March 13, 1951 J. F. CRAWFORD 2,545,229

BILLET PIERCING APPARATUS

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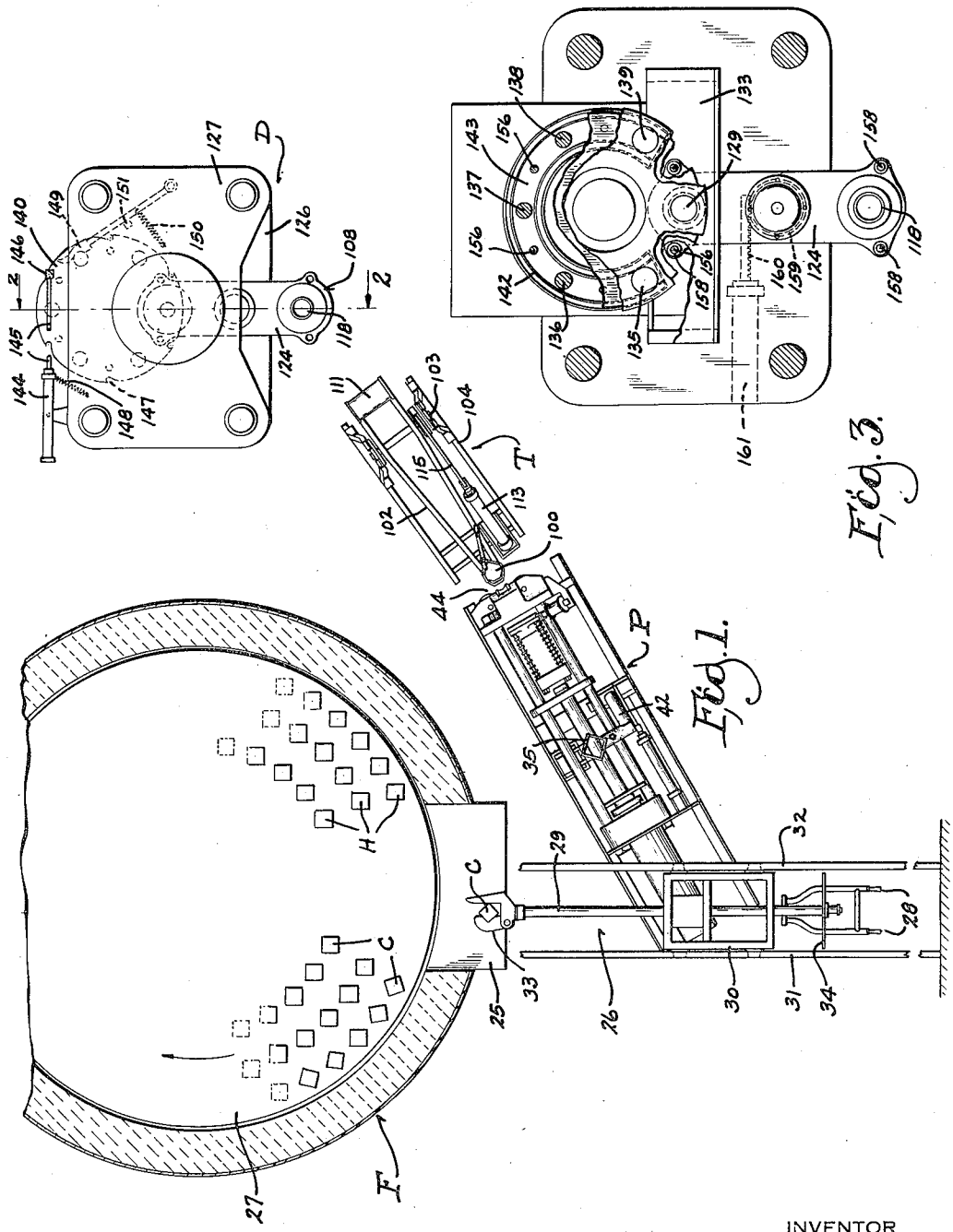


Fig. 3.

Fig. 1.

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BILLET PIERCING APPARATUS

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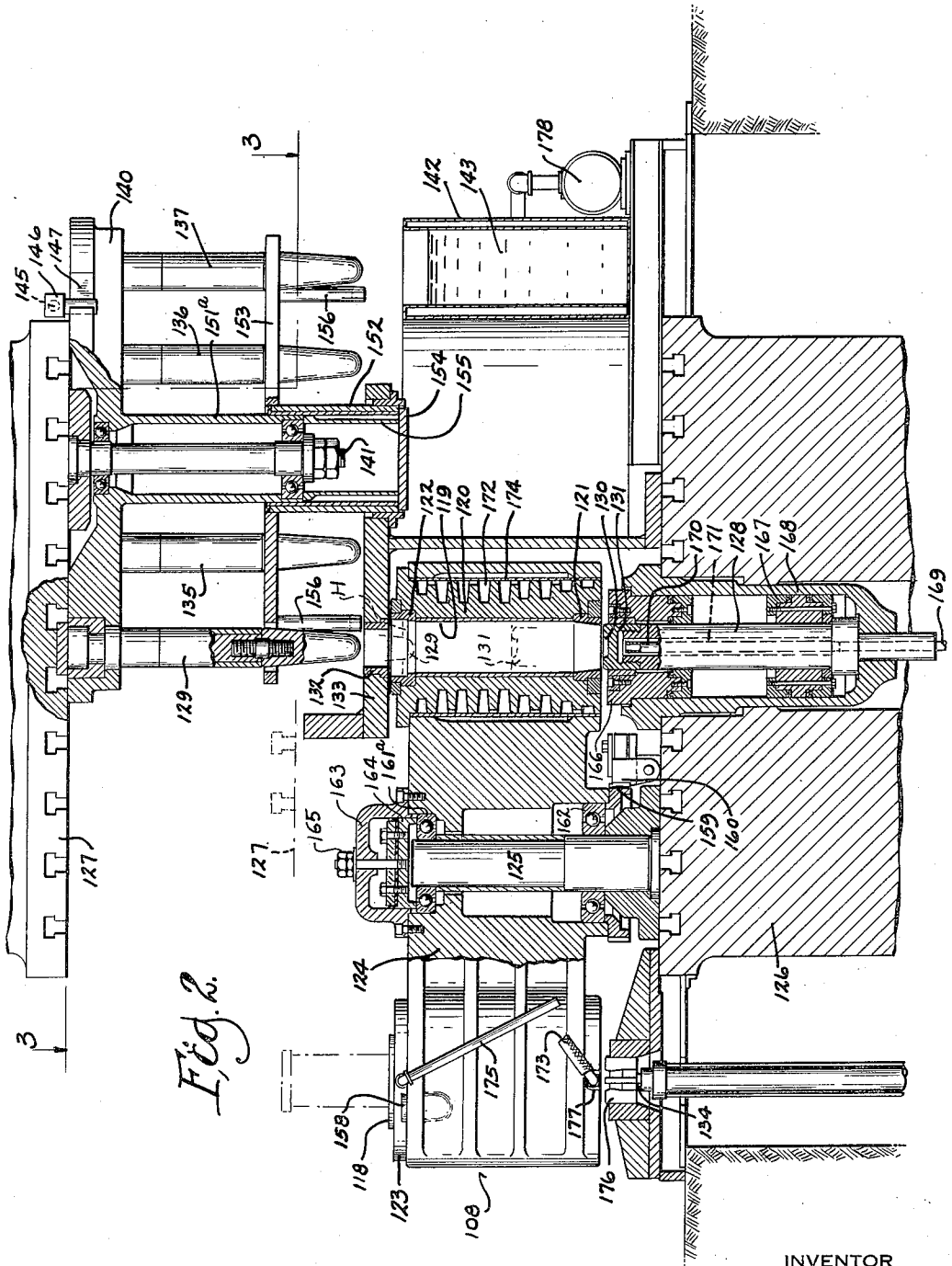


