July 29, 1969 YOSHITOMO TEZUKA ET AL 3,457,874

QUICK DIE CHANGING SYSTEM

Filed Sept. 19, 1966 5 Sheets-Sheet 1

Fig. 1

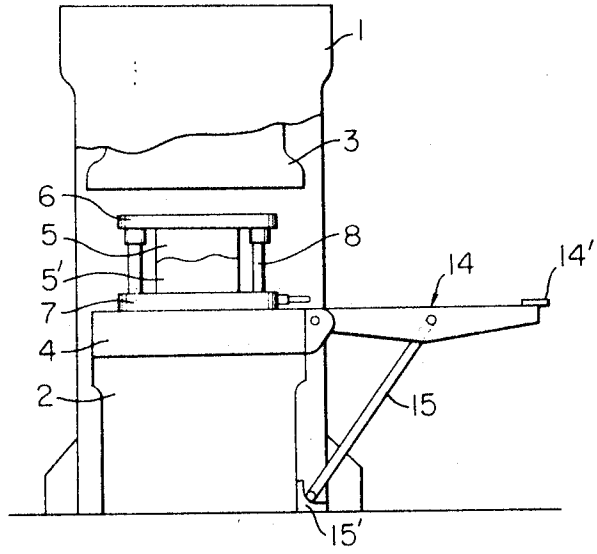
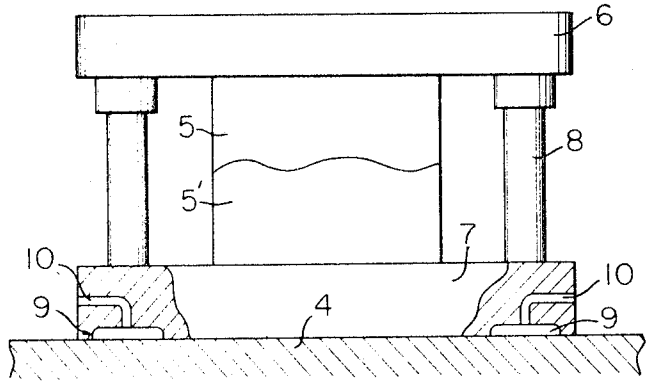


Fig. 2



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Fig. 3

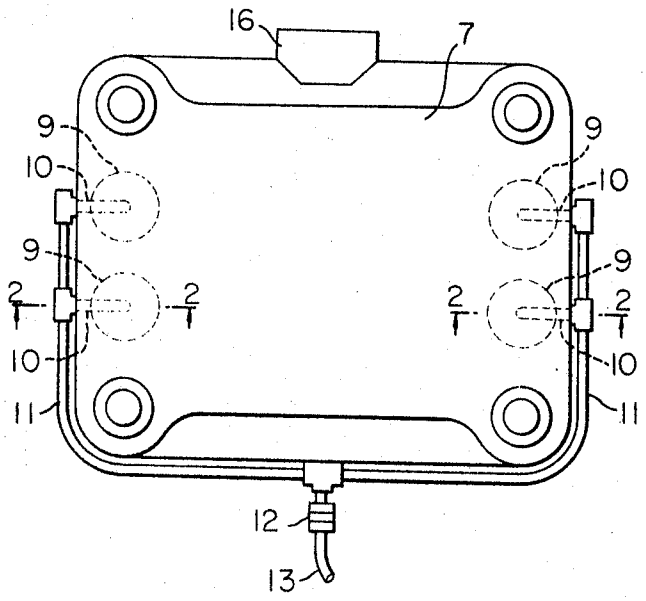
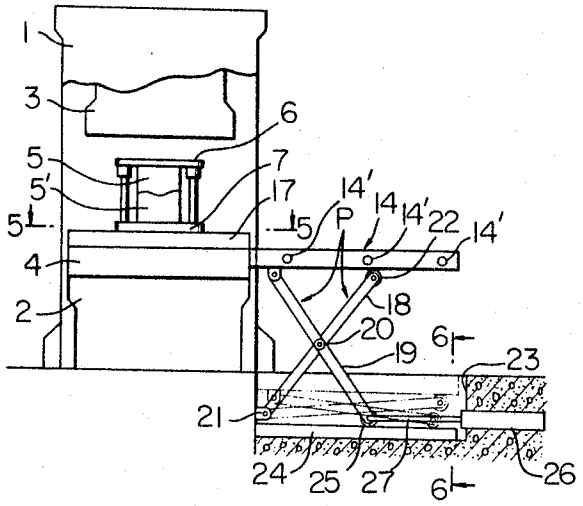


