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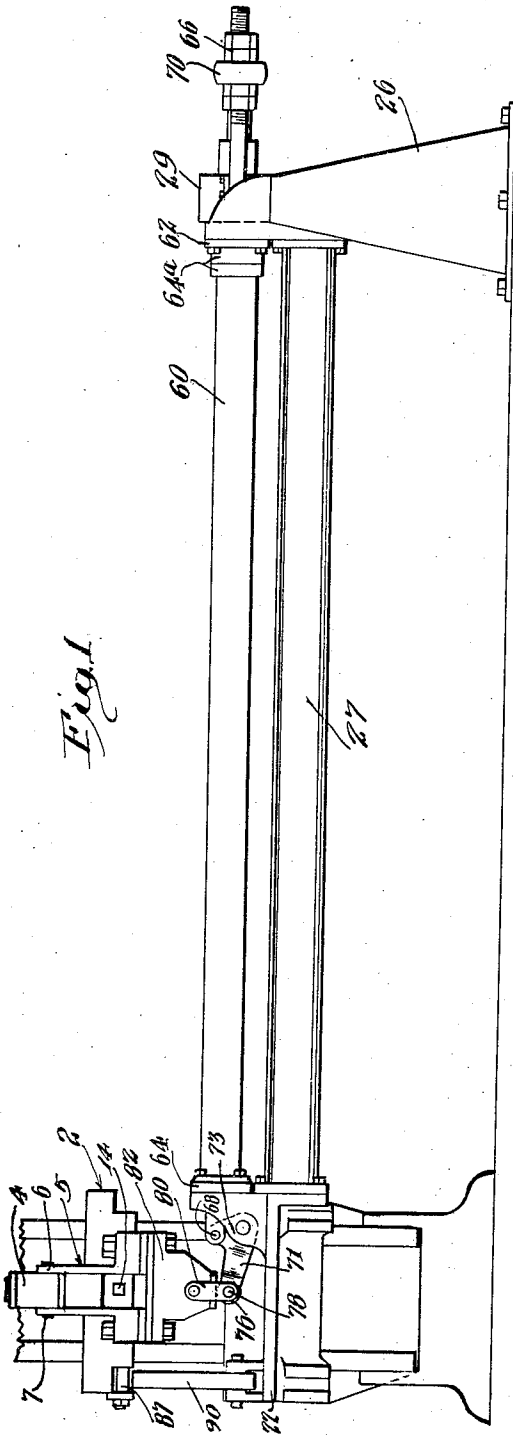
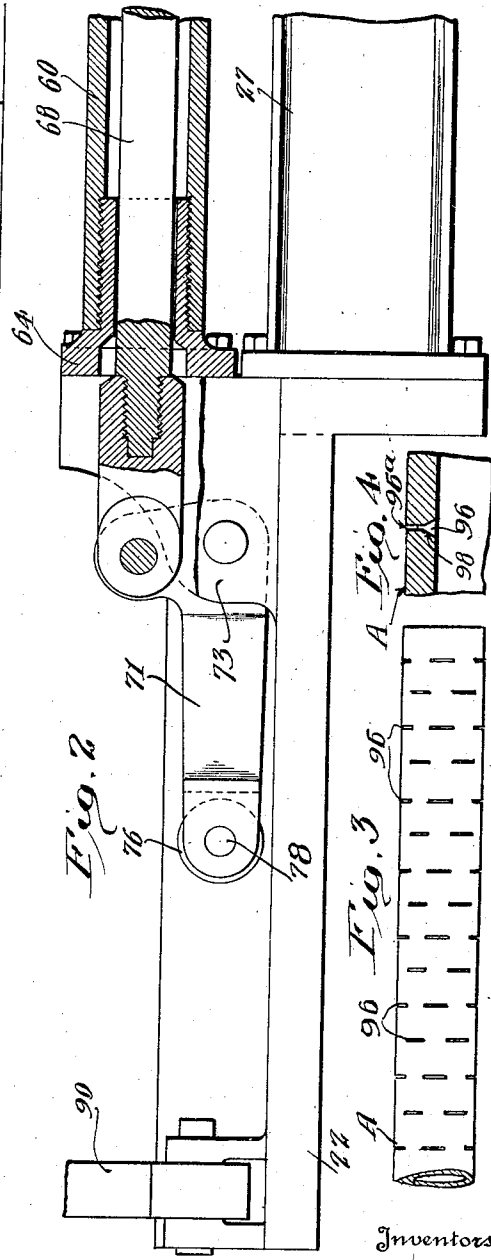
M. J. TRUMBLE ET AL

