous embodiment. It is provided with a bore 44 which has a relatively close fit with the post 41 as previously described in connection with the other embodiment. The lower part of the bore, however, is enlarged to provide an enlarged liquid holding chamber 46. A packing gland 22' is provided at the top of the enlarged bore 46 surrounding the post 41. The structure of the packing gland 22' has a bearing upon the operation in this case, since the member 27 acts as a valve allowing fluid to escape in a downward direction but prevents fluid from escaping in an upward direction. The bottom of the chamber 46 is closed by a plate 47 which may be secured thereto in any suitable manner and in which a plug 48 is provided should it be desired to drain the same. The upper end of the cylinder 44 is closed by a cap 20' similar

in construction to that described in the preceding embodiment except that the flange is threaded and screws onto the top of the cylinder 45. A packing gland 22 is also provided which prevents loss of fluid from around the post 41. An annular chamber 49 is provided adjacent the top of the cylinder and may be somewhat longer than that shown in Fig. 1. A duct 50 may also be provided connected to a tube 51 for the purpose of the initial filling of the device. It is contemplated that the tube 51 be sealed off after the device is once filled or the opening may be plugged.

The post 41 is also provided with ducts 52 which extend through the sides of the post into the bore 42 approximately midway between the top and the bottom of the post. The position of these ducts may be varied depending upon the stroke of the press.

The bottom of the bore 42 in the post 41 is provided with a ball check valve 53 which is held seated on the seat 54 screwed in the bottom of the duct, by a spring 55.

In operation the device is filled with oil through the pipe 51 to approximately the level indicated at 60. This provides oil in the chamber 46, in the bore 42 up to the point 60 and between the walls of the cylinder at 44 and the post 41. The chamber in the bore of the post above the level of the fluid at 60 is filled with air, which as previously stated could be increased in volume by adding the auxiliary chamber at the top. This might be particularly desirable when the stroke of the press is increased.

In operation, the plates 10 and 12 being shown in the position where the dies are farthest apart, when the two plates 10 and 12 are brought together the post 41 pushes down into the chamber 46 displacing the fluid, which may be oil, from the chamber 46 which then passes upward past the check valve 53 through the bore 42 compressing the air in the air chamber. This increased pressure also causes the oil flow through the ducts 52 and downward in the space between the post 41 and the wall 44 of the cylinder.

When the post is withdrawn from the chamber 46 to the position shown, the air expands and the fluid is forced back into the chamber 46 by way of ducts 52 and the space 44'. The packing gland 22' also acts as a valve in this instance causing the flow of liquid to always be in a downward direction and the reciprocation of the post 41 acts as a pump which provides a constant film of oil in the space at 44' holding the post and cylinder 43 and the plates 10 and 12 in proper alignment for most efficient operation.

Fig. 4 is a diagrammatic view depicting the invention as applied to the die carriers of the high speed press of my copending application, Serial No. 497,792, now Patent No. 2,406,808 dated September 3, 1946. In this case the upper die carrier is indicated at 61 and the lower carrier at 62, both mounted for movement in an orbital path toward and from each other on the eccentrics 63. The posts 11 correspond to the posts 11 of Fig. 1 and the cylinder 13 also corresponds to the cylinders 13 of Fig. 1. In this case because the carriers both move, it is necessary to connect the inlets 30 to a hydraulic ball bearing joint 64 in order that those ducts may be flexibly connected to the outlet of a pump such as 39 of Fig. 3. Another hydraulic joint is indicated at 65, it being understood the object of these connections is to connect the movable die sets to the pump, which is connected by couplings that

permit relative movement therebetween. Likewise the outlets 36 are connected by similar couplings 66 shown to the inlet side of the pump. The operation otherwise is the same as that depicted for Figs. 1 and 3. Although I have shown Fig. 4 as being particularly adapted to utilize the specific invention of Fig. 1, it will be quite apparent that the device as shown in Fig. 2 could be used with this type of press structure, and that in case the structure of Fig. 2 was used, that the connections and exterior pump would be unnecessary.

It will also be apparent that the hydraulic couplings would be replaced by flexible pressure resistance tubing in which joints such as 64, 65, and 66 would be unnecessary.

In Figs. 5 and 6, I have illustrated another modification of my invention, and wherein the leader pin may be rectangular in cross section and reciprocated between spaced plates which act as the guides.

More specifically, the upper plate 10 has secured therein in spaced relation to each other a pair of members 70. These members may be secured into or onto the plates in any suitable manner. As can best be seen in Fig. 6, these members are rectangular in cross section.

A third member 71 of similar shape is secured to the plate 12 and extends upward between the members 70 with its walls in closely spaced relation to the opposing faces of the members 70. It should be pointed out that for the purpose of clarity of description, the space between the member 71 and the members 70 is exaggerated, and that in actual practice, this space would be very small, being less than a thousandth of an inch.

