Nov. 17, 1959 M. M. SEELOFF ET AL 2,913,568

HOT UPSETTING MACHINE

Filed Jan. 8, 1957 5 Sheets-Sheet 1

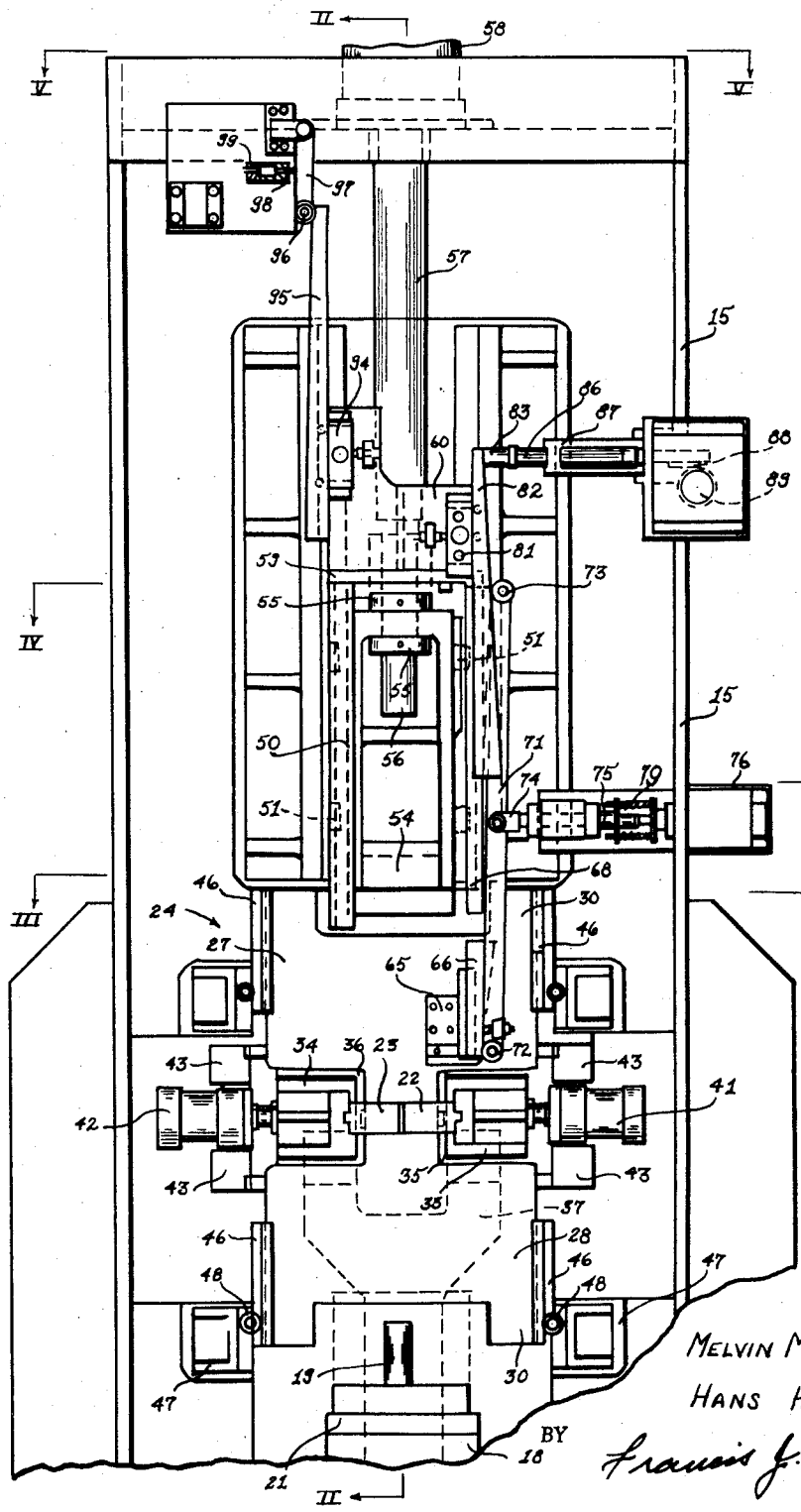


FIG. 1