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APPARATUS FOR PERFORATING CASINGS

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3 Sheets-Sheet 1



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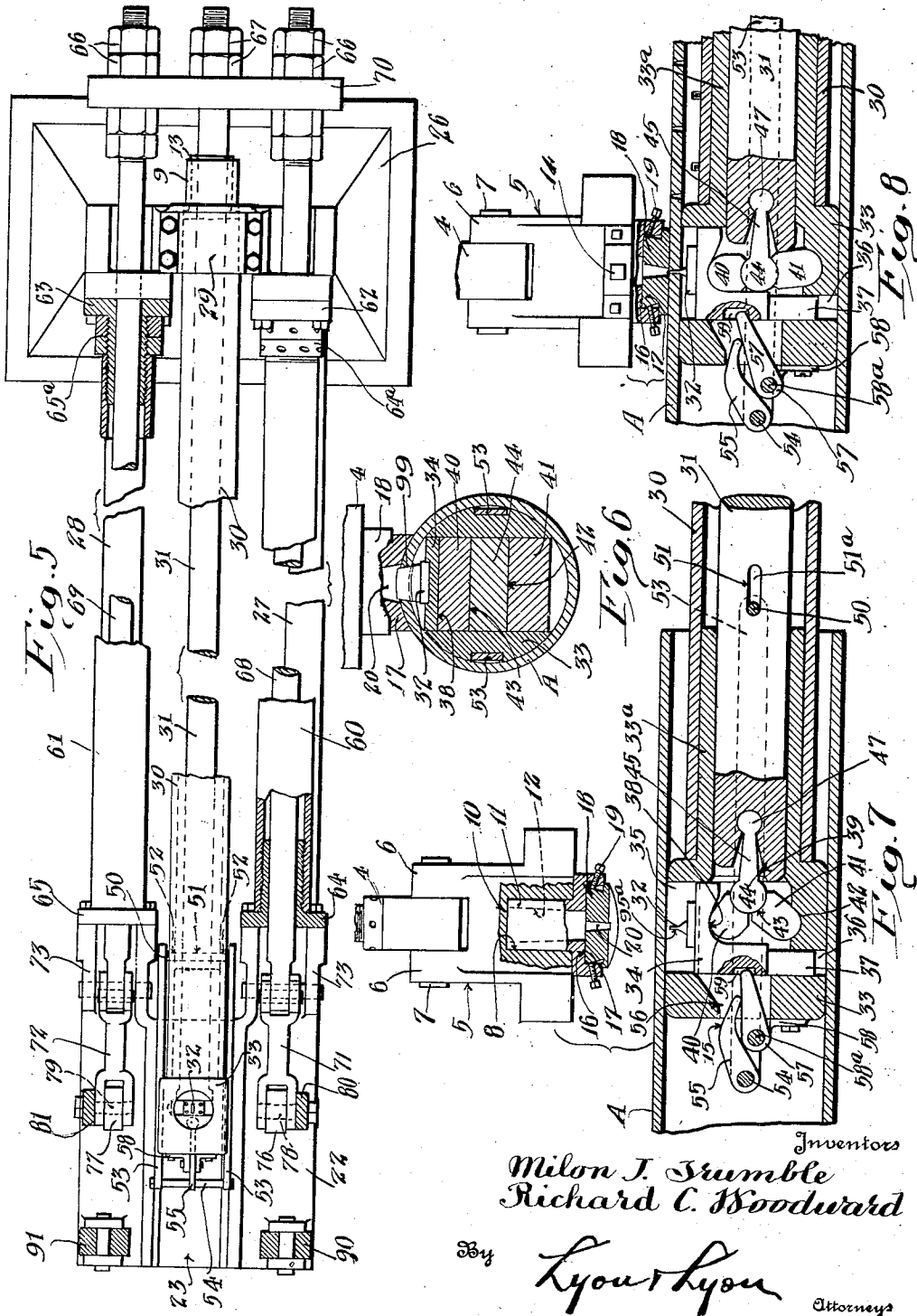
