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**Foster et al.**

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## [54] FORGING PRESSES WITH EJECTOR MEANS


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July 3, 1969 Great Britain.....33,510/69

[52] **U.S. Cl.** .....**72/429,** 72/427, 72/453

[51] **Int. Cl.**.....**B21j 9/12**

[58] **Field of Search**.....72/406, 427, 344, 72/346, 453, 429, 67, 112, 115, 126



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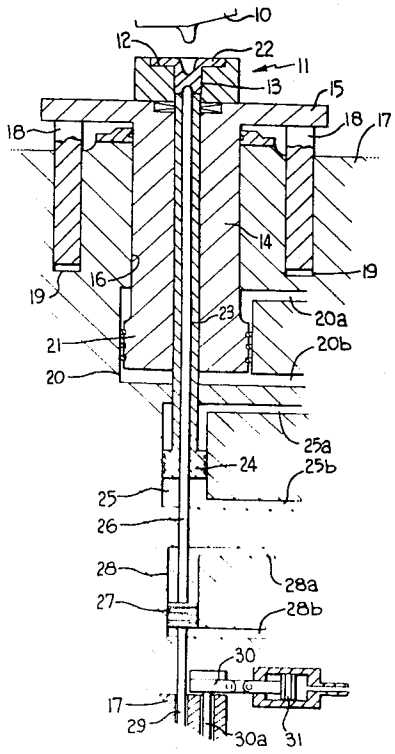
[57] **ABSTRACT**

An upsetting or forging machine having at least one pair of relatively movable dies, one of which is arranged to carry out a circular rocking motion about a point related to the center of one of the dies of the die set, the other die including at least one linearly movable element in order that the die can be moved towards or away from the rockable die, there being a ram means associated with the linearly movable die in order that a workpiece after upsetting or forging can be ejected from the die set.