Fig. 2.

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BILLET PIERCING APPARATUS

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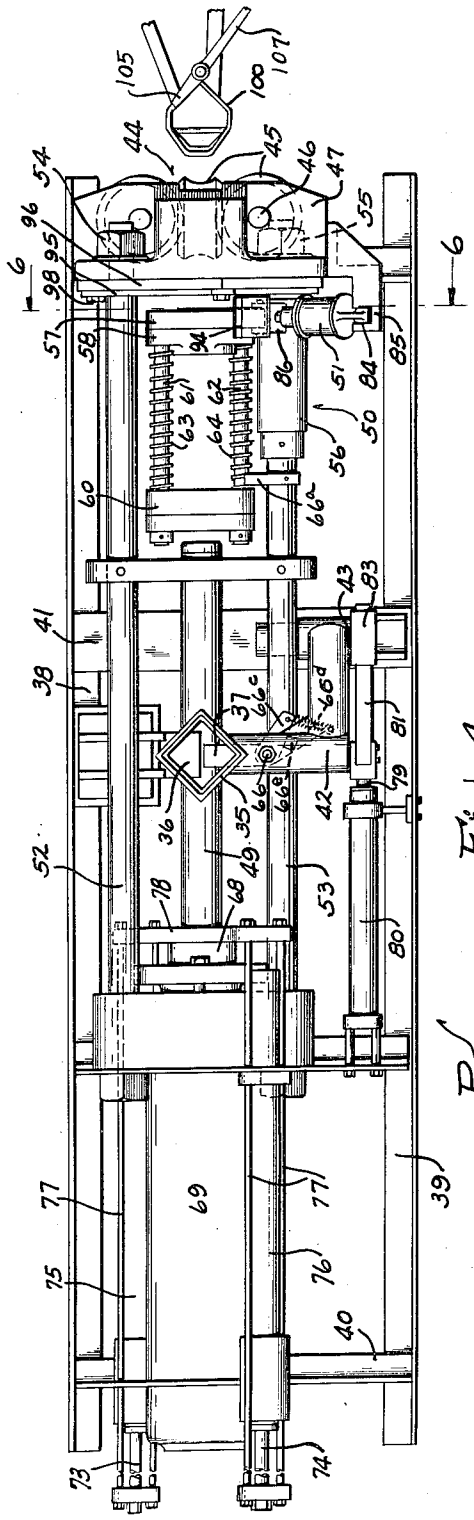


Fig. 4.

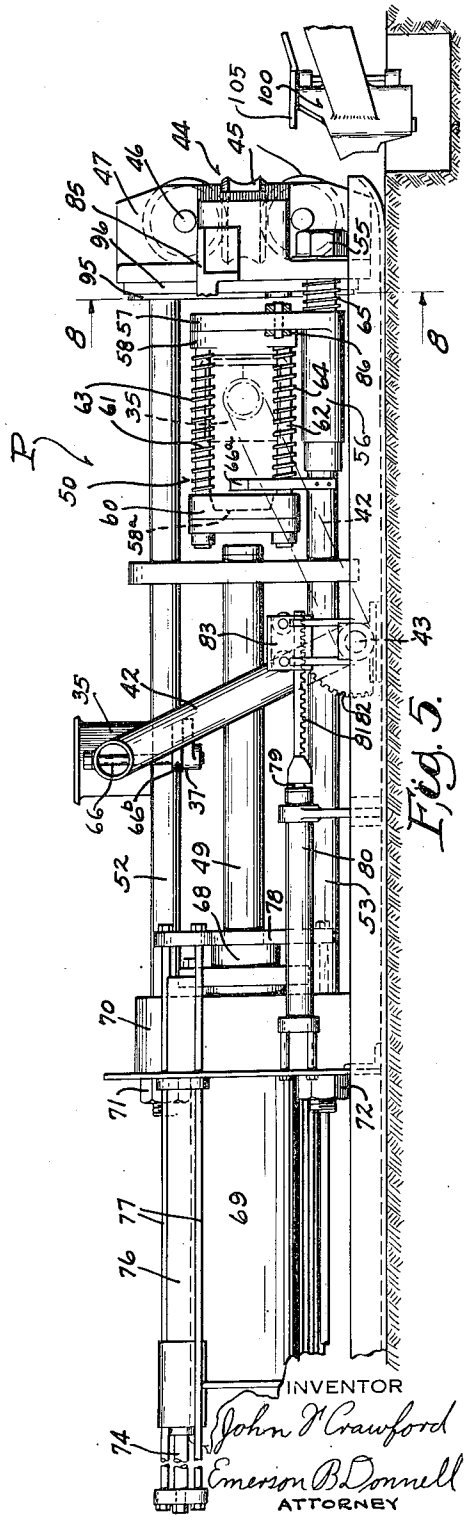


Fig. 5.