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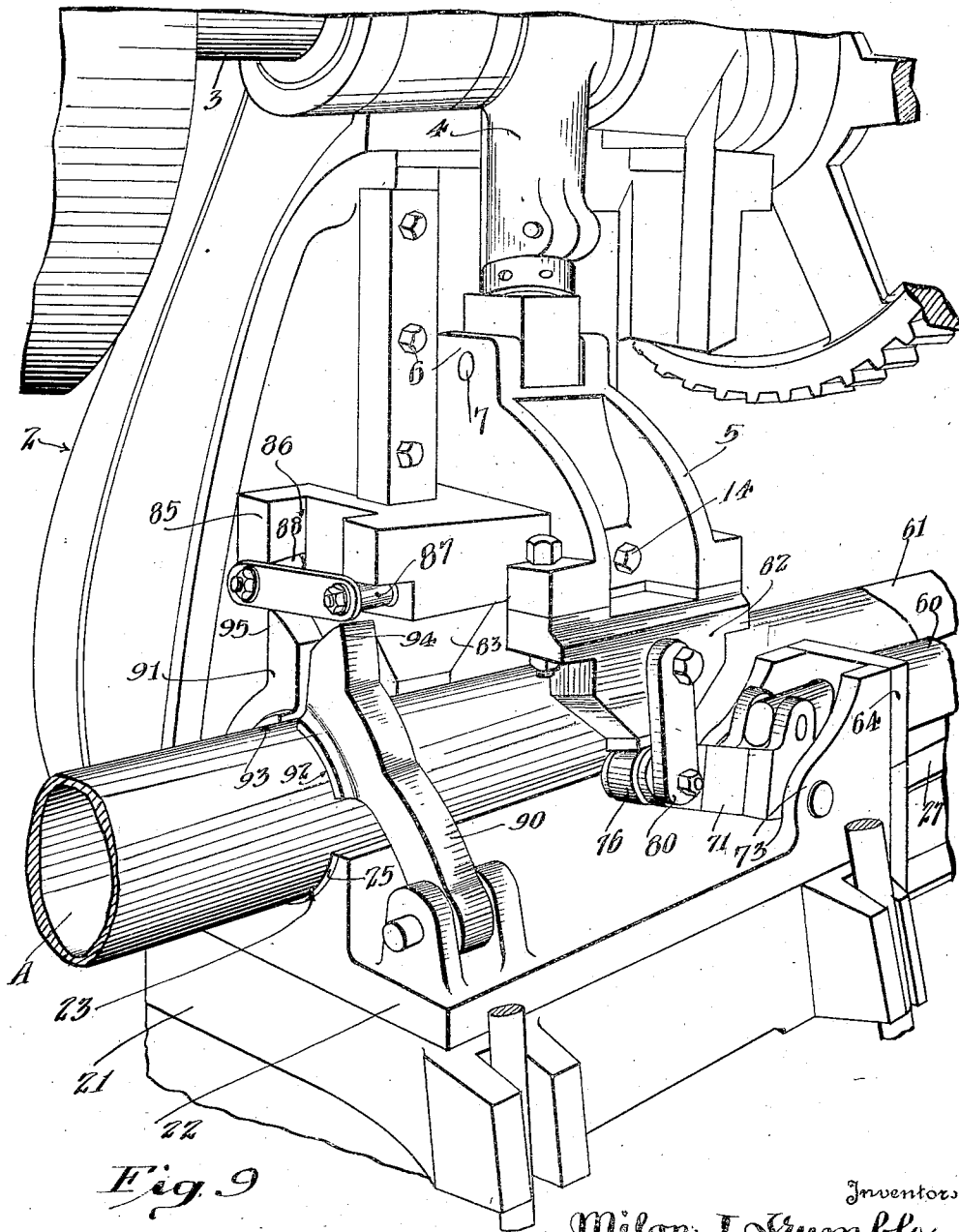


Fig. 9

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UNITED STATES PATENT OFFICE

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APPARATUS FOR PERFORATING CASINGS

Application filed September 28, 1925. Serial No. 59,246.