**14 Claims, 8 Drawing Figures**



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SHEET 1 OF 6

FIG. 1

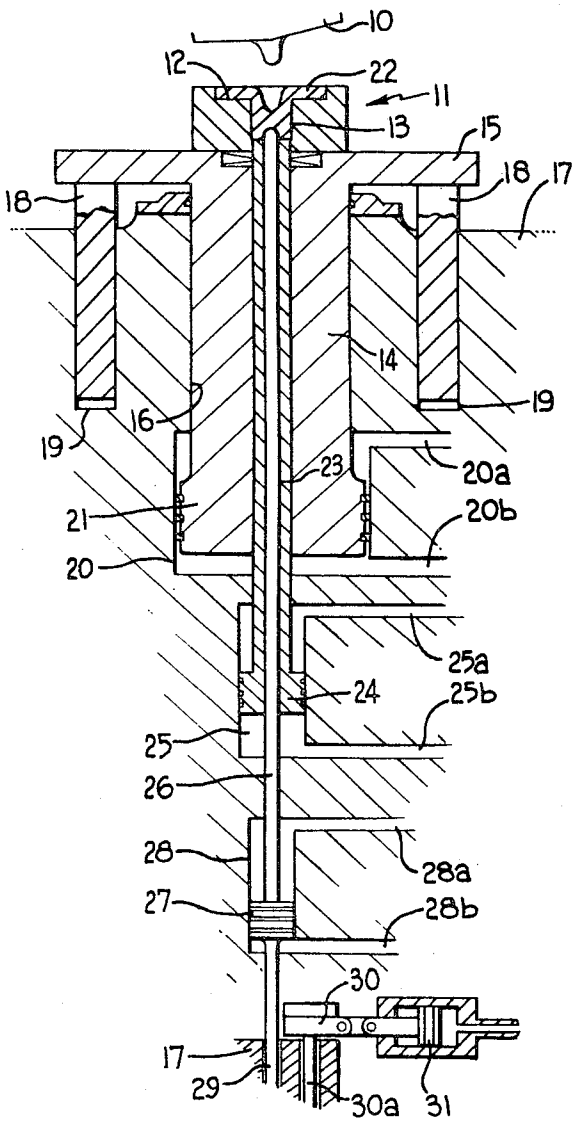


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FIG 2

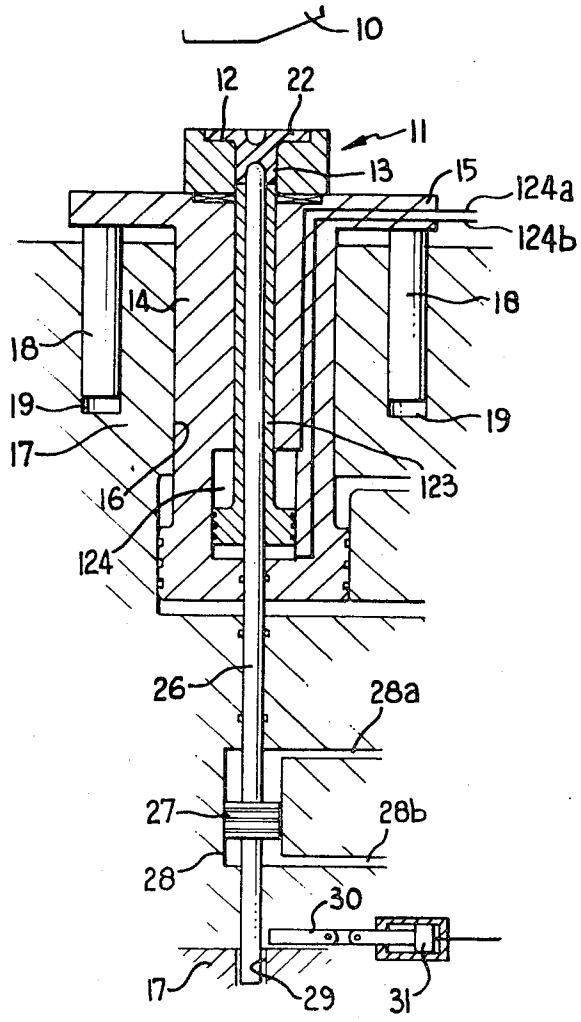


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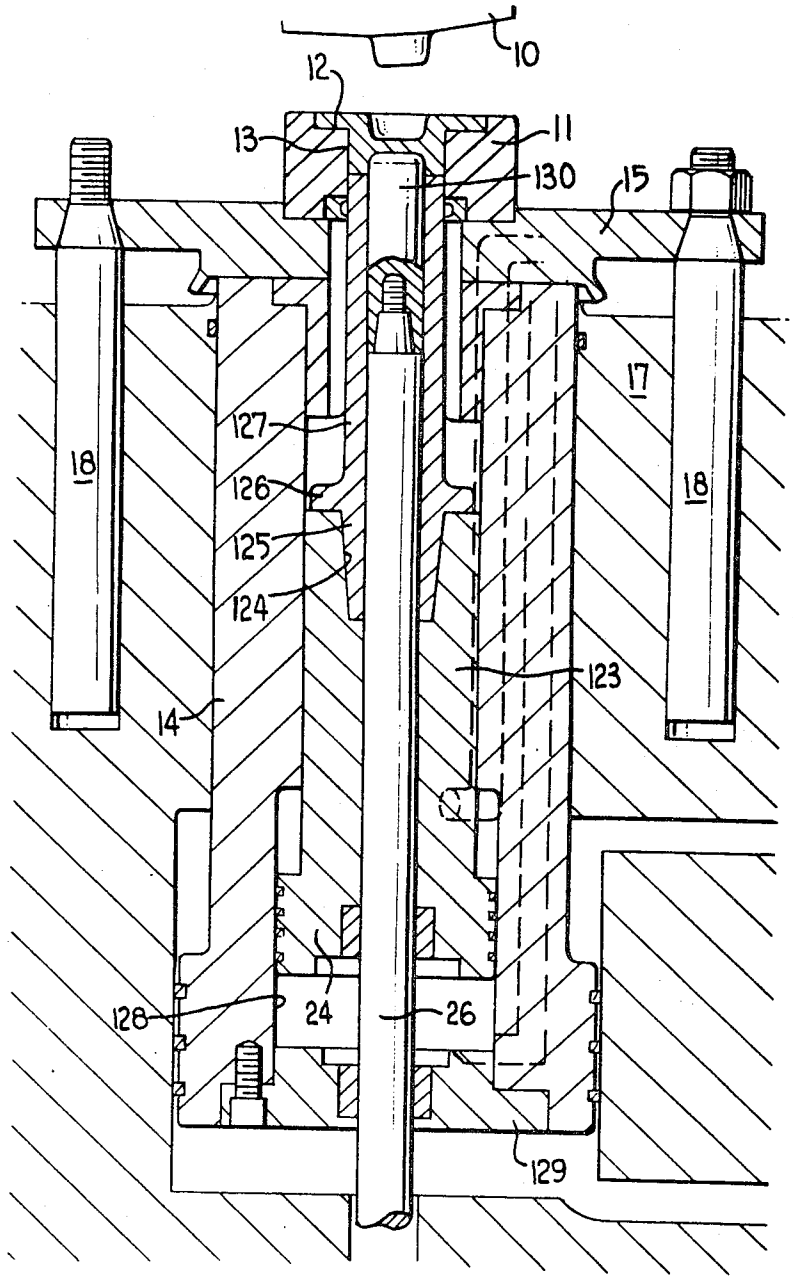
FIG 3