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HOT UPSETTING MACHINE

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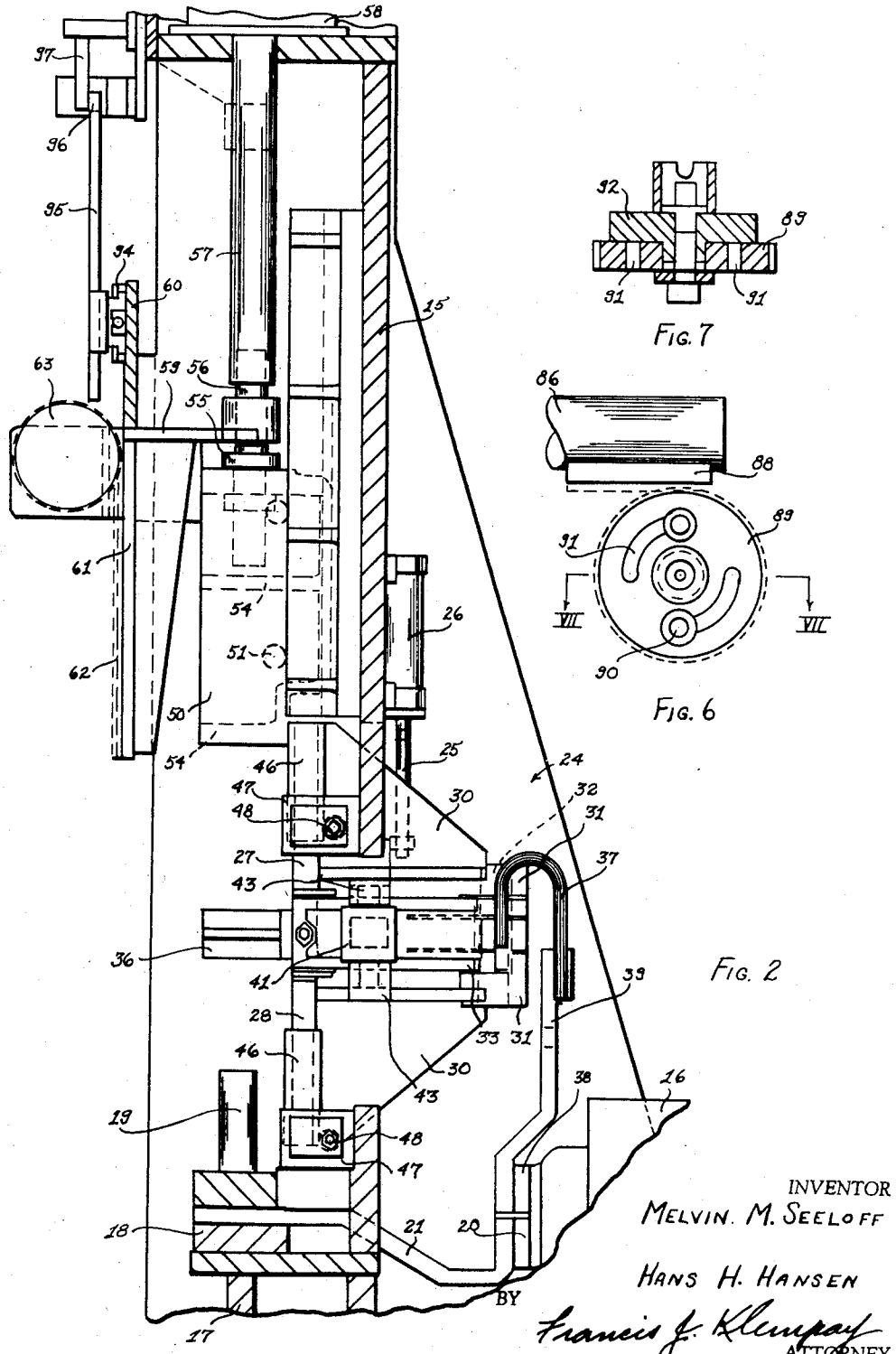