This invention relates to apparatus for perforating casing and refers particularly to apparatus for perforating of casing for use in oil or water wells either for the perforation of the casing to form well screen or for the preparation of other products. The invention will be described in the form particularly adapted for the formation of well screen from which the other analogous uses of the apparatus will be readily apparent.

Heretofore the art has had considerable difficulty in the economical manufacture of well screen for oil or water well use. A screen for oil or water use must for proper action be provided with openings of uniform size and the casing in which these openings are formed must possess considerable resistance to collapsing. Various methods have been heretofore employed in attempting to provide an economical well screen with uniform size of openings and of sufficient strength so that caving in of the well on the screen or fluid pressure in the well will not collapse the screen. Among these attempts have been the milling of casing or tube from the inside, which, however, is found to remove so much material from the casing that the resultant product is weak and easy to collapse. The art has also attempted to provide proper screen openings by forming them separate from the casing or tube in the form of a button or plug which is screw threaded or otherwise affixed in a large opening in the screen tube. This method not only produces a screen weak where the button connects with the tube, but also involves considerable expense. The art has also attempted to form screening openings by initially milling the casing from the outside and then punching the wall adjacent the opening so as to crimp the wall over and regulate the size of the final screening opening. This leaves the screen weak at the perforations and produces a screen with a rough exterior.

In the co-pending application of Milton J. Trumble, filed October 12, 1925, Serial No. 62,190, there is described a method and apparatus for forming well screen by punching openings in the casing from the inside,

the punch being forced against the casing opposite to where a die is positioned on the exterior. By the apparatus and method of such co-pending application, it has been found possible to produce screen openings of desired size and with a minimum removal of material from the casing and without substantially roughening or weakening the casing around the openings and at the same time consolidating or hardening the material of the casing around the openings by a cold pressing action, so that the resultant screen, when produced, is of a strength substantially equal to and at times greater than the strength of the untreated casing.

It is an object of the present invention to provide an apparatus for forming similar well screen to that formed by the invention of said co-pending application, which apparatus is adapted to more positively synchronize the action of the die and punch or other tool employed and can be constructed in a more durable form more readily adjusted.

More specifically, an object of the present invention is to provide for means for operating the punch or other tool within a well casing to be treated from a horizontally reciprocating rod connecting the punch with a reciprocating ram of a punch press operating to present or retract the die to the casing.

Another object of the present invention is to provide a means for gripping and holding the casing being treated during the punching or other casing treating operations.

Various further objects and advantages of the invention will appear from a description of a preferred apparatus embodying the invention, for which purpose reference is made of the accompanying drawings, in which a preferred example of the apparatus is illustrated.

Referring to the drawings:

Fig. 1 is a front elevation, the upper end of the punch press being broken away,

Fig. 2 is an enlarged view partially in vertical section of certain connections between the ram of the punch press and means em-

ployed in actuating the punch of the apparatus.

Fig. 3 is a section of a well screen formed by the apparatus,

Fig. 4 is an enlarged fragmentary section of well screen taken through one of the perforations or slots,

Fig. 5 is a plan view of the apparatus, the upper part of the punch press being broken away, and certain parts of the apparatus being in longitudinal section.

Fig. 6 is a transverse section through the punch operating means of apparatus disclosing the punch in the operation of perforating a well screen and discloses the position of the die during such operation.

Fig. 7 is a view at right angles with Fig. 6, mainly in vertical longitudinal section showing the die and punch in the retracted position.