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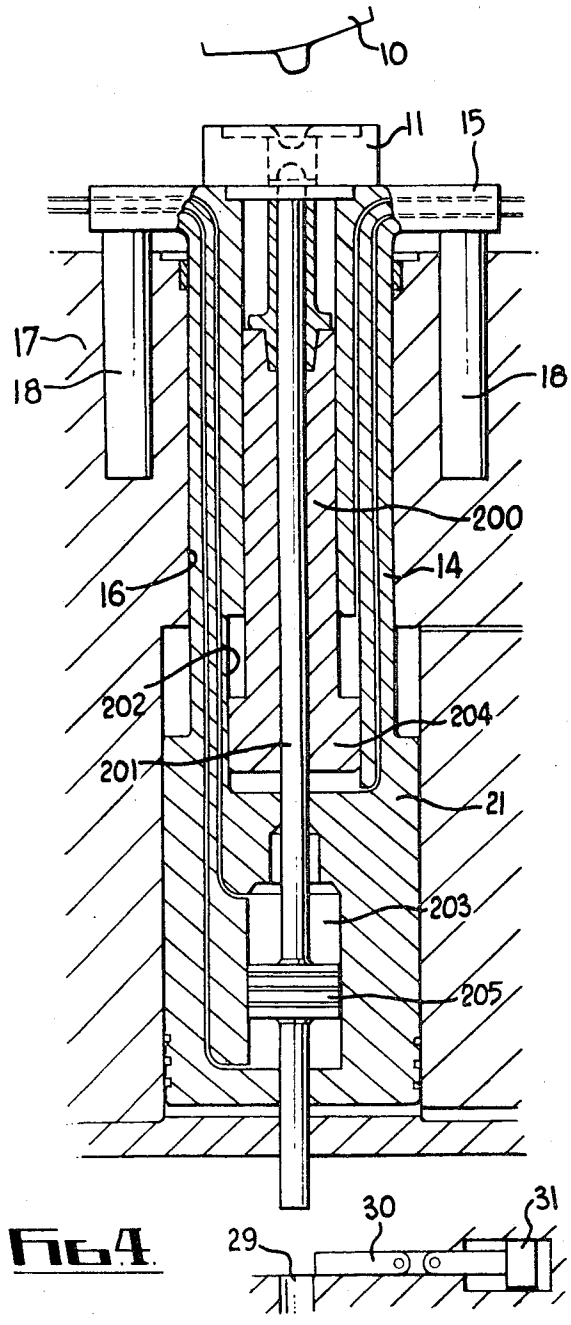


Fig 4.

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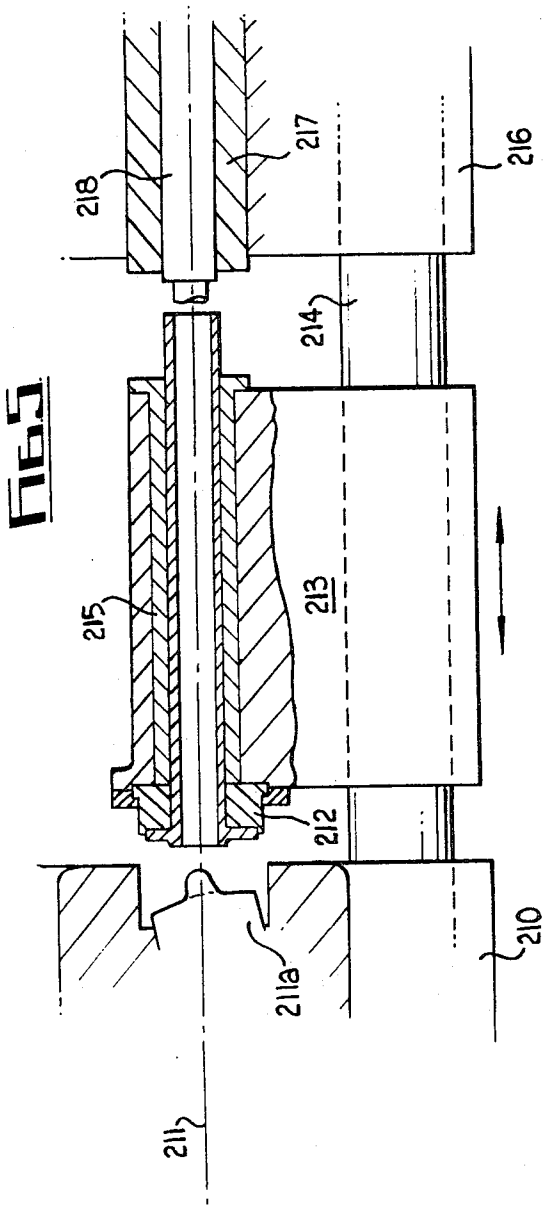