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BILLET PIERCING APPARATUS

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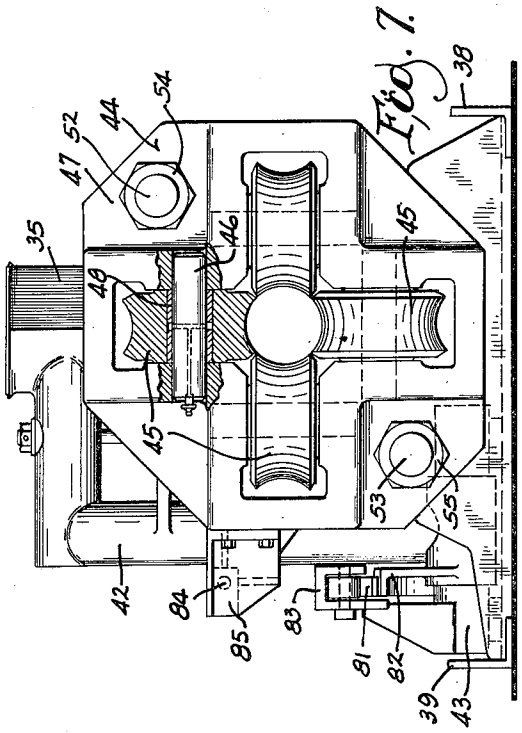


Fig. 7.

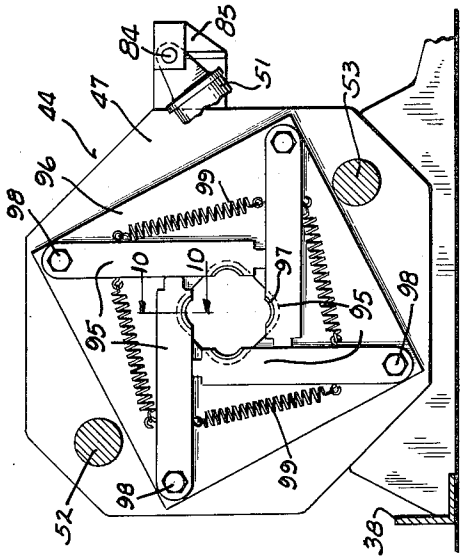


Fig. 8.

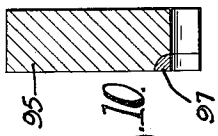


Fig. 10.

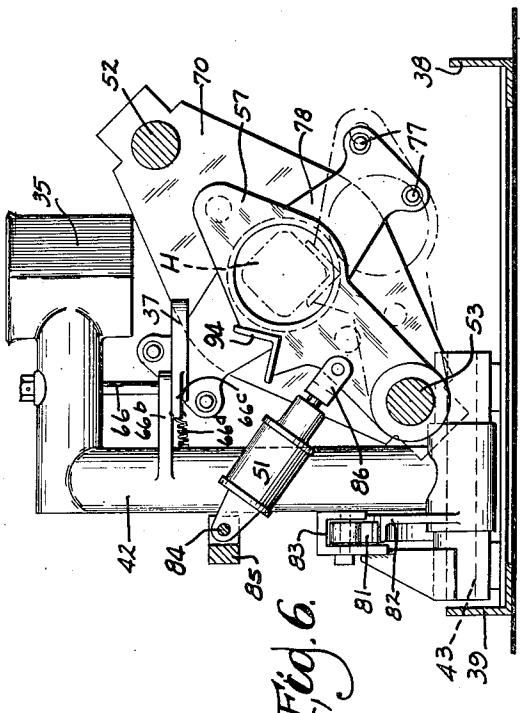


Fig. 6.

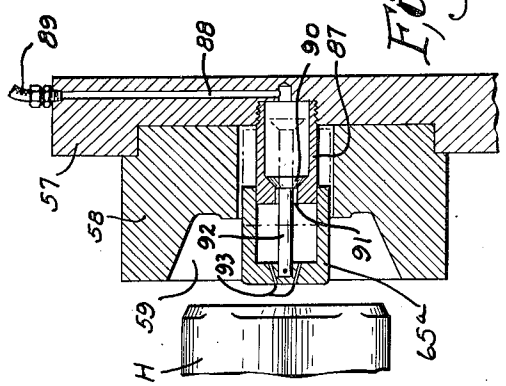


Fig. 9.

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BILLET PIERCING APPARATUS

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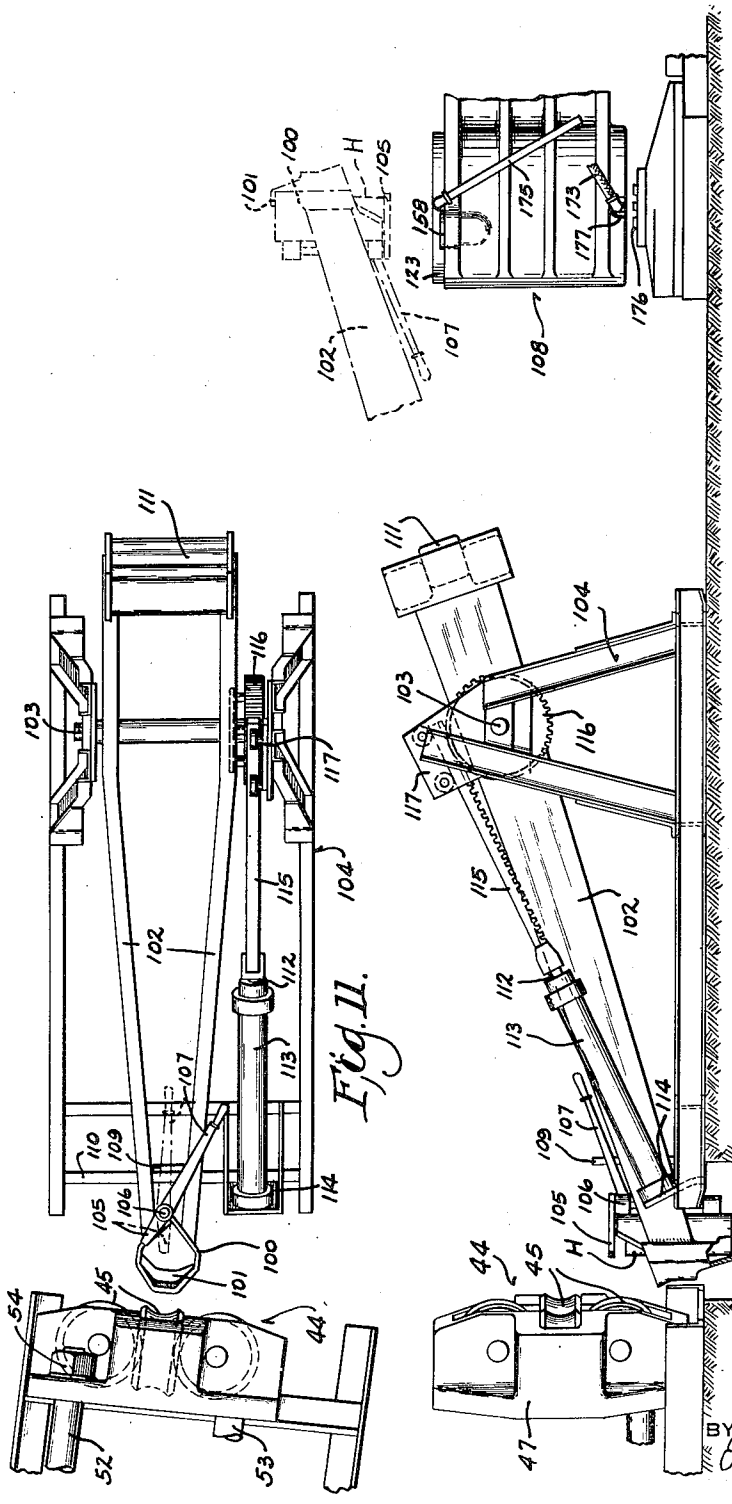