FIG. 2

FIG. 7

FIG. 6

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HOT UPSETTING MACHINE

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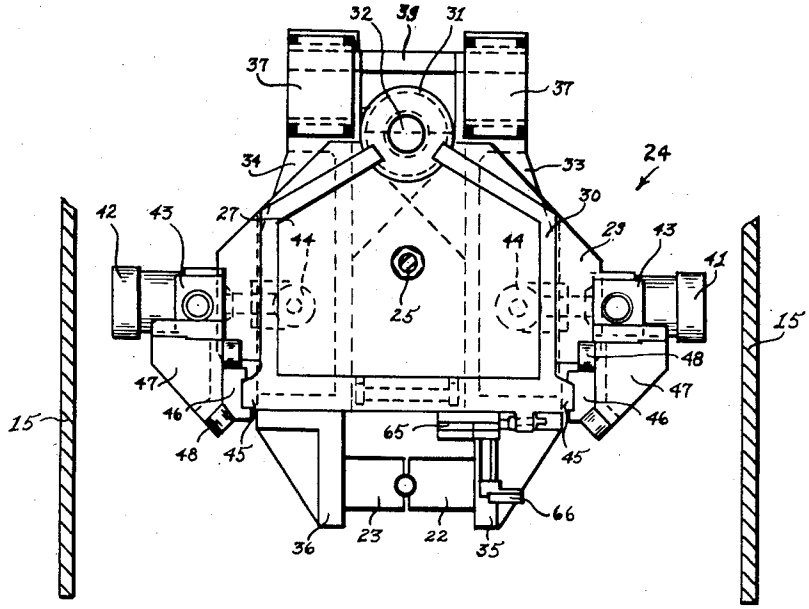