Fig. 4



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QUICK DIE CHANGING SYSTEM

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Fig. 5

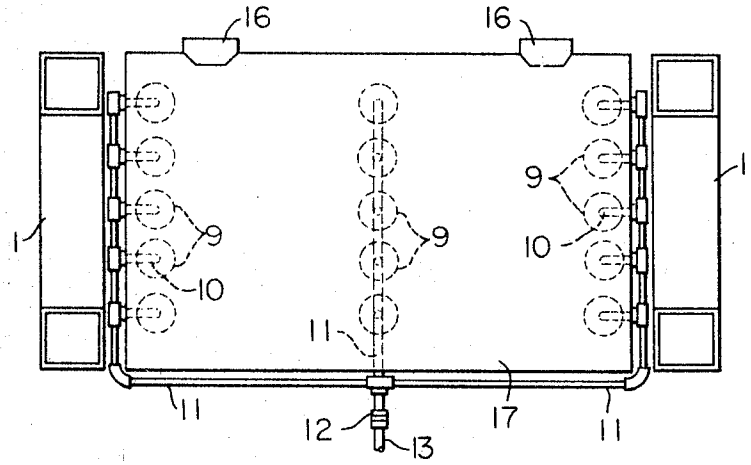
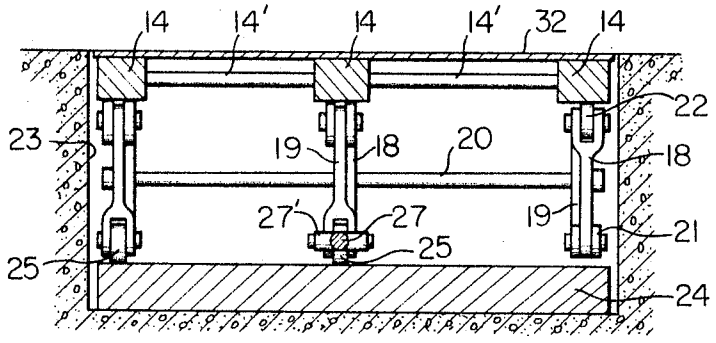


Fig. 6



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Fig. 7

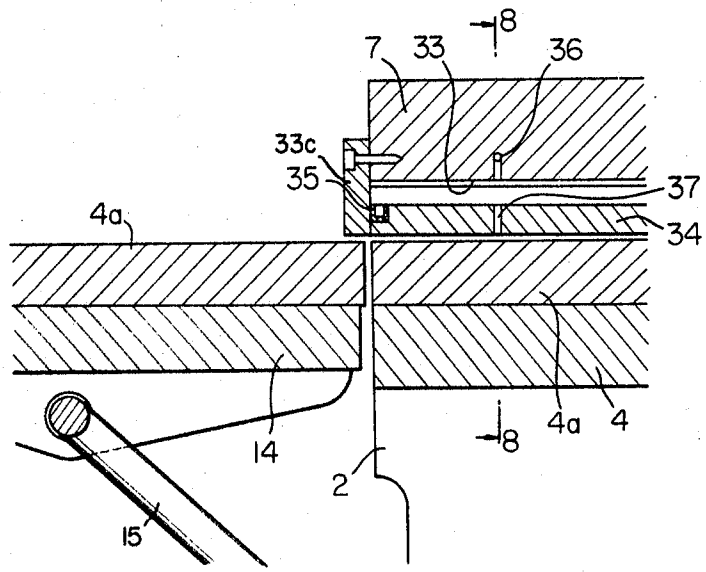
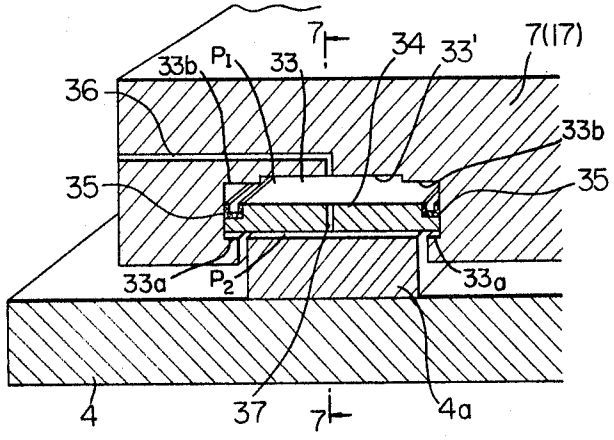