Fig. 11.

Fig. 12.

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BILLET PIERCING APPARATUS

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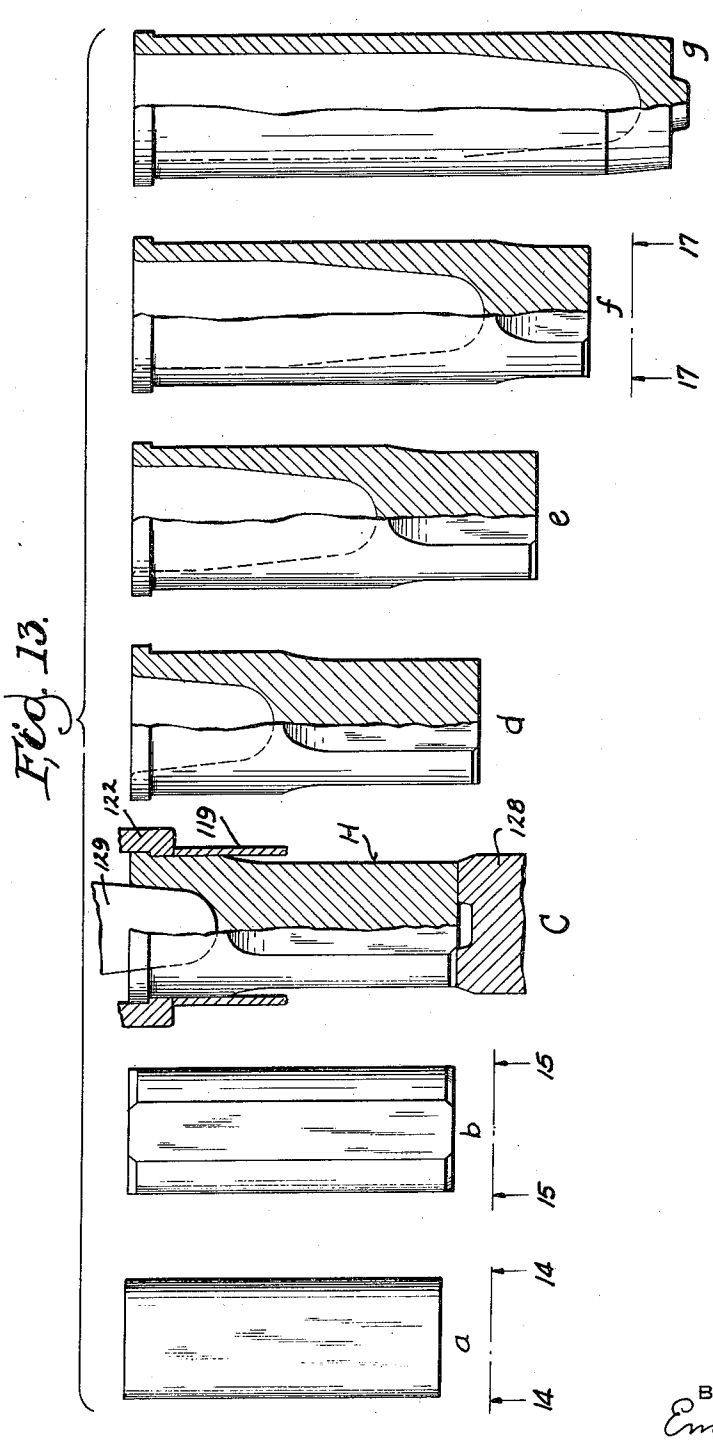


Fig. 13.

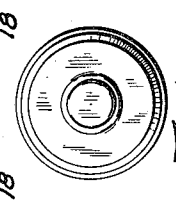


Fig. 18.

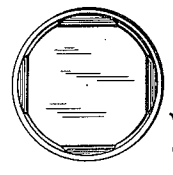


Fig. 17.

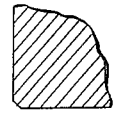


Fig. 16.

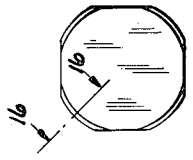


Fig. 15.



Fig. 14.

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UNITED STATES PATENT OFFICE

2,545,229

BILLET PIERCING APPARATUS

John F. Crawford, Racine, Wis., assignor to J. I. Case Company, Racine, Wis., a corporation of Wisconsin

Application April 28, 1945, Serial No. 590,896

2 Claims. (Cl. 78—9)

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The present invention relates to a forging apparatus, and an object thereof is to generally improve the construction of such mechanism. A further object is to provide an apparatus for forming a round forging from an angular billet. A further object is to avoid the formation of a claw-like appendage at the end of the billet. Further objects are to provide an apparatus for forming a round hollow forging from an angular billet in one heat and for causing an improved flow of metal in such a forging so as to improve the grain structure in the resulting forging. Further objects are to provide expedients for the realization of the above objects.