Fig. 8 is a similar view, but with the die and punch in the punching position, and

Fig. 9 is a perspective view of the punch press and of the apparatus, certain parts being broken away to contract the view.

Referring to the drawings, the apparatus preferably comprises a punch press 2 which should be of considerable size and may be of the ordinary type provided with a horizontal shaft 3 carrying a cam or other means for reciprocating a vertically depending ram or arm 4 as the shaft 3 is rotated. Said ram or arm 4 carries a holder 5 which is employed in the apparatus for holding a die block 18. In practice, it is found practical to employ 30 to 60 ton press forming a one inch slot or perforation in a well casing and such press is provided with a cam or eccentrics, which will furnish 3" to 4" stroke on the press arm. These figures are given for the purpose of illustration and without intention to limit the invention to the use of such a punch press, as various other means for actuating the die may be employed without departing from the invention. The holder 5 is provided with ears 6-6 at its upper end abutting opposed sides of the ram 4 and through the ears 6-6 and ram 4 is passed pin 7 for attaching the holder to the arm. The lower end of the holder 5 is provided with a socket 8. 10 indicates a die holding head having an extension 11 fitting into the socket 8 of the holder 5 and provided with a tapered bore 12. Said die head 10 is held to the holder 5 by set screws 14 and V-block. The lower end of the die holding head 10 is provided with a socket 16 receiving a tenon 17 of the die holding head 18, set screws 19 being threaded through the die holding head 10 to engage the sides of the tenon 17 and anchor the die block therein.

The base 21 of the punch press mounts a base member 22 having a longitudinal groove 23 shaped to conform with the ex-

terior surface of the casing, which is to be perforated by the apparatus, the base member thus being adapted to serve as a casing rest. Preferably the base member 22 has its casing receiving groove 23 lined with a replaceable bearing material 25 as indicated in Fig. 9. Positioned at one side of the punch press 2 is placed a footstock or pedestal 26, being placed a little over one half the length of the casing to be perforated by the apparatus.

The footstock 26 is connected with a punch press 2 by parallel I-beams 27 and 28 spaced horizontally apart.

A pipe 30 has one end resting on the center of the footstock 26 and clamped thereto by yolk 29. Said pipe 30 extends to the rear of the footstock and is provided with a collar 9 carrying a bushing 13. The pipe 30 extends from the footstock to a point under the ram 4 of the punch press. Said pipe 30 encloses a horizontally reciprocal operating rod 31 for the punch 32 of the apparatus, said punch 32 being positioned below the die block 18 and in position to cooperate therewith and upon vertical movement partially entering the slot 20 therein. Preferably the specific form of die and punch is similar to that described in the copending application of Richard C. Woodward, Serial No. 59231, filed September 28, 1925.

The punch 32 is mounted in a punch holder 34 reciprocally mounted on a punch head or guide 33. Said punch head 33 is provided with a tubular stem 33^a fitting within the rod enclosing pipe 30, the stem serving to provide the operating rod 31 with a bearing or bushing at its forward end, and the punch head 33 is thus supported by the pipe 30. The punch head 33 is further provided with a cylindrical bore 35 extending downwardly from its upper side in which the punch holder 34 is mounted to slide in a vertical direction and the punch head 33 is provided with a reduced cylindrical bore 36 extending downward with the main bore 35 at the forward end of the bore which reduced bore 36 receives a cylindrical guiding extension 37 of the punch holder. The side of the punch holder 34 adjacent the operating rod 31 is recessed as indicated at 38 to receive a toggle connection generally indicated at 39, one arm or link 40, of which engages the upper side of the recess 38 in position to urge the punch holder 34 upward and the lower arm or link 41 of which engages within a groove 42 in the head 33. The inner ends of the arms 41 and 40 are shaped to engage a cylindrical surface 43 provided by enlargement 44 at one end of the loose link 45, the opposed end of the link having a cylindrical surface provided by the enlargement 47 fitted in a transverse bore near the end of the operating rod 31, the operating

rod 31 having an inwardly contracting recess communicating with such lateral bore through which the central part of the loose link 45 extends.