FIG. 5

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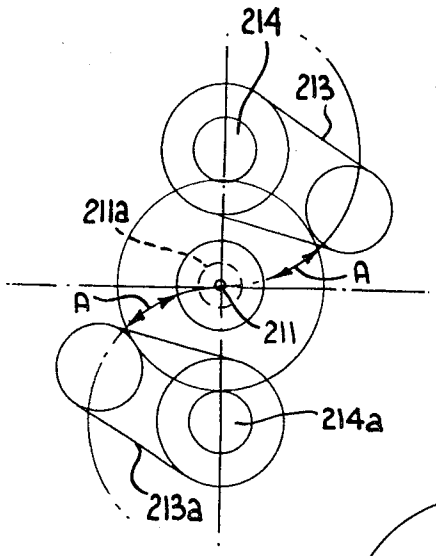


FIG. 6.

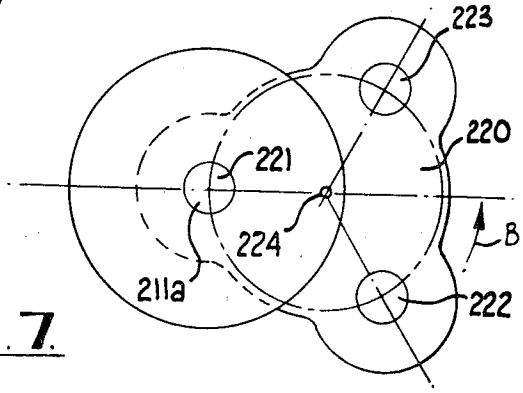


FIG. 7.

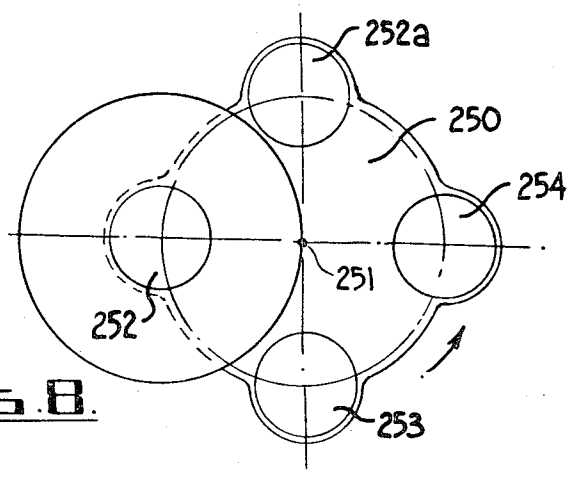


FIG. 8.

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# FORGING PRESSES WITH EJECTOR MEANS

This invention concerns upsetting or forging machines.

The invention refers particularly though not exclusively to upsetting or forging machines for upsetting or forging, forming or rolling circular or other shaped objects of regular or irregular form.

In upsetting or forging machines of the generally known kinds the total surface of the article or object is operated upon simultaneously with the result that very high peak loads are produced necessitating extremely strong, heavy and consequently expensive machines. A further difficulty experienced in upsetting or forging machines, particularly when producing forgings from tube or bar stock, lies in the inability to gather or upset the material for the forging without bending or otherwise deforming the stock and thus creating fault lines in the finished forging. It has been generally considered that there is a practical limit to the amount of metal which can be upset and that this limit bears a direct relationship to the ratio between the length and the diameter of the stock. The generally accepted length to diameter ratio between which it is possible to produce forgings without fault lines is 3:1 and above this it is accepted that the possibility of efficient operation does not exist due to the risk of bending or otherwise deforming the stock.

The primary object of the present invention is to provide an upsetting or forging machine in which the above mentioned disadvantages are overcome or at least substantially reduced.

It has previously been proposed by the applicants to provide an upsetting or forging machine in which the dies are so formed and the motion of the machine is so contrived that different parts of the dies come successively into operation so as to ensure that sufficient pressure is created only between the operative parts of the disc to enable the material of the workpiece to be manipulated to create the desired form in the workpiece.

It is therefore a further object of the present invention to provide in an upsetting or forging machine the ability to operate the machine in such a manner that the maximum pressure required to create the forging is substantially less than that which will be required to produce the identical forging in a machine in which the whole of the surface of the workpiece is subjected simultaneously to pressure.

According to the present invention an upsetting or forging machine including a pair of relatively movable dies between which a workpiece or a part thereof may be located there being a workpiece receiving die formed from one or more linearly movable elements adapted to be controlled individually, collectively or in groups before or during upsetting or forging, a means for ejecting a finished workpiece from the die, and a co-operating die adapted to carry out a circular rocking motion about a point at or near the center of one of the dies whereby a complete upsetting or forging operation may be carried out by the one pair of dies.