Fig. 8



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Fig. 9

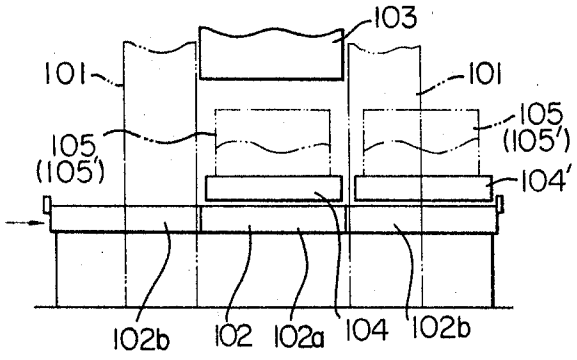


Fig. 10

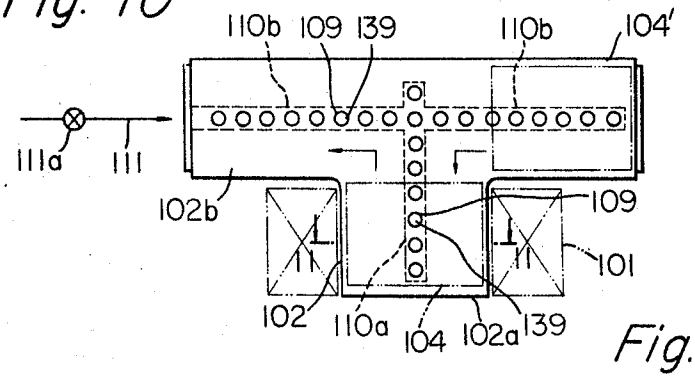
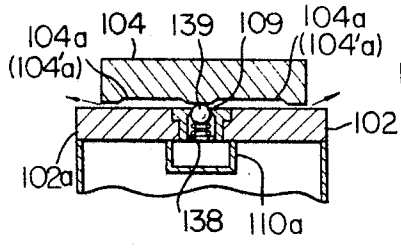


Fig. 12

Fig. 11



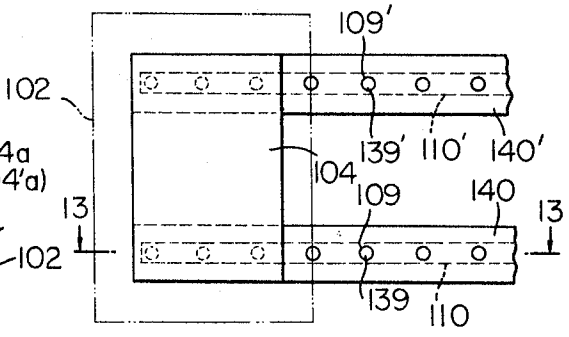
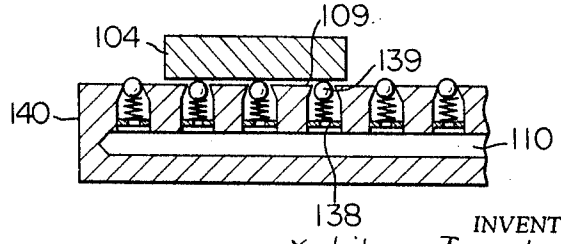


Fig. 13



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United States Patent Office

3,457,874

Patented July 29, 1969

3,457,874

QUICK DIE CHANGING SYSTEM

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Filed Sept. 19, 1966, Ser. No. 580,337

Int. Cl. B64f 3/00; B60v 1/00

U.S. Cl. 104—23 5 Claims

ABSTRACT OF THE DISCLOSURE

In a press machine of the type having a set of die members exchangeable for another set, a die change device comprising a punch holder which releasably holds an upper die member and means for releasably holding a lower die member, means for positioning said punch holder and said holding means in the operation position in said press machine, means disposed outside of said operation position and adapted to receive said die members and punch holder and said holding means from said positioning means, said holding means having a plurality of recesses therein, sealing blocks in said recesses and movable therein in a direction transverse to the surface of said positioning means, said sealing blocks cooperating with said recesses and permitting leakage of air under pressure from within said recesses behind said sealing blocks, said holding means further having air passages therethrough opening into said recesses, and means coupled to said holding means for supplying air under pressure to said passages and said recesses, said sealing blocks cooperating with said positioning means and said receiving means for lifting said holding means and said dies upwardly off said positioning means under the effect of the air under pressure which moves said sealing blocks downwardly and then leaks past said sealing blocks to form a film of air between the sealing blocks and the positioning means.

The present invention is directed to improved means for quickly and efficiently changing dies in press machines. More particularly, it is concerned with such a die change device in which the die assembly is transferred from one place to another horizontally by means of man power assisted by air and which is particularly suited for use in combination with a medium size press machine.