FIG. 3

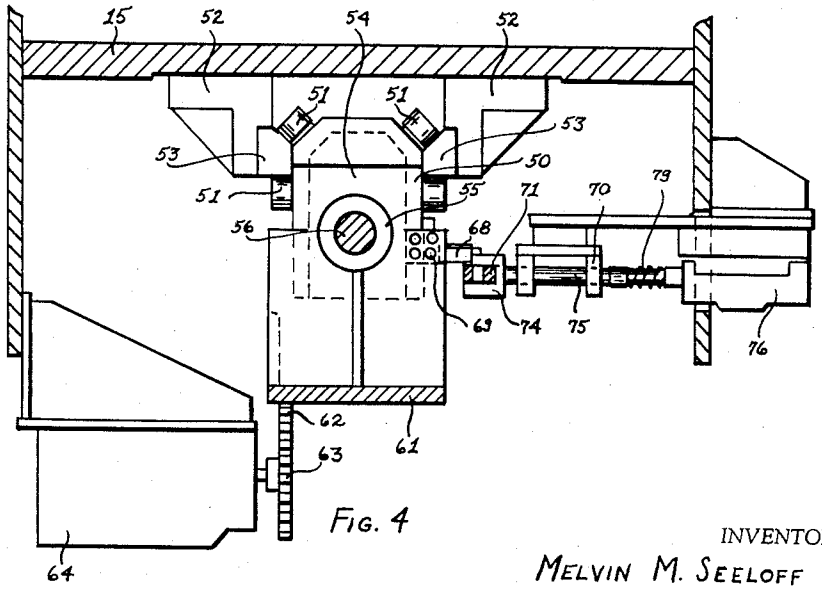


FIG. 4

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HOT UPSETTING MACHINE

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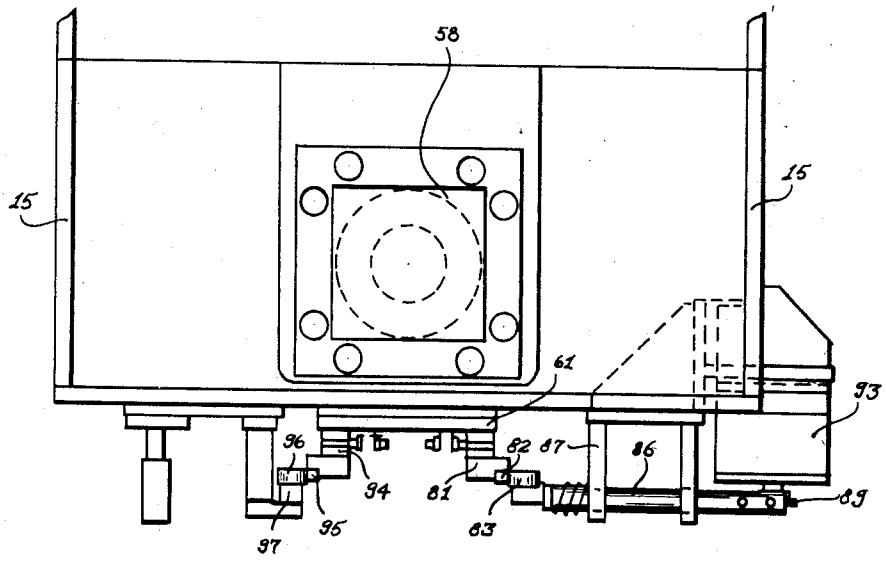


FIG. 5

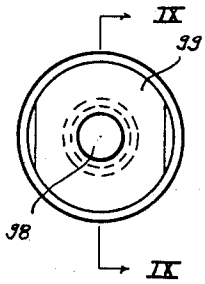


FIG. 8

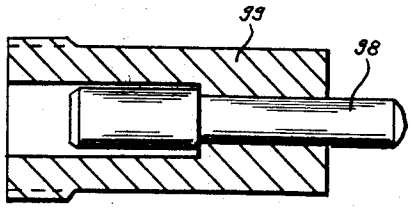


FIG. 9

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HOT UPSETTING MACHINE

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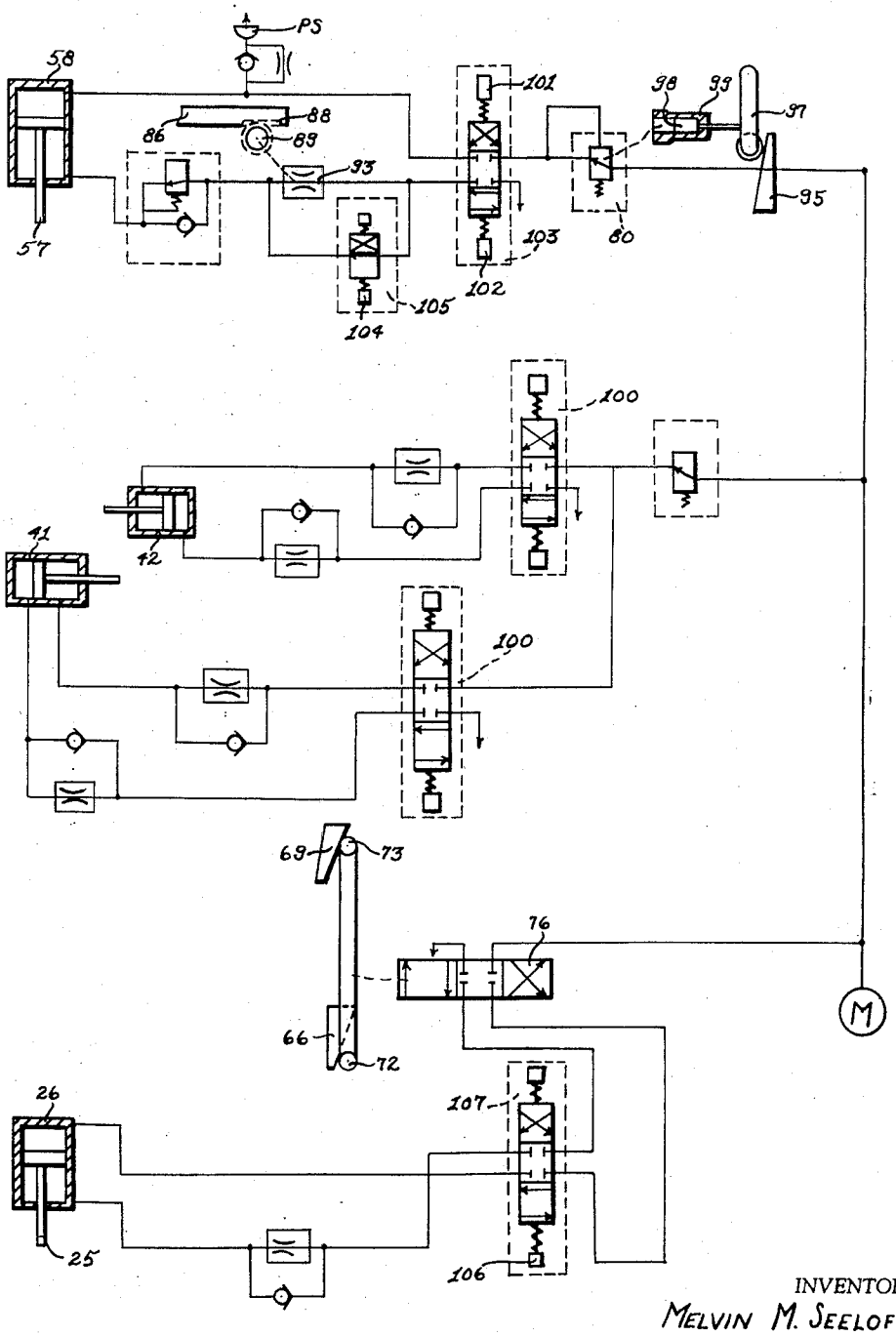