5 The operating rod 31 is also provided with a horizontally elongated slot 51 aligning with similar slots 51^a in opposed sides of the rod enclosing pipe 30 through which a rod 50 extends. Such rod 50 is connected at its
10 opposed end to horizontal bars 53 which are extended beyond the die head 33 and are there connected by rod 54 which pivotally mounts a pawl 55. The pawl 55 extends into an opening 56 in the die holder and
15 normally rests against a second pawl 57. Said pawl 57 is pivotally mounted on a rod 58^a supported by a bracket 58 bolted to the end of the head 33. Said latter pawl 57 extends through the opening 56 in the head
20 and engages within a recess 59 in the punch holder 34. The pawl 55 is shaped to provide a slanting surface 15 which when brought in engagement with the edges of the upper side of the recess 56 will cause the
25 pawl 55 to press downwardly upon the pawl 57, in order to bring punch 32 back into the retracted position.

There is thus provided a means for forcing the punch 32 through the casing A
30 which is to be perforated and which in operation is positioned or inserted over the punch head and supported by pipe 30. There is thus also provided a means for retracting the punch from the casing A upon a reverse
35 motion of operating rod 31. In practice, the casing A to be perforated is telescoped over the head 33 and the rod 31 and enclosing pipe 30 and pushed back towards the footstock 26 to bring the front end of the casing A in position to be perforated. This
40 end, in turn, is supported by the screen rest 22 mounted on the base 21 of the punch press 2. It can be seen that by reciprocation of the operating rod 31 the punch holder 34
45 will be vertically reciprocated within the punch head 33, being first forced upwardly by the toggle connection 39, said toggle connection permitting the exertion of a large force on the holder 34 to force the same
50 through the casing A. The punch head 33 receives support during the punching operations by reason of its engagement with the casing A to be perforated which in turn engages the casing rest 22 which is roved to
55 conform with the exterior of the casing A. The mandrel 34 is caused to descend on the reverse movement under the rod 31 by the action of the pawl 57 upon the mandrel 34, this pawl 57 being pressed downwardly by
60 the pawl 55 which is forced against the press holder 34 through the action of the rod 50 engaging the ends of the opening 51 of the operating rod 31. It is thus seen that the punch 32 may be reciprocated to form open-
65 ings in the casing by the reciprocating action

of the operating rod extending through the casing A to be perforated. This is found to be a valuable improvement over the form of punch actuating means described in said
70 co-pending application Serial No. 62,190 inasmuch as there is no tendency thus imparted to the punch to rotate the same out from alignment with the die. Moreover the high pressure necessary to the consolidating
75 or cold pressing of the material on the casing around the perforations, is thus imparted to the punch 32 by connection through the casing A (rod 31) which is subjected only to endwise compression and
80 not placed under a torque load which would have a tendency to destroy the timing or synchronism between the motions of the die and punch.

In order to provide a means by which the operating rod 31 can be actuated in syn-
85 chronism with the reciprocation of the die block 18 and be actuated by force from the punch press 2, rod enclosing pipes 60 and 61 are provided at opposed sides of the pipe 30 extending horizontally from the punch
90 press 2 to the pedestal or footstock 26 of the apparatus. Such pipes 60 and 61 are attached to the footstock 26 by means of flange bushings 62 and 63 and attached to the punch press by means of bushings 64 and
95 65 bolted to the punch press. 64^a and 65^a indicate lock nuts fastened to the bushing for tightening the pipes 60 and 61. 68 and 69 indicate rods which are enclosed within the pipes 60 and 61, the rear ends of which
100 rods extend from the pipes 60 and 61 to the rear end of the pedestal 26 and there are connected by a cross bar 70 to operating rod 31. 66 indicates nuts which may be used to adjust the position of rods 60 and 61, and
105 67 indicates nuts serving as an adjusting means to adjust the position of the rod 31.