Medium size press machines generally employ die members weighing from 100 kg. to several tons. The transfer of such heavy die members for the purpose of exchange or replacement is rather hard work for the operator of the press machine. Usually, two or more assistant workers are required to effect such work. As the working space is limited, this work takes much time for completion and is moreover dangerous. During this die change operation, the whole machine is necessarily stopped which means an important time loss. Various means, such as power driven lifting or pulling machines or cranes, have been proposed. However, when it is desired to incorporate such means in a medium size press machine, the space is not large enough for efficient installation.

Accordingly, an object of this invention is to provide a new die change device for use in a press machine which enables an assembly of die members to be moved on the bolster surface or the like with greatly reduced friction and minimizes the man power necessary for the die transfer operation.

Another object of this invention is to provide a die change device which is simple and compact in construction.

Still another object of this invention is to provide a die change device by which the transfer of the die assembly is effected in a very short time and efficiently and yet safely.

According to the present invention, there is provided a die change device for a press machine which comprises means for releasably holding die members, means for positioning said holding means in the operation zone of said press machine, means disposed outside of said operation zone of the press machine and adapted to receive said die members from said holding means, and means for supplying compressed air under the bottom surface of said holding means, so as to create thereunder an air film whereby the holding means are supported thereby so that they can be displaced with a slight manual force.

Further objects and advantages will appear from the following detailed description of preferred embodiments of this invention taken in conjunction with the drawings, in which like reference numerals designate equivalent parts on the various figures.

FIG. 1 is a schematic side elevational view of a press machine incorporating one type of die change device of the present invention;

FIG. 2 is an enlarged side elevational view of the FIG. 1 die change device, with part of the device shown in section taken substantially along line 2—2 in FIG. 3;

FIG. 3 is an enlarged plan view of the die holder of said die change device;

FIG. 4 is a schematic side elevational view of a press machine incorporating another type of die change device of the present invention;

FIG. 5 is an enlarged cross-sectional view taken substantially along line 5—5 of FIG. 4;

FIG. 6 is a schematic sectional view taken substantially along line 6—6 of FIG. 4, with the carrier shown in folded position;

FIG. 7 is a schematic sectional view of still another type of die change device of the present invention, taken substantially along line 7—7 in FIG. 8;

FIG. 8 is a view in section of the FIG. 7 die change device taken substantially along line 8—8 of FIG. 7;

FIG. 9 is a schematic side elevational view of a press machine incorporating still another type of die change device of the present invention;

FIG. 10 is a plan view of the FIG. 9 device;

FIG. 11 is an enlarged sectional view taken substantially along line 11—11 in FIG. 10;

FIG. 12 is a fragmentary plan view of still another type of die change device of the present invention, and

FIG. 13 is a slightly enlarged sectional view taken substantially along line 13—13 in FIG. 12.

Referring now more particularly to FIGS. 1 to 3 of the drawing, one type of die change device of the present invention, as applied to a conventional press machine, will

be described. The press machine essentially comprises a machine framework 1 and a stationary bed 2 housed in the framework. A slide member 3 is slidably mounted on the framework 1 and is driven vertically by a conventional means to effect press operation. A bolster 4 is fixedly mounted on top of the bed 2. An upper die member 5 is releasably secured to the underside of a punch holder 6 which in turn is releasably secured to the underside of the slide member 3 by any means known to the art. The punch holder 6 is shown in FIG. 1 as released from the slide member 3. A mating lower die member 5' is also releasably secured on the top surface of a die holder 7 which in turn is releasably secured on the top surface of the bolster 4 by any conventional means. The punch holder 6 has upright guide posts 8 extending upwardly from the holder 7 at its corners and the lower ends of the posts are press fitted or threaded into corresponding bores formed in the die holder 7 to be firmly retained therein. The punch holder 6 preferably has bushings fitted in bores formed therein corresponding to those of the die holder, said bushings having central bores for slidably guiding the guide posts 8 therethrough. The punch holder 6 with the upper die member 5 is movable toward and away from the lower die member 5' fixed on the holder 7, through guide of the posts 8, to effect pressing operation on the work.

As seen from FIGS. 2 and 3, the underside of the die holder 7 of this invention is formed with a plurality of spaced circular recesses or pockets 9. In this embodiment, four pockets 9 are provided equally spaced from center point of the die holder 7, of which two are arranged at the left side edge and the other two at the right side edge of the holder as best seen in FIG. 3. The pockets, however, may be rectangular or of any desired shape and the number of the pockets may also be increased as desired. Each of these pockets has a depth of about 0.05 to 0.10 mm. Substantially L-shaped air passageways 10 extend from the outlet port formed at the center of each respective pocket 9, through the body of the die holder 7, outwardly to an inlet port formed in its side wall. To each inlet port is connected a U-shaped air supply conduit 11 which surrounds substantially the three sides of the die holder 7 for feeding air to all the passages 10. The conduit 11 has a coupling 12 connected to the center point of the intermediate portion between the two legs thereof for receiving air. A flexible pipe 13 is adapted to be connected to the conduit 11 through the coupling 12 for feeding compressed air from the supply source (not shown). The above pockets 9 have each the same configuration and volume which volume may be made larger or smaller depending upon the total weight in combination of the upper and lower die members 5 and 5', punch holder 6, and die holder 7 as well as upon the pressure of the compressed air employed in the system.