FIG. 10

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United States Patent Office 2,913,568 Patented Nov. 17, 1959

2,913,568

HOT UPSETTING MACHINE

Melvin M. Seeloff, Warren, and Hans H. Hansen, Cortland, Ohio, assignors to The Taylor-Winfield Corporation, Warren, Ohio, a corporation of Ohio

Application January 8, 1957, Serial No. 633,118

18 Claims. (Cl. 219—152)

The present invention relates to the metal forming and working art, and more particularly to an improved machine for the electric resistance heating and hot forming of metal workpieces into desired shapes and sizes.

In the production of valve members for internal combustion engines, and other parts having a generally small shank or stem portion with a bulbous section of material at some point along such stem, it has been common practice to employ hot upsetting methods wherein a workpiece of relatively small cross section is heated through a localized area to the point of plasticity whereupon pressure is applied to the ends of the workpiece to upset or gather a large bulb-like quantity of material conforming somewhat in shape and size to the desired end product. This procedure is often preferred over forging operations, for example, as being faster, simpler, more economical and productive of superior results.

Generally, in hot upsetting operations, a desired area of the workpiece is heated by bringing current carrying electrode members into contact therewith and passing a high amperage through the desired localized area whereby the same becomes heated to a plastic condition. As pressure is applied between the ends of the workpiece, material flows into and gathers within the area between the electrodes. The shape and size of the bulb of gathered material may be varied by controlling the rate of flow of heating current, the application of upsetting pressure, and by adjusting the position of the current carrying electrodes.

All of the above is generally well known in the art. However, insofar as we are aware, most apparatus heretofore devised for carrying out hot upsetting has been of a more or less limited nature, capable of only low rates of production and in requiring constant and the close personal attention and supervision of the machine operator. In addition, such prior art apparatus is generally limited to the shaping of one or two specific products and not adapted for the making of a variety of products since many major modifications must be made to change from one product to another. This has somewhat limited the utilization of such apparatus. It is therefore the primary or ultimate object of the present invention to provide apparatus of an improved nature which is characterized by its extreme flexibility in operation whereby the apparatus may be easily converted from shaping one product to shaping another with a minimum of "down time" and/or expensive alterations. As will be apparent upon further consideration of the following specification, the apparatus of the present invention is ideally suited for installation where numerous products are to be formed, as in an experimental laboratory, for example.