At the punch press the rods 68 and 69 are connected to rocker arms 71 and 72,
110 respectively, such rocker arms are mounted at opposed sides of the punch holder 34 in lugs 73 of the base member 22. The opposed ends of the rocker arms 71 and 72 are bifurcated to receive bearings 76 and 77 mounted upon rods 78 and 79, such rods 78 and 79
115 are respectively connected by links 80 and 81 to bolts passing through bearing blocks 82 and 83 which are, in turn, bolted to the bottom of the opposed sides of the die holder 5 of the punch press 2, such bearing blocks
120 82 and 83 extend downward into engagement with the bearings 76 and 77, respectively supported by crank arms 71 and 72.

By the mechanism just described it will be seen that upon vertical reciprocation of a
125 punch arm 4 of the press the rocker arms 71 and 72 will be rocked and thus reciprocate the rods 68 and 69 which connect with the punch operating rod 31 so that such rod 31 thus may reciprocate the punch 32 in
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synchronism with the reciprocation of the die block 18. The rocker arm thus provides a means by which the reciprocation of the die block 18 creates a second reciprocating motion at right angles thereto and directly therefrom, which may be used to actuate the punch 32 and thus action of the punch and die may be more positively synchronized.

Another feature of the invention is the provision of means adapted to grip and release the casing A, which is being punched. This gripping means operates to hold the casing A when the same is being punched or perforated and to release the same so that the casing A may be shifted upon retraction of the punch. Such means includes a vise block 85 carried by the die holder 5, which vise block is provided with an extending groove 86 disposed above the casing A. The base member 22 mounts a pair of gripper arms 90 and 91 which have grooved surfaces 92 and 93, respectively, shaped to conform with the exterior surface of the casing A. These gripper arms 90 and 91 are adapted to swing over the casing A and are provided at their upper ends with cam surfaces 94 and 95, respectively, which are in position to pass into the groove 86 of the vice block 85. Thus each downward reciprocation of the arm 4 will cause the cam surfaces 84 and 85 to be pressed together by the vice block 85 and the casing A thus to be tightly held by the gripper arms 90 and 91. In order to decrease friction rollers 87 and 88 may be mounted in the lower end of the groove 86 with their inner surfaces extending slightly beyond the groove 86 for initially pressing the gripper arms 90 and 91.

It is understood that the die and punch 32 may be of various types or shapes for performing different operations upon casings or like material and that in place of a punch 32 the apparatus may have other tools for performing other operations. However, when it is desired to perforate well casing the punch 32 is provided with straight side walls 95^a for a short distance at its tip so that when forced into the casing any inaccuracies in the sides of the casing A or other causes will not effect the size of the finished screen opening. Below this straight wall portion the punch is provided with a tapered base 96 which will enlarge the opening formed in the casing A inwardly and also act to press the material of the casing outward from the punch to consolidate the material or cold press the same, strengthening the structure of the casing around the opening and thus permitting the perforation of the casing without weakening of the same. This angle of taper is preferably between 15 and 45 degrees.

An important advantage of the present invention is that the rod 31 is subjected

only to endwise compression in actuating the punch to the punching position. This insures the punch and die being accurately brought to the correct operating position. Moreover this direct and straight line compression on rod 31 is placed thereon by a straight pull on rods 68 and 69 in a direction parallel to the line of force to be applied on rod 31 and the lines of force on rods 31, 68 and 69 are all in the same parallel plane. Thereby the force imparted to rod 31 from rods 68 and 69 is prevented from imposing on the footstock 26 any force tending to bend or tilt the same which would result in the punch and die being actuated to position in which they were not aligned.

The punch is preferably actuated through a comparatively short stroke to that of the die. Thus when the die is actuated through a 3" to 4" stroke it is preferable to actuate the punch through a $\frac{1}{8}$ " to $\frac{3}{8}$ " stroke. Moreover, the punch is made to reach substantially the end of its punching stroke prior to the die with the following beneficial results. As the punch advances to the end of its punching stroke the punch engages the inner wall of the casing and presses there against. The outside of the casing adjacent the punch being at this time unsupported the punch does not punch through the casing, but bulges the same out around the punch tips and the punch assumes the position where any pressure thereon from the casing is substantially applied to the casing below the casing A. The die then contacts with such bulge on casing A and irons the same out, causing the punch to perforate the casing. In this manner the greater pressure necessary to perforate the casing may be applied to the die working without the casing.