Preferably the machine includes a workpiece receiving die formed of a plurality of die elements in which the elements are each controllable as to their sequence and rate of movement, the direction of movement and their distance moved.

In one form the workpiece receiving die is composed of a series of concentric elements.



In a modification the workpiece receiving die is of unitary construction and is mounted upon a linearly movable contral element, the die and the control element being provided with a through bore adapted to receive a bar or tube stock workpiece, means being provided for advancing the workpiece as upsetting or forging takes place.

In a further modification the workpiece receiving die is of unitary form and is mounted upon a control element there being a co-operating die adapted to carry out a circular rocking motion and simultaneously be advanced towards the workpiece receiving die, the latter and the control element being bored to receive a bar or tube stock workpiece and means being provided to advance the workpiece as upsetting or forging takes place.

The invention will now be described further, by way of example only with reference to several practical forms thereof and the accompanying drawings in which:

FIG. 1 is a diagrammatic sectional elevation of part of one form of die and operating mechanism;

FIG. 2 is a view similar to FIG. 1 of a modification of the apparatus;

FIG. 3 is a more detailed view of part of the apparatus of FIG. 2;

FIG. 4 is a view similar to FIG. 1 of a further modification;

FIG. 5 is a schematic view of a further modification; and

FIGS. 6, 7 and 8 are schematic views showing a means of operating a machine having a die and operating mechanism similar to any one of those illustrated in FIG. 1 to 5.

In the following description reference is made only to that part of the machine directly concerned with one die part, the remaining parts of the machine being either of generally known or proposed form and thus reference in detail to such parts is not considered to be necessary for a clear understanding of the operation of the machine. It is pointed out however, that the apparatus to be described below is particularly suited for controlling a die part in such manner as to give to that part a circular rocking motion about a point at or near the center of the rocking die. Such an arrangement is disclosed in our co-pending application for the grant of Letters Patent filed July 1, 1970, under Ser. No. 51,537.

Referring now to FIG. 1 there is provided a die set comprising a die **10** adapted to perform a circular rocking motion about a point at or near the center of that die. A second die **11** is provided and this consists of an outer portion, in the case being described having a recess **12** and a centrally disposed through hole **13.** This die is either formed integrally upon the upper surface of a ram **14** or is attached to that ram. In either case the die stands proud of a flange **15** of the ram **14.** The ram **14** extends through a bore **16** in the bolster **17** of the machine and the flange **15** is provided with a pair of jack rams **18** located at diametrically opposed positions on the flange **15.** The jack rams are mounted in cylinders **19** in the bolster and are provided with fluid supply lines (not shown) by means of which operating fluid can be pumped to the cylinders to move the jack rams, and thus the die **11** rapidly towards the die **10.** The ram **14** is in this specification referred to as the main ram. At the end of the main ram **14** is a cylinder **20** to which

fluid lines **20***a* **20***b* are provided so that fluid can be pumped to either side of the ram piston **21** located therein so that the main ram can be moved under operating pressure towards the die **10** during upsetting or forging of a workpiece **22** located in the die **11.** In the drawing the workpiece **22** is shown finished and ready for ejection. The main ram is provided with a through bore located axially thereof and within this is located a second ram **23** the piston **24** of which is located in a cylinder **25** located at a position more remote from the die **10** than the cylinder **20** of the main ram **14.** Fluid lines **25***a* and **25***b* are provided to the cylinder **25** of the second ram both above and below the piston **24** to enable the second ram to be moved into and out of the die **11.** The top of the second ram, or a replaceable head piece attached thereto forms effectively a second die part and in the case in point is located in the base region of the through bore **13** of the die **11.**

The second ram **23** is provided with a through bore, as is the cylinder **25** and through this passes an ejector ram **26** having a piston **27** located in a cylinder **28.** This cylinder is provided with fluid lines **28***a* and **28***b* in order that fluid can be pumped to either side of the piston **27.** The piston **27** is provided with a stem extending from the face opposite to the ram and this passes through the cylinder **28** into a hole **29** in the bolster **17** when the piston is retracted relative to the die **11.** Adjacent this hole **29** is a stop member **30** connected to the ram of a piston **31.** The arrangement is such that when the piston **27** is advanced relative to the die **11** the stem is moved from the hole **29** and the stop member **30** can be moved across the hole to prevent the piston **27** being retracted relative to the die **11.** Ejection of a finished workpiece **22** is thus possible as the main ram **14** is retracted relative to the die **10.** If desired the vertical position of the stop member **30** may be adjustable, for example by providing, within the bolster **17,** a vertically adjustable and lockable column indicated generally by the member **30***a.*

All of the fluid lines are provided with valves so that a control system can be programmed to ensure that the corrected valves open and close in sequence to ensure that the correct operational steps are carried out during forging.