The member 71 is provided with a duct 72 which communicates with a duct 73 in the plate 12, an inlet conduit 74 being connected thereto by a coupling 75. Branch ducts 76 connect with the duct 72 and open through the face of the member on opposite sides. These ducts comprise the means whereby fluid under pressure is admitted between the opposing faces of the member. If desired surface grooves, not shown, may be provided branching from the outlets of the ducts 76 to assist in the distribution of the fluid between the faces.

A fluid collection housing is provided at 80 and comprises a shell of rectangular cross section which surrounds the members 70 and 71, the lower end of the shell being secured in fluid tight relation by screws 81 which extend through a flange 82 and threaded into the plate 12. The upper end of the shell is provided with rectangular openings 83, through which the members 70 may reciprocate. The openings 83 surrounding the members 70 may be provided with packing glands 85 which prevent fluid from escaping around the members 70 and allow free reciprocation thereof in the openings.

One or more exhaust ducts 86 are provided through the plate 12 and opening into the interior of the shell being connected by the conduits 87 to a suitable pump such as 39 of Fig. 3.

As shown in Fig. 6, four sets of the elements just described are provided, being disposed at the corners of the die set. It should be noted that the orientation of the elements on the diagonally opposite corners are the same but that the elements on adjacent corners are rotated 90 degrees relative to each other. This arrangement provides lateral control of the plates 10 and 12 in all directions.

In operation a fluid, such as oil, is supplied to the ducts 72 by a pump 39 (Fig. 3) under pressure; the fluid escapes through the branch conduits 76 into the opposing faces of the members 70 and 71 which provide a pressure resistant film between the faces holding the element 71 midway between the elements 70.

The fluid under pressure gradually escapes from between the plates and is collected by the shell 80, being exhausted through the ducts 86 back to the pump 39. It may be desirable to provide a fluid reservoir of substantial capacity ahead of the pump 39 on the inlet side. In some instances, it may be desirable to have a separate pump for providing the exhaust and the pressure.

It will be appreciated that although I have shown the leader pins and guides as being cylindrical in cross section, they can be square or polygonal in cross section without departing from the spirit of my invention.

It will thus be seen that I have provided an invention wherein the lateral movement of the dies relative to each other is limited. The film of oil or other fluid used is sufficient, especially when the pressure providing the film is maintained, to rigidly hold the posts and cylinders in predetermined concentric positions without the application of undue frictional resistance. This results in a reduction in the lateral movement of the plates enabling the dies to be operated so that their cutting or forming edges do not ride on each other. The end results being longer die life and the ability of the press to operate on extremely thin stock at high speed to provide sharp clean edges on the pieces being stamped or pressed.

It should be understood that although I have mentioned oil specifically as being the fluid used, other fluids such as glycerine or metals in the fluid state such as mercury could be used with equal facility.

Having thus described my invention, I am aware that numerous and extensive departures may be made therefrom without departing from the spirit or scope of the invention.

I claim:

1. An apparatus of the class described comprising upper and lower die supporting bases movable toward and away from each other, means to maintain lateral alignment of said bases comprising a post carried by one base and extending toward the other, a cylinder carried by the other base for receiving said post, a fluid film between the cylinder and post walls and means for maintaining said film comprising fluid inlet and outlet ducts for said cylinder and means connected to said ducts to circulate fluid therethrough.

2. An apparatus of the class described comprising upper and lower die supporting bases movable toward and away from each other, means to maintain lateral alignment of said plates comprising a post carried by one plate and extending toward the other, a cylinder carried by the other plate for receiving said post, a film of oil under pressure disposed between the walls of the posts and cylinder and holding them out of contact with each other, and means to maintain said oil film comprising fluid inlet and outlet ducts for said cylinder and means connected to said ducts to circulate oil under pressure therethrough.

3. A die set comprising upper and lower plates adapted to be secured in a press and to carry die parts, means to maintain alignment of said plates during pressing or punching operations

comprising posts carried by the upper plate and extending downward in the direction of movement of the dies, cylinders carried by the lower plate and having said posts extending and reciprocable therein, a chamber at the top of each of said cylinders surrounding said post and inlet means connecting to said chamber, an outlet provided at the bottom of said chamber and means to force fluid under pressure into said upper chamber and maintain a fluid film between said post and cylinder walls, and connected to said outlet duct to receive the fluid therefrom.

4. A die set comprising upper and lower plates adapted to be secured in a press and to carry die parts, means to maintain alignment of said plates during pressing or punching operations comprising posts carried by one plate and extending in the direction of movement of the dies, cylinders carried by the other plate and having said posts extending and reciprocable therein, means for sealing said cylinder and post against fluid escape comprising a packing gland carried by the cylinder and surrounding said post adjacent the top thereof and surrounding said post and inlet means connecting to said chamber, an outlet provided at the bottom of said chamber and pump means connected to said inlets and outlets to force fluid under pressure into said upper chamber and maintain a fluid film between said post and cylinder walls.