It is also an object of the present invention to provide apparatus of an improved nature which is adapted to carry out hot upsetting operations with a minimum of operator attention in a substantially automatic manner. In this respect, the machine of the present invention embodies many features disclosed and claimed in two patent applications of Hans H. Hansen and Roy W. Pearson which are assigned to the assignee of the present invention, namely Serial No. 479,903, now U.S. Patent No. 2,768,282, filed January 5, 1955, entitled "Apparatus for the Hot Upsetting of Metal Workpieces," and Serial No. 528,174, filed August 15, 1955, now Patent No. 2,768,282, entitled "Electrode Actuating Mechanism for Hot Upsetting Machines." However, as will become apparent, the present apparatus incorporates many improved features which form the basis of this disclosure.

More specifically, it is an object of the invention to provide a novel and improved arrangement for mounting a pair of current carrying electrode members so that the same can be retracted and opened and closed in a proper manner during the operational cycle of the hot upsetting machine. As set forth in the above identified patents it is desirable during an upsetting operation to retract the movable electrode members away from the anvil electrode at an accurately controlled rate so that the size and shape of the gathered bulb of material may conform as nearly as possible to that of the desired final product. In accordance with the teachings of the present invention, the retracting movement of the movable electrode members is positively and directly related to movement of the pressure applying means through new and novel fluid mechanism so that at all times there is an exact and positive relation between the retracting movement of the movable electrode members and the quantity of material gathering between the electrodes.

Yet another object of the invention is to provide means responsive to the position of the pressure applying ram means to independently control both the pressure exerted on and the speed of gathering of the workpiece being formed. In this manner of operation both the speed and pressure applied by the pressure applying means can be accurately controlled to effect the desired upset pattern as required for any given product.

Another object of the invention is to provide a machine of the character described wherein the mechanical movements of the pressure applying means and the movable electrode members as well as the speed of the upsetting operation and the upsetting pressure can be easily and quickly changed and are infinitely adjustable to provide the correct operational pattern best suited for any given workpiece and desired final product. As will become more fuly apparent, the movement of the movable electrode members and the pressure applying means, as well as the other controllable features, are actuated and controlled by new and novel cam and cam follower means of appropriate construction to effect the above described results.

An ancillary object of our present invention is to provide an improved fluid circuit for regulating the various mechanical operations of the hot upsetting operation.

A further object of the invention is to provide a hot upsetting machine having the characteristics outlined above which is of the utmost simplicity in construction and operation whereby upsetting of metal workpieces is carried out in an expeditious and automatic manner.

The above and other objects and advantages of the invention will become apparent upon full consideration of the following detailed specification and accompanying drawing wherein there is disclosed a certain preferred embodiment of the invention.

In the drawing:

Figure 1 is a fragmentary front elevational view of a hot upsetting machine constructed in accordance with the teachings of my present invention;

Figure 2 is a side sectional view taken along the section line II—II of Figure 1;

Figure 3 is an enlarged fragmentary plan sectional view of the movable electrode members and mounting

carriage therefor taken along the section line III—III of Figure 1;

Figure 4 is a plan view taken along the section line IV—IV of Figure 1;

Figure 5 is a plan view of the apparatus of Figure 1 taken along section line V—V;

Figure 6 is an enlarged view showing specifically a portion of the means employed for controlling the speed of the upsetting operation;

Figure 7 is a sectional view taken along the section VII—VII of Figure 6;

Figure 8 is an end view showing a portion of the means employed for regulating the pressure applied during an upsetting operation;

Figure 9 is a sectional view taken along the section line IX—IX of Figure 8; and

Figure 10 is a schematic plan of the various fluid circuitry utilized for controlling the hot upsetting machine.

Referring now to the drawing, and initially to Figures 1 and 2 thereof, the reference numeral 15 designates the main supporting framework of our hot upsetting machine which houses near the bottom thereof a low voltage-high amperage transformer 16 (see Figure 2) of the type commonly employed in electric resistance welding, for example. Rigidly mounted adjacent the bottom portion of the framework is a support 17, upon which is mounted, by means of an auxiliary current conductive bracket 18, a fixed or anvil electrode 19 having an upwardly facing contact surface. One of the terminals 20 of the transformer 16 is connected by a heavy conductor 21 with the current conductive bracket 18, and hence with the fixed or anvil electrode 19.