Other objects and advantages of the invention will become apparent from a consideration of the following detailed description taken in connection with the accompanying drawings wherein a satisfactory embodiment of the invention is shown. However, it is to be understood that the invention is not limited to the details disclosed but includes all such variations and modifications as fall within the spirit of the invention as herein expressed.

In the drawings,

Figure 1 is a plan view partly diagrammatic in character of an apparatus.

Fig. 2 is a vertical sectional view on the line 2—2 of Fig. 1.

Fig. 3 is a horizontal sectional view on the line 3—3 of Fig. 2 on a somewhat reduced scale.

Fig. 4 is an enlarged detail of a portion of Fig. 1.

Fig. 5 is an elevation of the portion of the machine shown in Fig. 4.

Fig. 6 is an enlarged vertical section substantially on the line 6—6 of Fig. 4.

Fig. 7 is a right end elevation (enlarged) of the structure seen in Fig. 5 with parts broken away.

Fig. 8 is an enlarged vertical sectional view substantially on the line 8—8 of Fig. 5.

Fig. 9 is an enlarged vertical sectional view on the line 9—9 of Fig. 4.

Fig. 10 is an enlarged vertical sectional view on the line 10—10 of Fig. 8.

Fig. 11 is an enlarged plan view of certain mechanism indicated in Fig. 1.

Fig. 12 is a side elevation of the same.

Fig. 13 is a diagrammatic representation of a billet in the various stages of the operation of forming a hollow object therefrom, the various stages being designated as *a* to *g* inclusive and parts being broken away.

Fig. 14 is an end view of the billet prior to the forming process, as indicated by the line 14—14 in Fig. 13.

Fig. 15 is a view of the billet taken on the line 15—15 of Fig. 13.

Fig. 16 is an enlarged sectional view on the line 16—16 of Fig. 15.

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Fig. 17 is a view taken on the line 17—17 of Fig. 13 showing the hollow object nearly completed.

Fig. 18 is a view taken on the line 18—18 of Fig. 13 showing the completed object.

The invention may be best understood in a preliminary way by a consideration of Fig. 1. The billets which are to be forged are heated in a furnace F, being delivered to a feed plate 25 in any suitable manner forming no part of the invention and not necessary to describe further. A gripping and handling unit generally designated as 26 is used to place the cool billets in furnace F and also to remove heated billets and place them in a pointing and descaling unit generally designated as P. The billets are cleaned of the scale acquired in the furnace, partially pointed and rolled into a substantially round or cylindrical form in the unit P and then delivered into a transferring and inverting unit T by which they are transferred to and placed within a forging die unit generally designated as D where the billet is formed into a hollow object of the desired form, in the present instance a shell blank. The several operations take place in quick succession, the elapsed time from the placing of the billet in the unit P to its removal from the unit D being commonly in the neighborhood of not more than 90 seconds. For this reason, it is possible to perform the several operations which will be described in detail presently, while the billet retains the heat which it had when first removed from furnace F. In other words, it is unnecessary to reheat the billet once the cycle of operations is started. This, of course, reduces the loss of metal by oxidation and also greatly reduces the amount of handling as compared with any process in which reheating of the billet is required between the steps of the method. It is commonly more convenient for forged objects of the nature dealt with in the present invention to obtain material of angular formation, in the present instance square, the billets dealt with in this case having approximately the cross section indicated in Fig. 14, namely square with rounded corners. For making a round hollow object, the billet must be brought to a substantially round outer configuration and then pierced. The apparatus which applicant has devised will now be described in the most convenient and efficacious manner.

The furnace F is of a well-known type having a floor 27 which rotates very slowly in the direction indicated, the temperature within the furnace being maintained at the desired high level by any well-known means not necessary to describe. Handling unit 26 is in the nature of a remote control pair of tongs having handle grips 28 and a long pole-like body 29. Portion 29 is pivotally supported from a trolley 30 freely movable on rails 31 and 32 which are to be under-

stood to be located well above the head of an operator manipulating grips 28. Portion 29 is substantially balanced and pivotally suspended beneath trolley 30 and has a claw-like jaw unit 33 which can be opened and closed by suitable control means in the neighborhood of grips 28. A shield 34 protects the operator from the intense radiations from within furnace F. By manipulation of grips 28, cold billets as C may be lifted by jaw 33 and placed within furnace F on floor 27. In the course of time floor 27 will have substantially completed a revolution, whereupon the billets will appear at H in a highly heated condition.

Unit 26 is also manipulated to grip heated billets and remove them from furnace F. It will be understood that suitable controls, not necessary to describe, are associated with unit 26 and that the parts are suitably cooled by internal circulation of water, etc., so as not to be damaged by the heat of the furnace. Unit 26 is readily moved in and out and swung from side to side so as to keep furnace F charged with billets being heated and to remove heated billets as fast as necessary to supply the forging process.

It will be understood that suitable shields and the like are associated with the mechanism to protect the operators and make working conditions as comfortable as possible, most of these being omitted to avoid obscuring the essential features of the invention.

In operation the unit 26 is manipulated to pick up one of the hot billets H and is then swung to position the billet over a holder 35. Turning to Figs. 4 and 5, holder 35 comprises an upright box-like receptacle which is open at both ends. Unit 26 is then manipulated to release the billet which drops into holder 35 and rests on an abutment plate 36. A retainer tongue 37 extends partially beneath the billet and serves to prevent the latter from dropping out of holder 35. Plate 36 is supported in any suitable manner, as from a frame member 38, other frame members as 39, 40, 41, etc., being united to provide a base for supporting the several operative parts in correct relation.

Holder 35 is carried on a swinging arm 42 pivoted at 43 on a suitable bearing carried by frame members 39 and 41. Arm 42 may swing from the full line position of Fig. 5 to the dotted line position therein, thereby carrying holder 35 and billet H into position for a preliminary operation.

The preliminary rounding of the billet is accomplished by forcing it through a roller set generally designated as 44 which as best seen in Fig. 7 comprises rollers 45—45, journaled on pins as 46 carried in a yoke, ring or plate member 47, bushings as 48 being introduced, if desired, where the rollers run on the pins. The configuration of rollers 45 is such as to form a substantially round opening therebetween, whereby a billet forced through the space between the rollers will be compressed into substantially round form.

Billet H is forced between the rollers in the present instance by a ram 49 so that rollers 45 are rotated by contact with the moving billet. In this type of operation in the past, the rollers have displaced backwardly some of the metal of the corners which would overhang the rear face of the billet and form a pronged claw-like extension which would be objectionable. Furthermore, difficulty might be expected from resistance of the billet to entering between rollers 45. These difficulties are obviated by the use of the pointing operation above referred to.