For example, to produce the forging **22** illustrated the rams would all be retracted relative to the die **10** at the commencement of an operating cycle. A billet would be inserted in the central bore **13** of the die **11.** The jack rams are now moved by pressure fluid to bring the die **11** into close proximity with the die **10** during which movement the valve to line **20***a* would be open to drain and the valve to line **20***b* would be connected to pre-fill supply. When the die **11** is positioned close to the die **10** the main ram **14** is then advanced towards the die **10** by fluid entering the cylinder through line **20***b* at the same time ram **23** is advanced by fluid pumped to the cylinder **25** via line **25***b;* line **25***a* being open to drain. As the forging operation proceeds the ejector ram **26** is advanced to enter into the workpiece to produce a blind hole in the central portion of the billet, retraction of this ram being prevented by the stop member **30** being located over the hole **29.** The ejector ram **26** is thus effectively solid with the bolster **17.** As the forging continues the jack ram fluid supply lines are opened to drain. At the termination of forging the main ram cylinder is opened to pump via line **20***a* and to drain via line **20***b* and the second ram cylinder **25** is also opened to pump via line **25***a* and drain via line **25***b.* As the main ram and the second ram are retracted simultaneously the forging is ejected by the ejector ram **26** and when ejection is completed the stop member moves and the ejector ram is retracted due to line **28***a* being open to pump and line **28***b* to drain.

The cycle can now be repeated.

Whilst it is very convenient for the jack rams **18** to be located as shown in FIG. **1** and various other figures of the drawing since they then perform the function of providing resistance to rotation of the die **11** they can be replaced by a single jack ram inside the main ram and surrounding the second ram but in this case other means for preventing rotation of the die **11** must be provided.

Since many parts of the arrangements of FIGS. **2, 3** and **4** correspond to those of FIG. **1** like reference numerals will be used on these figures to indicate like parts and only the Modification will be referred to. Thus in FIG. **2** it can be seen that a second ram **123** is located in a cylinder **124** located wholly within the main ram **14.** In this case the ejector ram **26** and its cylinder **28** is constructed and arranged as in FIG. **1** and the operating cycle is the same as that of the arrangement of FIG. **1** for producing the forging **22.** The fluid supply lines to cylinder **124,** that is lines **124***a* and **124***b* pass, in this case through the flange **15** to their respective pumps.

Referring now to FIG. **3,** which shows, on a larger scale a more detailed view of part of the arrangement of FIG. **2** it will be seen that the die **11** is secured to the flanged end **15** of the main ram **14.** The second ram **123** is provided at its end remote from the piston **24** with a frusto conical bore **124** into which seats a correspondingly shaped spigot **125** formed at one side of a flange **126** adapted to seat on the end of the ram **123** and extending from this flange **126** is a head **127.** The main ram **14** is provided with a stepped bore **128** at the end remote from the flange **15** and the piston **24** seats in this bore which is closed by an end plate **129** having a bore therethrough to accommodate the ejector ram **26** which latter is also provided with a head piece **130** removably secured thereto. The head pieces **127** and **130** are produced from hardened steel to enable them to resist wear and since they are removable they can relatively easily be replaced after a period of use.

Referring now to FIG. **4** it can be seen that both a second ram **200** and an ejector ram **201** may have their respective cylinders **202** and **203** and pistons **204** and **205** within the main ram **14.** In this case the ejector ram piston **205** is again provided with a stem adapted to cooperate with a stop member **30.**

Fluid supply lines for the cylinders **202** and **203** are in this case provided by boring the main ram **14** from its flanged end **15.**

In all of the arrangements so far described the rams are preferably vertically disposed with the die **11** located below, and movable upwardly towards the die **10** which performs a circular rocking motion. It is however possible to arrange these rams in the horizontal plane if desired.

Referring now to FIG. **5** it will be seen that it is advantageous in certain cases to arrange for the machine to operate in the horizontal plane. This is the case particularly where the machine is adapted for use in upsetting and forging operations on bar or tube stock.

As shown in FIG. 5 there is provided a fixed cross head 210 in which is located a die 211*a* adapted to perform a circular rocking motion about a horizontal axis 211. This axis is extensive with a central axis of a die 212 fixed in a second cross head 213. The cross head 213 is slidably mounted on guides 214 and the cross head 213 is bored to receive a wear resistant sleeve 215 of hollow form. The die 212 is bored centrally to a shape corresponding to the shape of the bore of the sleeve 215. The sleeve 215 is removable from the cross head to allow for changes to be made. For example the sleeve 215 may have a circular base to receive circular cross sectioned stock or it may be bored to other shapes to receive stock of cross sections other than circular.