A die carrier 14 is pivotally connected at one end to one side of the bolster 4, (see FIG. 1) and is supported nearly at its center by a pivoted stay 15 adapted to rest on a foot block 15' thereby maintaining the upper face of the carrier horizontal. The die carrier 14 is provided at its free end with a handle 14' by which it is slightly pulled up firstly to disengage the stay 15 from the foot block and then can be swung down, together with the stay 15, into a pit (not shown) underneath, whenever the carrier 14 is not in use.

When it is desired to exchange the used die members for a new set of die members, the punch holder 6 is detached from the slide member 3 and the die holder 7 is also detached from the bolster 4. Thereafter, the handle 14' of the die carrier 14 is pulled upwardly to swing the carrier about its pivotal axis to such a degree as to permit the foot of the stay 15 to be pushed back and positioned to rest on the foot block 15'. When the handle is released, the carrier 14 is supported and maintained in the horizontal position by the stay.

After the punch holder 6 and die holder 7 have been detached from the slide member and bolster and the die carrier 14 has been erected to the position shown in FIG. 1, the stop valve (not shown) provided in the air supply conduit 13 is opened to allow compressed air to flow from the supply source to the pocket 9 through the coupling 12, U-shaped conduit 11 and the respective air passageways 10. As the compressed air enters the pocket 9 and begins to leak between the abutting surfaces of the bolster 4 and the die holder 7, the pressure acts on the under face of the die holder 7 as well as on the upper surface of the bolster 4, ultimately raising the die holder slightly above the bolster, and thus a slight clearance is established between the die holder and bolster. As the air is continuously supplied under pressure, the clearance filled with the compressed air is maintained substantially in a state of equilibrium and the resulting thin air film supports the die holder 7 in a floating state above the bolster surface. In this floating state, the entire die unit (which includes the upper and lower die members 5, 5', punch holder 6 and die holder 7) can be moved easily in a horizontal direction onto the die carrier 14 on which is also formed the air film as the die holder travels. During this transfer of the die unit from the machine to the carrier, the die unit is maintained in its floating state above the upper surfaces of the bolster 4 and the carrier 14, because the air film is successively formed under the die holder 7. In other words, the air film is successively formed within the limited area which the die holder occupies in relation to the bolster and/or the carrier and therefore, substantially no frictional resistance is developed between the die unit and the bolster and/or the carrier. When the die unit has been properly positioned on the die carrier 14, the valve of the air supply conduit 13 is closed to discontinue the flow of the compressed air from the supply source to the die holder pocket 9 whereby the air film dissipates and the unit firmly settles on the carrier. Now the upper and lower used die members 5 and 5' are removed from the punch holder 6 and die holder 7 respectively and replaced by a new set of die members, the whole unit being reassembled. The valve of the air supply conduit 13 is again opened to allow the compressed air to flow into the respective pockets 9. An air film is again built up in the same manner as described above, as the die unit travels from the carrier 14 onto the bolster 4. As described in connection with the transfer of the die unit from the bolster onto the carrier, the floating die unit is thus transferred horizontally from the die carrier 14 onto the bolster 4 merely by a man power with the aid of the air film. In order to properly position the die unit on the bolster 4, the die holder 7 is provided at one edge thereof with a positioning or index means 16 (FIG. 3). After the die unit has been completely transferred onto the bolster 4, the supply of compressed air is again discontinued by closing the valve of the air supply conduit 13. Thereafter, the die holder 7 is again secured to the bolster 4 and the punch holder 6 is again secured to the slide member 3. Now the press machine is ready for a pressing operation with a new set of die members.

The air pressure for forming the air film is such that the die holder 7 may be floatingly supported at a distance of 0.03 to 0.1 mm. from the upper surface of the bolster 4 and/or that of the die carrier 14.