A set of dies generally designated as 50 is provided and which may be swung into and out of the path of plunger 49, for example by means of a fluid cylinder 51. Pointing unit P includes the above mentioned dies and a pair of tension rods 52 and 53 which are united with yoke 47 by nuts 54 and 55. Rods 52 and 53 serve to hold some of the operative parts in correct relation with each other, in the present instance die member 59 being mounted on rod 53. A sleeve 56, Figs. 4 and 5 is slidably journaled on rod 53 and has a bracket portion 57 supporting a die 58 which is provided with a cavity 59, as best seen in Fig. 9. A similar die 60 is slidably supported on rods 61 and 62 supported from bracket 57 and die 60 is forced away from die 58 by springs 63 and 64. Dies 58 and 60 are therefore held apart sufficiently that holder 35 with billet H therein can be introduced between them by swinging of arm 42. Bracket 57 is urged to the left as seen in Figs. 4 and 5 by a spring 65. In operation, bracket 57 is swung downwardly about rod 53 after which arm 42 is swung to the dotted position indicated in Fig. 5. Holder 35 then being horizontal, billet H will remain therein and tongue 37 will be swung upwardly about a pivot 66 by means of an abutment 66*a*, suitably supported on the machine. Pivot 66 passes through the horizontal portion of arm 42 and is also supported by a bracket 66*b* extending from arm 42, and tongue 37 has an arm 66*c* connected by a spring 66*d* to a point on arm 42. Spring 66*d* yieldingly maintains arm 66*c* against a stop 66*e* and thus maintains tongue 37 in position to prevent billets from passing through holder 35. When holder 35 takes the dotted position of Fig. 5, finger 37 is pushed out of the way by abutment 66*a*, so as to clear what was previously the lower end of holder 35. Bracket 57 is then swung upwardly by means of cylinder 51 so as to position dies 58 and 60 at opposite ends of holder 35 and billet H. Ram 49 is then advanced into contact with die 60. The resulting pressure of ram 49 compresses spring 65 and allows bracket 57 to shift into contact with ring 47 which, as above stated, is anchored to above mentioned rods 52 and 53. Pressure of ram 49 also compresses springs 63 and 64 so as to bring die 60 against one end of billet H and also to force the other end of billet H into die 58. Bracket 57 is supported by yoke 47 against further movement and the pressure of ram 49 accordingly presses billet H into the cavity 59 of die 58 and into a corresponding cavity 58*a* in die 60. This action bevels the ends of the billet and the pressure also upsets the billet or causes it to swell somewhat with a corresponding reduction of its length. This upsetting or swelling causes most or all of the accumulation of scale, which is brittle, to break and fall off the billet. Ram 49 is then retracted whereupon die 60 is forced away from the billet by springs 63 and 64. The billet is unseated from die 58 by means of a fluid pressed cylinder 65*a* whereupon die set 50 is swung downwardly about rod 53 out of the way of plunger 49, leaving billet H resting in holder 35.

Owing to the pointing, beveling or chamfering of the forward end of the billet, it will enter readily between rollers 45 and furthermore, if the material of the corners is forced backwardly somewhat by the rollers, it will merely fill out the corners which were chamfered by the rear die 60 so that the rear face of the billet will be approximately flat and square after the rolling operation.

Returning to a more detailed description of the construction of the apparatus, ram 49 is actuated

by a plunger 68 reciprocable in a cylinder 69 supported on members 38, 39, 40, etc., and having a flange 70 in which above mentioned rods 52 and 53 are anchored as by means of nuts 71 and 72. Therefore, the reaction of the pressure of ram 49 on cylinder 69 is transmitted to and counteracts the reaction in the opposite direction exerted in ring 47 by billet H passing between rollers 45. Plunger 68 is actuated in the present instance by hydraulic pressure from any suitable or well-known source not necessary to describe and is retracted when desired by plungers 73 and 74 reciprocable in cylinders 75 and 76. Plungers 73 and 74 connect as by pull rods 77—77 with a cross head 78 engaging plunger 68.

Arm 42 is swung by the action of a ram 79 reciprocable in a cylinder 80 and actuating a rack 81 engaging a sector 82 rotatable about pivot 43 and fixed with arm 42. A guiding device 83 maintains rack 81 in driving relation to sector 82.

Cylinder 51 is pivotally connected at 84 with a bracket 85 fixed in the present instance in relation to yoke 47 and has a bifurcated connection 86 with a portion of bracket 57. Reciprocation of portion 86 caused by cylinder 51 will therefore cause swinging of bracket 57 in a generally up-and-down direction about rod 53.

It is to be understood that suitable piping and controls are provided for actuating the several rams in proper sequence and they are preferably provided with interlocking means in well-known manner to prevent inadvertent actuation of any one of the rams at the wrong time. These controls being well-known in general and forming no part of the present invention, it is considered unnecessary to unduly complicate the showing by describing them further.

Above mentioned cylinder 65*a* comprises a cap-like member reciprocably fitted in a fluid-tight manner on a stationary piston 87 fixed in relation to bracket 57. Piston 87 is hollow and connected by means of a passageway 88 with a source of fluid under pressure, represented by a flexible connection 89. A valve 90 disposed within piston 87 is seated about an outlet port 91 and has a stem 92 fixed with cylinder 65*a*. Cylinder 65*a* extends slightlpy beyond a position flush with the face of die 58. As will be seen, pressure in passageway 88 will tend to continuously maintain cylinder 65*a* as far as possible to the left as seen in Fig. 9, valve 90 closing port 91 and relieving the fluid tight joint between cylinder 65*a* and piston 87 of pressure except when actually working. It is to be understood that the pressure of billet H into die 59 is substantially in excess of the pressure of cylinder 65*a* so that cylinder 65*a* is forced to the right causing opening of port 91 whenever a billet is pressed into die 58. A plurality of perforations 93 extend through cylinder 65*a* so as to expose the end of billet H to fluid under pressure from the interior of cylinder 65*a*. This fluid, commonly cold water, immediately disintegrates and washes away scale on the end of billet H. However, the water is so small in amount and the duration of the flow is so short that no material cooling of the billet is effected. The clearing of this end of the billet of scale is important since it is this end which will be exposed to the piercing punch as will appear.

In the retracting movement of arm 42 and holder 35, tongue 37 is restored by spring 66*d* to position to prevent a billet from falling out of the holder when the latter is again moved.