Also mounted on the guides 214 is a ram cross head 216 which may be positionally adjusted relative to the cross heads 210 and 213 so that stock of various lengths may be positioned in the bore of the sleeve 215 and die 212. Within the cross head 216 is a main ram 217 which is hollow and accommodates therein a second ram 218. The main ram 217 serves in use to move the cross head 213 towards the cross head 210 to position the dies 211*a* and 212 in close proximity and the ram 218 is then adapted to move to push the stock forwardly towards the die 211*a* to enable material of the stock to be gathered or upset. When sufficient material has been gathered the main ram 217 moves the cross head 213, and thus the die 212, closer to the die 211*a* to enable the gathered material to be forged to the requisite shape between the dies. At the termination of forging the main ram 217 and second ram 218 are withdrawn and the cross head 216 is retracted to enable the cross head 213 to be retracted for a sufficient distance from the cross head 210 to enable the stock to be removed from the sleeve 215 and die 212. Thus operation is conveniently carried out by moving the second ram forwardly to eject the stock from the sleeve. Clearly this operation whilst feasible is relatively slow due to the fact that loading of the stock, upsetting and forging and ejection are all carried out with the axes 211 of the die 211*a* the bore of the cross head 213 and the main and second rams in alignment and thus it is desirable to be able to move at least the cross head 213 out of line with the die 211*a* and the main and second rams so that it can be ejected.

There are several alternatives available for increasing the rate of production from the machine and one of these is schematically illustrated in FIG. 6. In this arrangement the cross head 213 is duplicated, there being one cross head 213 on one guide 214 and a second cross head 213*a* on a second guide 214*a*. In this arrangement each cross head is rotatable about its corresponding guide so that, for example, when the cross head 213 is positioned with the axis of its sleeve coextensive with the axis 211 of the die 211*a* and main and second rams 217 and 218 the cross head 213*a* is positioned clear of the machine and can be loaded with stock. When an upsetting and forging operation on the stock in cross head 213 is completed it is pivoted to the position shown in FIG. 6 and the cross head 213*a* is pivoted into its operative position from the combined loading and ejection position as shown. During upsetting and forging of the stock in cross head 213*a* the forged stock is ejected from cross head 213 (preferably by an ejector ram) and a new piece of stock is loaded. The cycle can now be repeated.

The directions of movement of the cross heads 213 and 213*a* is indicated by the arrows A on the drawing.

It is possible to provide three cross heads in this arrangement in which case one would be in the forging and upsetting position, whilst a second is in the loading position, and the third is in the ejection position.

In the schematic layout shown in FIG. 7 a single cross head 220 is provided, in this case there are three operating stations for the cross haed. The cross head 220 of this arrangement is provided with three dies 221 and 222 and 223 at 120° spacing and these dies are adapted, by rotation of the cross head 220 to be brought successively into position in alignment with the die 211*a* which latter, in the drawing has located in alignment therewith the die 221. The cross head 220 rotates about the axis 224 of a guide. Assuming the direction of rotation to be as shown by the arrow B the die 223 is at a loading station and the die 222 is at an ejection station. If the direction of rotation of the cross head were reversed then the die 223 would be at the ejection station and the die 222 at the loading station. In this arrangement there would be an ejector ram at the ejection station.

The schematic layout of FIG. 8 is somewhat more complex than the preceeding arrangements in that there are four stations for a rotary cross head 250 (having four dies) which rotates about the axis 251 of a guide. In addition, there are two dies 252 and 252*a* adapted to perform a circular rocking motion. The die 252*a* is adapted to perform an upsetting action and aligned with this die is a main and second ram arrangement similar to that of FIG. 5. At this station a piece of stock is worked on to gather material for forging and when this operation is completed the cross head 250 is indexed through 90° to bring the upset stock into alignment with the die 252 which, in conjunction with a further main and second ram assembly similar to that of FIG. 5 serves to enable forging to be carried out. At the end of the forging operation the cross head 250 is indexed through 90° to bring the forged stock to an ejection station 253 at which is located an ejection ram. The cross head can now be indexed through a further 90° to bring the now empty die to a loading station 254. Clearly in this arrangement whilst a piece of stock is being forged a further piece is being upset and ejection and loading operations are being carried out. The direction of rotation of the cross head is assumed to be as shown by the arrow C. If the direction of rotation is reversed then the die 252 becomes the upsetting die, the die 252*a* becomes the forging die and the station 253 and 254 become respectively the loading and ejection stations.