FIGS. 4 through 6 show another type of the die change device of the present invention which is adapted to change relatively heavy die members to be used in a relatively heavy duty press machine. In this embodiment, an adapter 17 is detachably mounted on the bolster 4 by any conventional securing means (not shown), on which is fixedly mounted the die holder 7 in a conventional manner. As shown in FIG. 5, the adapter 17 is provided on the bottom with a plurality of circular spaced recesses or pockets 9 (in this instance, fifteen circular pockets 9 are shown in three rows with each row including five pockets and spaced from one another). These pockets 9 have the same circular configuration and the depth in the order

of 0.05 to 1.0 mm. However, the configuration may be of any desired shape and the number may also be varied according to various conditions.

The air passages **10** extend from the pockets **9** to the air supply conduit **11**, substantially in the same manner as described and shown in connection with FIG. 3. The only difference is that the conduit has three parallel branches, the center one of which extends through the body portion of the adapter **17**, as shown in FIG. 5. The conduit **11** is connected to a flexible pipe **13** through a coupling **12**, as already described. The die carrier **14** of this embodiment consists of three sections connected together by tie bars **14** (FIG. 6) and is supported by a pantagraph type collapsible device generally designated by P in FIG. 4. This device P comprises also three sets of collapsible units (FIG. 6). Each unit comprises two rods **18**, **19** crossing each other and pivoted at their center on a common shaft **20**. Each rod **18** has a roller **22** rotatably mounted at its upper end which slides along the under surface of the carrier **14** and the lower end of the rod **18** is pivoted to a bracket **21** fixed to the foundation of the machine or to one end wall of a recess **23** formed in the floor on which the press machine is installed (FIG. 4). Each rod **19** is pivoted at its upper end to a bracket depending from the under surface of the carrier **14** and has at its lower end a roller **25** rotatably mounted thereon to slide along a base block **24** disposed in the recess **23**. A hydraulic cylinder **26** is arranged in the opposite end wall of the recess **23** and has a piston rod **27** extending therefrom to the lower end of the rod **19** of the central unit. The piston rod **27** is formed at its end with a yoke **27'** adapted to connect the roller **25**, the end of rod **19** and the yoke **27'** together in a pivotal manner. As the lower end of the rod **19** is pivotally connected to the piston rod **27**, the said end of the rod **19** can be driven in either direction by the piston rod when the cylinder **26** is energized. When the piston rod **27** has advanced into the recess **23** as indicated in FIG. 4 pushing the lower end of the rod **19**, the rollers **22** and **25** of the crossing rods **18** and **19**, connected together centrally by the common shaft **20**, are caused to slide respectively along the under surface of the carrier **14** and along the upper surface of the base block **24** toward the bed **2** of the machine. Accordingly the carrier **14** is raised to the predetermined operative position in which the upper surface of the carrier **14** is in alignment with that of the bolster **4**. Though not shown in the drawing, any known locking device may be provided to keep the carrier in this position during the die change operation.

If the piston rod is retracted, the device P is folded as shown in FIG. 6 and the carrier **14** is lowered below the floor surface. A protecting sheet of metal may be placed thereon when desired.

In order to perform the die exchange operation in this type of embodiment, the punch holder **6** is detached from the slide member **3** and the adapter **17** is detached from the bolster **4** in the same manner as described in connection with the first embodiment. The adapter **17** on which the entire die unit is supported is then floatingly transferred onto the carrier **14** by providing an air film between the bottom of the adapter **17** and the upper surface of the bolster **4** in the manner as already described. When the adapter **17** has been properly positioned on the carrier **14**, the air valve is closed and the upper and lower die members **5** and **5'** are detached from the punch holder **6** and die holder **7** respectively and then a new set of die members are mounted in their place between the punch holder and die holder and assembled together. The whole assembly may then be returned, with the aid of the air film, to the pressing position of the machine.

Another type of die change device is shown schematically in section in FIGS. 7 and 8. In this modification, a number of guide rails **4***a* are mounted fixedly on the bolster **4** as well as on the carrier **14**. A corresponding number of grooves **33** are formed in the bottom of the die holder **7** (in the case of the first type as in FIG. 1) or of the adapter **17** (in the case of the second type as in FIG. 4). The grooves extend in parallel relationship with the respective rails **4***a* and the lower parts of the grooves receive therein the upper parts of the rails, with slight clearances on opposite sides, so that the die holder **7** or the adapter is guided along the rails. The cross section of the groove **33** is such that the mouth is just wide enough to receive the rail **4***a* but the upper part is widened to accommodate a sealing block **34** overlying the guide rail. The sealing block **34** is hermetically sealed on four sides by means of packings **35** so as to be sealingly movable between the lower shoulders **33***a* formed at the mouth of the groove and the upper shoulders **33***b* formed on the upper part of the groove **33**. L-shaped air passages **36** are formed in the holder **7** and extend from the outside wall thereof to the top of the respective grooves **33**. The sealing blocks **34** are also provided with corresponding air passages **37** extending vertically therethrough. The air passages **36** are connected with the outer air conduit, coupling and flexible air supply conduit to receive compressed air from the supply source in the manner as described in connection with the first embodiment.