Bracket 57 when moved downwardly, as shown in dotted lines in Fig. 6, presents a V-shaped channel 94 in the path of billet H and which serves to guide the latter between rolls 45 and to insure proper starting of the billet therein. Ram 49 is again advanced, this time directly against the rear surface of the billet which is forced over support 94 and between rollers 45. Any remnants of scale remaining on the corners of the billet would be forced into the surface and accordingly a plurality of scraper blades 95—95 is provided pivoted on plate 96 carried on above mentioned yoke 47. Blades 95 have sharpened inserts 97—97 which serve to scrape the corners of the billet immediately before they pass between the rollers. In this way the hot metal is substantially entirely clean when it passes between the rollers and no scale is rolled into the material. Blades 95 are pivoted as at 98 and pulled inwardly by springs 99 so as to insure contact with the billets and allow reasonable variation in size without difficulty. Plunger 49 forces billet H entirely through yoke 47 between rollers 45, the billet falling into a receptacle 100. It is to be noted that the end of billet H which was cleaned by fluid from perforations 93 is disposed at the bottom of the receptacle 100.

Receptacle 100 is partially open at the bottom as seen in Fig. 12 but has a lip 101 which extends inwardly sufficiently to prevent a billet from dropping entirely through the receptacle. However, the major portion of the receptacle is open at the bottom as indicated. In this manner, any scale which may still be dropping from the billet is eliminated at this point. Receptacle 100 is fixed at the end of a swinging arm 102 fulcrumed at 103 on a stand 104 of any suitable construction, arm 102 being capable of swinging from the full line to the dotted line position in Fig. 12. It is to be noted that receptacle 100, in the dotted position, is inverted in relation to its full line position. As arm 102 swings, billet H will be brought first to a horizontal position and then to an inverted position. In the progress of this movement, the billet will shift from contact with lip 101 and rest on a retaining tongue 105. Tongue 105 is swingable on a pivot 106 on receptacle 100 and controlled by a hand lever 107. As seen in Fig. 11, tongue 105 has been swung clear of the entrance to receptacle 100. However, when arm 102 approaches a vertical position, tongue 105, due to the preponderence of weight of lever 107 thereover, will swing to the dotted position in Fig. 11, thereby preventing billet H from dropping out of receptacle 100 prematurely. When the billet shifts away from lip 101, it is caught and rests against tongue 105 so as to be supported in position above a die unit generally designated as 108, constituting part of above mentioned forging die unit D. By this means, the preliminarily rounded billet is promptly transferred to a convenient position to enter die unit 108 and is inverted so that the cleaned end is uppermost in preparation for the piercing operation.

When it is desired to place the billet in die 108, lever 107 is swung to a position corresponding to that shown in Fig. 11, whereupon the billet drops out of receptacle 100 into die 108 as will be further explained. Arm 102 is then returned to the full line position of Fig. 12, ready to receive another billet. As arm 102 approaches said full line position, lever 107 encounters the inclined face of a cam 109 fixed with a frame member 110, constituting part of stand 104 and is automatically swung from the dotted to the full line position so as not to interfere with placing of another billet in receptacle 100.

Arm 102 preferably carries a counterbalance weight 111 to substantially counteract the very considerable weight of receptacle 100 and its contents and the arm is actuated in the present instance by a plunger 112 driven by fluid pressure in a cylinder 113 anchored at 114 to stand 104. Plunger 112 has a rack 115 engaging a gear 116 fixed with arm 102, a guiding device 117 serving to maintain rack 115 in proper relation to gear 116.

Pressure fluid for cylinder 113 is controlled by well-known means not necessary to describe as forming no part of the present invention. Sufficient to say, suitable interlocking elements are provided so as to make it impossible for a billet to be pressed through roll set 44 unless receptacle 100 is in position to receive it.

With receptacle 100 in the dotted position of Fig. 12, handle 107 is pulled toward an operator in the neighborhood of die unit 108 whereupon billet H, releases from retaining finger 105 and drops into a die 118, forming a part of die unit 108 Fig. 2, which is the counterpart of a die 119 which latter is in the forging position in Fig. 2.

Die 119 comprises a sleeve-like element supported in a casting 120 having an inwardly tapered ring 121 at one end and a shouldered ring 122 at the other.

Die 118 is supported in a casting 123 and the description of one will suffice for the other. Castings 120 and 123 are slidably supported in a die carrier 124 which is oscillatable about a post 125 carried on the bed 126 of a powerful hydraulic press of well-known form forming no part of the present invention. The press has an upper plate or head 127 which may be driven downwardly with heavy pressure to a predetermined point indicated in dotted lines in Fig. 2.

The hot billet dropped into either die 118 or 119 lodges near the bottom of the die in the tapered ring 121. Die carrier 124 is then oscillated 180° from the position shown in Fig. 1 until one of dies 118 or 119 occupies the position shown for die 119. A ram 128 is then moved upwardly, as will appear, and raises billet H to a point substantially flush with the top of ring 122. Head 127 then descends and a punch 129 enters ring 122 and commences to pierce billet H which is prevented from descending by ram 128.

The entrance of punch 129 spreads billet H to the extent permitted by ring 122. This is illustrated in Fig. 13—C. The upper end of billet H is therefore anchored to shouldered ring 122. As head 127 continues to descend, punch 129 thrusts deeper into billet H, spreading the metal against die 119 and stretching the resulting side wall downwardly between itself and shouldered ring 122. The pressure on punch 129 is resisted by ram 128, pressing on the bottom of billet H to a certain point in the travel of punch 129, beyond which ram 128 descends but at a slower rate than punch 129. In this way, the pressure of punch 129 is divided between piercing and spreading the material of billet H against die 119 and stretching the resulting side wall downwardly from shouldered ring 122. Punch 129 descends to the limit of movement possible in head 127, the various stages of formation of the blank being indicated at *d*, *e*, *f* and *g* in Fig. 13. During the course of the downward stroke of punch 129, the metal is forced into a recess 130 in ram 128 to form a centering boss on the object. Substantially any desired configuration of the object at this end can be obtained by suitably forming ring 121 and the head 131 of ram 128. The forging process is thus complete in one heating of the billet and in one stroke of the press.