While the apparatus herein described is well adapted for accomplishing the purposes of the invention, various modifications may be made without departing from the spirit of the invention, and the invention is therefore capable of numerous modifications, all coming within the scope of the appended claims:

We claim:

1. In an apparatus of the class described, the combination of a base member forming a rest for a casing, a punch press having a plunger ram carrying a die and operative to reciprocate said die to alternately position the die and retract the die from the exterior of a casing resting upon said base member, a punch carried by a guide, means for mounting the guide within such casing in position to cooperate with the die, reciprocally mounted means for actuating the punch, and rocker arms connecting said means to said ram and operative to actuate said means from said reciprocations of said ram.

2. In an apparatus for perforating well casing, the combination with a punch press having a reciprocating ram, a die carried by the ram, means for supporting the casing under the ram, means for supporting a punch within the casing in position to cooperate with the die, a rod mounted to reciprocate within the casing, toggle means for actuating the punch from said rod, and means interconnecting the die and said rod whereby the force imparted to said reciprocating ram actuates said toggle means.

3. In an apparatus for perforating well casing, the combination of a die actuating means operated to present and retract the die from the casing, punch actuating means operated from said die actuating means, said latter means being operative within the casing to be perforated, and means supplemental to the die actuating means operative to grip the casing during each punching operation.

4. In an apparatus for perforating well casing, the combination of die actuating means, of a punch actuating means for cooperation therewith for effecting perforating operations, a die actuated by said die actuating means, a punch actuated by said punch actuating means, the punch actuating means being operable within the casing to be perforated, said punch actuating means embodying a toggle connection, a rod reciprocal longitudinally within the casing to be perforated, and means interconnecting the die and said rod whereby the die actuating means actuates said rod.

5. In an apparatus of the class described, the combination of a press and footstock rigidly united, the press having a plunger ram carrying a die, a pipe supported at one end by the footstock extending to the press and mounting a punch guide in fixed horizontal position, carrying a punch in position to cooperate with the die, a rod within said pipe for reciprocating said punch, a rod rigidly secured to said first rod at the footstock and extending to the plunger ram, and rocker means there connecting such last mentioned rod to the ram.

6. In an apparatus of the class described, the combination of a press and footstock connected together, a pipe supported at one end by the footstock and extending to the press, a tool mounted by the pipe so as to be reciprocable transversely relative thereto, a rod reciprocally mounted within the pipe for actuating the tool and extending to the rear of the footstock, said press including a ram carrying a die, a rod extending from the press to the rear of the footstock, rocker arms connecting said rod to said ram, and adjustable connecting means between the first and second mentioned rods.

7. In an apparatus for perforating casing, a punch press having a base groove to con-

form with the casing to be perforated when the same is mounted thereon, the punch press being provided with a reciprocable die carrying ram, a rocker actuated by said ram, a tool mounting means insertible into the casing to be treated, and connecting rods actuated by said rocker for operating the tool.

8. In an apparatus of the class described, a punch press having a reciprocable ram, a die connected to said ram to be presented and retracted thereby, a footstock mounting a punch supporting member extending beneath said ram, a punch reciprocally mounted by said member, a punch actuating rod, and operating means connecting said rod to said ram.

9. An apparatus for perforating casings for use in oil wells, comprising a punch press having a downward movable ram carrying a die, a footstock supporting a pipe extending beneath the ram, a punch head supported by said pipe beneath the ram, a punch reciprocally mounted by said head to cooperate with said die, and means for gripping and releasing a casing to be perforated when said casing is arranged over said punch head the gripping of said pipe being in synchronism with the operation of the ram.

Signed at Los Angeles, California, this 17th day of September, 1925.

MILON J. TRUMBLE.

RICHARD C. WOODWARD.

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