5. A die set including an upper plate and a lower plate, posts carried by the upper plate and extending toward the lower plate, cylinders carried by the lower plate adapted to receive said posts, said cylinders each comprising an upper portion formed to provide a close sliding fit with said posts and formed with a chamber at the lower portion, said posts adapted to extend into said chamber, each post having a duct therein opening into said lower chamber thereof, said chamber being provided with a fluid, said post adapted to displace the fluid in said lower chamber and effective during reciprocation to pump said fluid between the walls of the posts and the cylinders and to maintain a film of fluid therebetween.

6. A die set comprising upper and lower plates, posts carried by the one of said plates and extending toward the other plate, cylinders carried by the last mentioned plate adapted to receive said posts, said cylinders each comprising an upper portion formed to provide a close sliding fit with said posts and a chamber at the lower portion, said posts adapted to extend into said chamber, each post having a duct extending axially therethrough and communicating with said lower chamber, a check valve in said duct, said chamber being provided with oil, said post adapted to displace the oil in said lower chamber and effective during reciprocation to pump said oil between the walls of the posts and the cylinders and to maintain a film of oil therebetween.

7. A die set comprising spaced members movable toward and from each other and adapted to carry dies, means to maintain lateral alignment between said members and dies comprising a post carried by one member and extending toward the other member, a guide on said other member for receiving said post, said post being provided with a main duct extending axially thereof and opening out of the end remote from the supporting member, a check valve disposed in the end of the duct constituting an inlet means for allowing fluid to be admitted to the duct and preventing fluid from escaping through the end of the duct,

outlet ducts extending from the first mentioned duct spaced from the end of the post; said guide including a portion for providing a close sliding fit with said post and having an annular chamber at its upper end, a reservoir at its lower end, a packing gland disposed at the upper end of said chamber and sealing said chamber around said post, said gland being arranged to prevent fluid flow out of said reservoir and admit fluid flow into said reservoir, said post and reservoir being filled with fluid to a point above said outlet ducts and the upper end of said main duct constituting an expansion and compression chamber for air or gas trapped above said fluid level, said post upon reciprocation adapted to move into said reservoir and displace fluid therefrom through said check valve and to compress the gas or air in the upper end of said main duct, said compressed air or gas, upon the post being withdrawn from the chamber adapted to expand and force the fluid through the upper ducts into the annular chamber and downward between the walls of the post and cylinder to maintain a film of fluid under pressure therein.

8. An apparatus of the class described comprising spaced members movable toward and from each other and adapted to support forming elements, means for maintaining lateral alignment in all directions transversely to the direction of travel of said members comprising posts carried by one member and reciprocable between pairs of posts carried by the other member said first posts and said pairs of posts having sides disposed in closely spaced relation and means to maintain a film of lubricating pressure resistant fluid in the spaces between said members.

9. An apparatus of the class described including spaced members adapted for movement toward and from each other and to support die parts, means to maintain lateral alignment of said members comprising a plate secured to one member and extending toward the other, a pair of plates carried by the other member adapted to receive said first plate therebetween, means for providing a fluid film between said plates, and a housing surrounding said plates for collecting fluid escaping from between the plates.

10. An apparatus of the class described comprising members movable toward and from each other and adapted to support die parts, guide means for maintaining said members in alignment comprising posts carried by one member and extending toward the other member and formed with a pair of oppositely disposed flat faces, pairs of posts carried by the other members and having flat faces on each post facing each other, said first post adapted to reciprocate between said second posts, means including fluid ducts for said posts having outlet ports opening between said posts and fluid pressure means for forcing a fluid under pressure between said posts, and means to collect fluid escaping from between said faces including a housing surrounding said posts.

11. An apparatus of the class described comprising members movable toward and away from each other and adapted to support die parts, means for maintaining said members against lateral movement in all directions transverse to the direction of travel thereof comprising cooperating guide means carried by the members, said guide means being disposed in spaced relation to each other and each comprising a plate of rectangular cross section carried by one member and extending toward the other and reciprocable in closely spaced relation between a pair of plates carried by the other member, fluid ducts formed in at least one of said plates and opening into the spaces between the plates, and means connected to said ducts for forcing fluid under pressure into the space between said plates, said members being provided with a plurality of sets of guide means with some of said guides oriented in one direction and others oriented at 90 degrees thereto, and having means for said guide means to catch fluid expelled from between them.

12. A die set comprising spaced plates adapted for movement toward and from each other and to support die parts, guide means to hold said plates against lateral movement in all directions transverse to the direction of the travel comprising posts carried by one plate and extending toward the other, said posts having at least two opposite faces extending longitudinally thereof, said other plate being provided with a pair of spaced members adapted to reciprocably receive said posts therebetween and having faces disposed in closely spaced opposition to the faces in said post, said guide means being disposed in spaced relation from each other, said posts being formed with ducts therein and fluid outlet ports opening between said faces and means to force fluid into said ducts and provide a fluid film between said faces, and means encasing said guide means to receive fluid expelled from said faces and fluid outlet means for said encasing means to withdraw said fluid therefrom.

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