Above the anvil electrode 19 are positioned clamp-like workpiece engaging electrode members 22 and 23 which are mounted on a carriage, generally designated by the reference numeral 24, that is anti-frictionally guided on the framework 15 for vertical movement. Attached to the upper portion of the carriage 24 is the end of a piston rod 25 of a carriage retracting fluid cylinder 26 that is rigidly mounted on the framework 15. As shown in more detail in Figure 3 of the drawing, the carriage 24 comprises similar upper and lower portions 27 and 28, respectively, of a unitary casting, each of which has a generally flat supporting surface 29 of irregular plan outline and the integral but vertically extending sidewalls 30 that, as will be hereinafter more fully explained, provide guiding means for the carriage structure. Each of the casting portions 27 and 28 also includes a mounting boss 31 near the rear end portion thereof which is apertured to receive the mounting pin 32. It will be noted that the bosses 31 of the castings are vertically spaced on the mounting pin, being mounted on the ends thereof as shown in Figure 2 of the drawing.

Intermediate the portions 28 and 29, and journaled on the mounting pin 32, are a pair of forwardly extending but spaced arms 33 and 34 that mount on the forward faces thereof the fixtures 35 and 36 which in turn support the workpiece engaging electrode members 22 and 23 in the manner shown. The rear ends of each of these arms are formed with a vertically extending surface adapted to receive one set of ends of flexible current conductor bands 37 that are electrically coupled to secondary terminal 38 of the transformer 16 via the large conductor 39. It will be appreciated by those persons skilled in the art that the arms 33 and 34 are insulated from the mounting pin 32 by means of a suitable annular liner, not specifically shown, and are also insulated from the casting portions 27 and 28 in such a manner that during an upsetting operation current flow is limited to the arms 33 and 34, fixtures 35 and 36 and the workpiece engaging electrode members 22 and 23.

It is, of course, necessary to provide means for moving the arms 33 and 34, and hence the electrode members 22 and 23, toward and away from each other for the loading and unloading of workpieces. To accomplish this end we have provided a pair of fluid clamping cylinders 41 and 42 suspended between mounting clevises 43 that are rigidly attached to the supporting surfaces 29 of the two castings. The piston rod of each of these cylinders carries a vertically apertured fitting 44 which is pivotally connected to one of the arms in a suitable recess provided therein. The arrangement is such that upon appropriate actuation of the clamping cylinders 41 and 42 the arms 33 and 34 are caused to pivot about the mounting pin 32 thereby causing the electrode members 22 and 23 to move toward or away from each other.

For guiding the movement of the carriage assembly 24 the forward corners of the vertically projecting sidewalls 30 of both of the casting portions 28 and 29 have integral and vertically extending projections 45 that carry guides 46 having hardened and ground bearing surfaces thereon disposed in angularly related relation. In the illustrated apparatus there are four such guides, one at each forward corner of the carriage 24. The main framework 15 of the hot upsetting machine mounts four brackets 47 thereon and each of these brackets carries a pair of angularly related anti-friction rollers 48 and the positioning of the brackets is such that the anti-friction rollers cooperate with the ground bearing surfaces of the guides to accurately position and guide the carriage 24 in vertical movements; and in accordance with preferred practice in such cases the bearing surfaces and rollers are pre-loaded, by means of shims or wedges, not shown, so that there is absolutely no looseness or "play" in the movements of the carriage 24.

As set forth in U.S. Patent No. 1,849,185 to Giacchino and further explained in the above identified patents of Hansen and Pearson, for example, it is often desirable to change the relative positioning of the electrodes so that the direction of flow of the plastic material, and consequently the contour of the bulb of gathered material may be varied in a desired manner. To this end the electrode members 22 and 23 may be progressively moved away from the anvil electrode 19 in a manner dependent upon the actuation of the carriage retracting cylinder 26 by means which will be hereinafter more fully explained.