Whilst the schemes described with relation to FIGS. 6 to 8 have been related to the arrangement of FIG. 5 they could also be used in relation to any one of the arrangements of FIGS. 1 to 4 in which case more than one main and second ram assembly would be located in a bolster 17 and the latter would be arranged to be moved in either an arcuate reciprocatory manner or in a rotary manner.

It is also possible to arrange for movement of the bolster or the cross head in a reciprocatory manner in a straight line thereby to provide a loading station, an operating station for both upsetting and forging, and an ejection station. In this case the loading station when the bolster or cross head is moving in one direction becomes an ejection station when the bolster or cross

head is moving in the reverse direction. Similarly the ejection station becomes a loading station alternatively as the bolster moves first in one direction and then the other.

We claim:

1. In an upsetting or forging machine, at least one pair of relatively movable dies comprising a linearly movable workpiece receiving die and a second die adapted to carry out a circular rocking motion about a point related to the center of one of said dies, at least one linearly movable element in said workpiece receiving die, means for causing said linear movement of said workpiece receiving die at least during an upsetting or forging operation, and workpiece ejecting means co-operating with said workpiece receiving die arranged to eject a finished workpiece from said workpiece receiving die.

2. In an upsetting or forging machine as set forth in claim 1, said second die being adapted to carry out a circular rocking motion about a point at the center of said second die.

3. In an upsetting or forging machine as set forth in claim 1, said second die being adapted to carry out a circular rocking motion about a point at the center of said workpiece receiving die.

4. In an upsetting or forging machine as set forth in claim 1, said workpiece receiving die comprising a plurality of die elements, each element being adapted to be controlled independently.

5. In an upsetting or forging machine as set forth in claim 1, said workpiece receiving die comprising a plurality of concentric die elements, each element being adapted to be controlled.

6. In an upsetting or forging machine as set forth in claim 1, a plurality of die elements forming said workpiece receiving die, and pneumatic means for individually and independently controlling the movements of said plurality of die elements.

7. In an upsetting or forging machine as set forth in claim 1, a plurality of die elements forming said workpiece receiving die and hydraulic means for individually and independently controlling the movements of said plurality of die elements.

8. In an upsetting or forging machine, at least one pair of relatively movable dies comprising a die adapted to carry out a circular rocking motion about a point related to the center of said pair of dies, a workpiece receiving die including a series of hydraulic rams, cylinders for said hydraulic rams located along a common axis, fluid supply means for causing said hydraulic rams to be movable linearly at least during an upsetting or forging operation, and workpiece ejecting means co-operating with said hydraulic rams arranged to eject a finished workpiece from said workpiece receiving die.

9. In an upsetting or forging machine as set forth in claim 8, some at least of said hydraulic rams being located one within the other, said workpiece ejecting means including a hydraulic ram co-operating with at least one of said rams of said workpiece receiving die and being located along an axis common to the axes of said rams of said workpiece receiving die.

10. In an upsetting or forging machine as set forth in claim 8 said workpiece receiving die comprising a series of die elements, some at least of said hydraulic rams being located concentrically one within the other, one of said workpiece receiving die elements including a workpiece ejecting ram located along an axis common to the axes of said rams of said workpiece receiving die.

11. In an upsetting or forging machine at least one pair of relatively movable dies comprising a die adapted to carry out a circular rocking motion about a point related to the center of said pair of dies, and a workpiece receiving die comprising a main ram, a peripheral flange on said main ram, at least two jack rams associated with said flange of said main ram and arranged to move said flange of said ram rapidly, and thus said main ram rapidly in a direction towards said die adapted to carry out said circular rocking motion, an outer workpiece receiving die part associated with said main ram, a second ram concentric with said main ram, a second workpiece receiving die part associated with said second ram, an ejector ram concentric with said second ram, a third workpiece receiving die part associated with said ejector ram, cylinders associated with each of said rams, pistons in said cylinders associated with each of said rams, fluid supply and return means associated with each of said cylinders adapted to supply fluid to either side of said pistons of said rams.

12. In an upsetting or forging machine as set forth in claim 11, an ejector ram stem projecting from said ejector ram piston oppositely to said ejector ram, a stop member associated with said ejector ram stem and movable into or out of a path of movement of said ejector ram stem and means for adjusting the position of said stop member relative to a cylinder containing said ejector ram piston thereby to enable the stroke of said ejector ram stem, and thus said ejector ram, to be controlled.

13. In an upsetting or forging machine as set forth in claim 11 said second ram cylinder being within said main ram.

14. In an upsetting or forging machine as set forth in claim 11 said second ram cylinder being within said main ram, and said ejector ram cylinder being within said main ram.

* * * * *