In the present modification, when air is supplied under pressure through the air passages **36** into the grooves **33**, the pressure within the grooves **33** is increased. Blocks **33***c* (FIG. 7) may be used to seal the front and back end of groove **33**.

The sealing block is in its uppermost position resting on the upper shoulders **33***a* of the groove and when so positioned, helps define with recessed portion **33'** a thin elongated pocket thereabove. The increased pressure in the groove then builds within portion **33'** and gradually pushes the sealing block **34** down to the lower inwardly projecting shoulders **33***b* of the groove **33**, at the same time raising the die holder **7** upwardly. The air confined within the groove then seeks escapement through the air passages **37** from which the air leaks through the abutting faces of the sealing block **34** and the guide rails **4***a*. Accordingly a thin film of air is formed under the sealing block **34** to support the same in spaced relationship with the rail **4***a*. The air finally escapes through the clearances between the narrow lower portion of the groove **33** and guide rail **4***a* into the atmosphere. The sectional area of the air passage **36** and that of the air passage **37** are such that the air pressure P_1 within the space located above the sealing block **34** is kept somewhat greater than the air pressure P_2 of the air film formed on the guide rail **4***a*. As the entire die unit is thus supported on the air film formed on the guide rail **4***a*, the die unit can be shifted by man power in either direction toward or away from the carrier **14** for effecting the die change operation.

FIGS. 9 to 11 show a further modified form of die change device according to the present invention in which the bolster itself is movable on a pressurized air film formed thereunder by air forced out of the bed of the press machine. In this embodiment, the bed **102** of the press machine is T-shaped, as shown in FIG. 10, and comprises an operation portion **102***a* projecting transversly of the machine and a bracket portion **102***b* which extends parallel to the machine. The slide member **103** (FIG. 9) is mounted on the machine frame in a conventional manner and positioned above the operation portion **102***a*. As best seen in FIGS. 10 and 11, the bottom of the bed **102** is provided with a pair of air ducts **110***a* and **110***b* connected with each other. The air duct **110***a* extends centrally of the operation portion **102***a* while the air duct **110***b* extends centrally of the bracket portion **102***b*, the two ducts intersecting at right angles and communicating with each other. The duct **110***a* is closed at the opposite ends while the duct **110***b* is closed at one

end (the right end as seen in FIG. 10) and open at the other end for communication with an air conduit **111**. The conduit **111** is connected through a stop valve **111***a* to a suitable air supply source (not shown).

The bed **102** is further provided with a plurality of spaced air holes **109** communicating with the air ducts **110***a* and **110***b* which are welded to the bottom of the bed. As seen in FIG. 11, the upper end of each air hole **109** is so formed as to provide a valve seat for engaging with a ball **139** disposed within said hole and urged against said seat by means of a coiled spring **138** retained there by any conventional means. The upper end of each air hole is usually closed by the ball valve **139**, with its upper portion projecting slightly above the surface of the bed **102**.

The bolster **104** is mounted on the bed portion **102***a*, during the press operation of the machine, so as to firmly support a pair of upper and lower die members **105**, **105'** thereon. A second bolster **104'** is disposed at the right side of the bracket portion **102***b* (as seen in FIGS. 9 and 10) ready for exchange. This second bolster also has a new set of die members assembled thereon for next use. The bottom of these bolsters **104** and **104'** is usually flat, but may be recessed as at **104***a* and **104***a'* in FIG. 11, if desired.

To change the die members in this type of die change device, the stop valve **111***a* is opened to permit under pressure to enter the air ducts **110***a* and **110***b*. The ball valves **139** are still closed except where the bolster **104** and **104'** ride on the bed **102**. The balls positioned under each bolster are displaced downwardly by the weight of the bolster, thereby opening whatever valves **139** that are located under the bolster. Accordingly, air is forced out through such valves to the underface of the bolster, and a pressurized air film is finally established between the bolster and the bed, in the same manner as described in connection with previous embodiments. As this air film is supporting the bolsters **104** and **104'**, they can easily be removed and exchanged. The bolster **104** carrying the entire die unit is first transferred from the operation portion **102***a* backwardly onto the rear bracket portion **102***b* and then to the left side of the bracket portion **102***b*. The second bolster **104'** carrying the new die unit including the die members **106** and **106'** already assembled ready for use, on the right side of the bracket portion **102***b*, is then moved leftwards and forwardly onto the operation portion **102***a*. (See the arrows in FIG. 10.) The air holes **109** over which the bolster has passed away are automatically closed by the spring loaded ball valves **139** to minimize air consumption. After the second bolster **104'** carrying the new die unit has been properly positioned on the operation portion **102***a*, the valve **111***a* is closed to stop the air supply.