As soon as stage *g*, Fig. 13, is reached, head 127 is raised. The forged object, tending to follow punch 129 encounters a ring 132 in a stripper plate 133 anchored to bed 126. Punch 129 is therefore forcibly withdrawn from the forging which remains in the die. Ram 128 being in its lowered position, die carrier 124 is again oscillated until the die carrying the object is returned to the loading point, seen in Fig. 2. Here a ram 134 is pressed upwardly into the die and raises the forged object substantially into the position shown in dotted lines. Any suitable means is employed to transmit the object to a suitable place to be cooled and further processed.

It will be understood that while the above described operations are taking place in one die as 118, a corresponding series of operations is taking place in die 119, one die being unloaded and again loaded during the period that a blank is being formed in the other die.

Punch 129 receives considerable heat from the metal being processed and cannot be used repeatedly without proper treatment. Accordingly, a plurality of additional punches 135, 136, 137, 138 and 139 is provided depending from a rotatable plate 140 journaled on a stem 141 rigidly attached to plate 127. The whole assembly descends with head 127 and after each operation, plate 140 is rotated sufficiently to bring a new punch in line with ring 132 in stripper plate 133. In the situation shown, punch 129 is about to perform a forging operation. Punch 135, which has just been used and is heated will descend at one side of die carrier 124 into a tank or vat 142 in which is retained a body of cooling and lubricating fluid 143. Repeated strokes of head 127 immerses several of the punches in fluid 143 preparatory to a subsequent punching operation. By the time any one punch comes into position to forge a blank, it has been thoroughly cooled and coated with the necessary lubricating material.

Plate 140 is rotated as best seen in Fig. 1 by a hydraulic cylinder 144 pivoted to a portion of head 127. Cylinder 144 has a ram 145 having a pawl 146 engaging a series of notches as 147. Cylinder 144 is swung towards plate 140 by a spring 148.

At the conclusion of each turning movement of plate 140, a detent 149 engages one of the several punches, being yieldably pressed there against by a spring 150 and resting against a stop 151. In this manner, it is assured that plate 140 will be held in the proper position for its working stroke. Detent 149 is swung outwardly by suitable or well-known mechanism to clear plate 140 in its downward movement.

Plate 140 has a stem 151*a* reciprocable in a guide 152 which is fastened to a registering plate 153. Guide 152 rests on a plate 154 supported by a carrier 155 from stem 151. Thus upon downward movement of head 127, plate 153 also descends to the extent permitted by stripper plate 133. Plate 153 carries a series of pins 156 in the present instance spaced equally between punches 129, 135, etc. Pins 156 shortly prior to entering of any punch into any billet H pass through registering holes as 157 in stripper plate 133 and enter locating holes 158 in die carrier 124. In this manner, the dies are accurately registered with the punches before the punches enter the billets.

Die carrier 124 is oscillated by a gear 159 engaged by a rack 160 driven by a fluid pressure cylinder 161 of well-known type not necessary to further describe.

The pressure of punch 129 both downward and upward when being removed from the forging, is very substantial. For this reason, bearings 161a and 162 of die carrier 124 are protected from these forces. The weight of the die carrier is supported by pressure fluid in a cylinder 163 having a piston 164 which rests on post 125. The fluid, in the present instance air, raises die carrier 124 against stop nuts 165. Downward pressure of punch 129 overcomes the pressure in cylinder 163 until casting 120 rests on a collar 166 solidly supported on bed 126 and forming part of the mechanism of ram 131. Thus, bearings 161 and 162 are relieved of downward pressure. When punch 129 is being pulled out of the forged object, carrier 124 is again raised by the fluid pressure against stop nuts 165 but casting 120 is further raised until ring 122 rests against stripper plate 133 so that the upward pressure is taken by plate 133 and not by carrier 124.

Ram 128 is raised by a piston generally designated as 167 operating in a cylinder 168. Pressure fluid is supplied through a pipe 169, a continuation 170 of which extends to within a short distance of cap 131. Pipe 170 clears a bore 171 so that pressure fluid supplied through extension 170 passes through cap 131 and returns through bore 171 to the underside of piston 167. A considerable volume of fluid thus passes immediately beneath cap 131 during rising and falling movement of ram 128. In this manner, cap 131 is prevented from overheating. Casting 120 is provided with grooves as 172 to which cooling fluid, in the present instance water is supplied as for example by a hose connection 173. The fluid is confined in grooves 172 by means of a jacket 174 and passes from one groove to another, being finally exhausted through a pipe 175. Dies 118 and 119 are thereby prevented from being overheated and destroyed by the heat of the billet being forged.

Ram 134 has a claw-like lifting element 176 which engages the bottom of the forged object. Since the engagement with the hot forging is momentary only, element 176 is adequately cooled by the surrounding air. A slotted opening 177 is provided for connection 173 to provide freedom for raising and lowering of casting 120.

178 is a circulating pump which keeps the fluid 143 sufficiently agitated for effective cooling of punches 135, etc.

The operation of the mechanism is thought to be adequately clear from the foregoing description, the billet being pointed and upset in mechanism P where most of the scale drops off. It is then pressed through roller set 44, the corners being scraped by blades 95 immediately before being acted upon by the rollers. The billet is immediately inverted, by transfer unit T and placed in a forging die where it is pierced while being supported partly from beneath and partly from above by shouldered ring 122. In this manner the complete hollow object is forged in a single heat.

The above being a complete description of an illustrative embodiment of the invention, what is claimed as new and desired to be secured by Letters Patent of the United States is:

1. In a forging machine adapted to receive a billet and form it into a substantially cylindrical hollow object, the combination of a bed, a rotatable die element mounted on the bed, a punch, means for supporting the punch and advancing it toward the bed for piercing a billet, a plurality of dies supported by said die element and movable selectively by rotation thereof from a position registering with said punch, to a position removed from said punch, a stripper member rigid with the bed, and disposed adjacent said die element, and a locating pin movable with said punch and engageable with said stripper member and with said die element for accurately locating said die in registration with said punch preparatory to a piercing operation.

2. In a forging machine adapted to receive a billet and form it into a substantially cylindrical hollow object the combination, of a bed, a rotatable die element mounted on the bed, a punch, means for supporting the punch and advancing it toward the bed for piercing a billet, a plurality of dies supported by said die element and movable selectively by rotation thereof from a position registering with said punch to a position removed from said punch, a stripper member rigid with the bed and disposed adjacent said die element, and a plurality of spaced locating pins movable with said punch, a plurality of said pins engaging at spaced points with said stripper member and with said die element for accurately locating said die in registration with said punch preparatory to a piercing operation.

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