FIGS. 12 and 13 show a still further embodiment of the present invention which includes a single bolster carrying a die unit and supported on an air film created by the air introduced from the bed of a press machine as in the previous embodiment just described. In the present embodiment, however, guide rails **140** and **140'** are provided on both the bed **102** and the carrier. The rails **140** and **140'** are arranged in parallel and spaced from each other. Air passages **110** and **110'** extend longitudinally through the body portion of the rails and are connected with a number of air holes **109** and **109'** equally spaced longitudinally in the rails.

The upper end of the hole **109** (or **109'**) is narrowed to form a valve seat, against which a ball **139** is urged by a coiled spring **138**, housed and retained in the hole **109** in any conventional manner. Normally the ball **139** protrudes slightly out of the upper surface of the rail **140**, as stated in connection with the previous embodiment. With this construction, the ball valves under the bolster **104** are forced to open and a pressurized air film is formed in the same manner as described in the previous embodiment. The bolster may be transferred by a minimum of force to any desired die change platform for exchange of the die members and return, or may be replaced by a separate second bolster having fresh die members assembled thereon for ready use.

While there has been shown and described illustrative embodiments of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and reference should be made to the appended claims for a definition of the scope.

What is claimed is:

1. In a press machine of the type having a set of upper and lower die members exchangeable for another set, a die change device comprising a punch holder which releasably holds an upper die member and means for releasably holding a lower die member, means including guide rails for positioning said punch holder and said holding means in the operation position in said press machine, receiving means disposed outside of said operation position and adapted to receive said die members and punch holder and said holding means from said positioning means, said holding means includes a die holder adapted to hold the lower die member, said die holder having a plurality of recesses therein, said recesses are constituted by deep, elongated grooves extending in laterally spaced parallel relation and continuously extending throughout the longitudinal length within said die holder, said grooves including side and top walls; sealing blocks in said recesses and movable therein in a direction transverse to the surface of said die holder and said positioning means, parallel guide rails disposed on said positioning means and receiving means and projecting into said grooves and in engagement with said sealing blocks; said sealing blocks cooperating with said recesses and permitting leakage of air under pressure from within said recesses behind said sealing blocks, said die holder of the holding means further having air passages therethrough opening into said recesses, and means coupling to said die holder for supplying air under pressure to said passages and said recesses, said sealing blocks further cooperating with the guide rails of said positioning means and said receiving means for lifting said holding means including the die holder and any associated dies upwardly off said positioning means and rails under the effect of the air introduced into said grooves under pressure which moves said sealing blocks downwardly and then leaks past said sealing blocks to form a film of air between the sealing blocks and the guide rails of the positioning means.

2. A die change device as claimed in claim **1** in which said sealing blocks are elongated and extending continuously substantially the full length of the grooves in said die holder, said blocks having peripherally disposed sealing strips which are sealingly engaged with the walls of said recesses and have at least one bleed hole therein for allowing escape of air from behind the sealing blocks.

3. A die change device as claimed in claim **2** in which said grooves each have an elongated mouth portion just wide enough to receive a guide rail and a wider portion inwardly of said mouth portion in which said sealing block is slidable.

4. A die change device as defined in claim **2** in which said grooves each have an elongated mouth portion having a cross-sectional or transverse width just slightly wider than and wide enough to slidably receive a guide rail therewithin; said groove including a wider portion inwardly above and extending on opposite sides of said mouth portion and defining opposed lower shoulders, said wider portion being of a height in excess of said sealing block thickness and terminating at its top wall in a further shallow recess portion intermediate the side walls thereof to define opposed upper shoulders, and said sealing block via said strip sealingly engaging said

upper shouders when said die carrier is in a rest condition and selectively engageable with said lower shoulders when said die changing device is in a working condition and responsive to the aforesaid introduction of air under pressure into said grooves.

5. A die change device as defined in claim 4 wherein the construction of the guide rails, sealing blocks and grooves is such that when in the working condition the die carrier is pneumatically supported on said guide rails in a centralized non-friction manner whereby the escaping air pressure cooperates also with the opposite lateral sides of the mouth of the groove and with the sides of the guide rails projecting thereinto to better centralize the die carrier.

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U.S. Cl. X.R.

180—125; 214—1