As previously indicated, some means must be provided for applying pressure to the workpiece during the upsetting operation and in the present apparatus this is accomplished by means of a vertically movable ram 50 that is disposed vertically above and generally aligned with the electrode members 22 and 23. As shown particularly in Figure 4 of the drawing the ram 50 is more or less U-shaped, opening in a forwardly direction, and mounts a plurality of pairs of anti-friction rollers 51, there being two pairs of angularly related rollers at the upper and lower ends of the ram. Mounted rigidly on the framework 15 are spaced brackets 52 that carry oppositely disposed inserts 53 having hardened and ground bearing thereon adapted to cooperate with the rollers 51 and it is contemplated that the rollers and bearing surfaces will be pre-loaded so that the ram 50 is accurately and precisely guided for vertical movement.

The ram 50 further comprises several longitudinally extending webs 54, the lower of which forms an abutment surface adapted to engage and bear against one end of a workpiece, not shown, while the uppermost web is apertured and adjustably clamped thereto by nuts 55 is an extension 56 which in turn is rigidly attached to a piston rod 57 of an upsetting cylinder 58. The upsetting cylinder 58 is mounted on the top of the machine framework 15 and is of such size to be capable of supplying the necessary upset pressures required. Supported from the extension 56 is a forwardly projecting plate 59 that in effect forms a supporting bracket for the vertically disposed plates 60 and 61 extending above and below the plate 59, respectively. The left hand edge of the plate 61 is fitted with a gear rack 62, attention being

directed specifically to Figures 2 and 4 of the drawing, which meshes with a pinion **63** mounted on a shaft extending from a rotary limit switch **64**. The limit switch is suitably mounted in rigid relation with respect to the framework **15** of the hot upsetting machine and operates suitable solenoid valves, not specifically shown, in such a manner that ram **50** is caused to retract after predetermined downward movement thereof and after an upsetting operation has been completed. It will be noted that the relative vertical position of the ram **50** may be adjustably changed—by proper manipulation of the nuts **55**—without disturbing the position of the plates **59—61** and the various appurtenant equipment carried thereby.

During an upsetting operation, while the lower end portion of a workpiece is heated by the flow of current between the electrode members **22** and **23** and the anvil electrode **18** pressure is applied to the upper end of the workpiece by means of the ram **50**, the heated end portion of the workpiece is caused to deform and move slidingly downward through the electrode members and an increasing soft bulb of metal gathers so that it is desirable to retract the electrode member **22** and **23** away from the anvil electrode **18**.

Thus, in accordance with the teachings of our present invention, there is mounted on the forward face of the upper casting portion **27** on the right hand side thereof a cam mechanism **65** which carries a first cam **66** having an upwardly sloping camming surface. The cam mechanism **65** comprises various plates and is constructed in such a manner that the cam **66** carried thereby can be moved either to the right or left on the casting portion **27** and angularly with respect thereto. Preferably the cam mechanism is provided with suitable scales, not specifically shown, which indicate to the operator the relative position of the cam **66** with respect to the carriage **24**. A second cam **68**, see Figures 1 and 4, is attached by means of angles **69** to the right hand side of the ram **50** and is generally aligned with but positioned above the cam **66** mounted on the carriage **24**. The cams **66** and **68** are essentially elongated members of triangular, or, more specifically, trapezoidal, shape to thereby expose sloping camming surfaces.

An elongated and generally vertically extending whippletree **71** has cam follower rollers **72** and **73** mounted on the ends thereof adapted to contact the camming surfaces of the cams **66** and **68**, respectively, in the manner shown. The whippletree is pivotally connected intermediate its ends to a clevis-like fitting **74** attached to the forward end of an operating rod **75** of a fluid servo valve **76**. The servo valve **76** is rigidly attached to the machine framework **15** and, as is well known in the art, is essentially a proportioning device—that is the fluid supplied thereto will be proportioned in a manner dependent upon the position of its internal valve spool, not specifically shown. The operating rod **75** of the fluid servo valve **76** is shouldered at **78** to receive a yoke-like spring assembly **79** which insures that the rollers carried by the whippletree **71** are in contacting relation with their respective cams at all times. As detailed in Figure 4 of the drawing, an inwardly extending bracket assembly **70** is mounted on the framework **15** and serves to guide the operating rod **75** of the servo valve **76**.

The servo valve **76** is connected in such a manner, to be later described, that it is operative to proportion fluid to both ends of the carriage retracting cylinder **26** so that the relative differential between the camming surfaces of the cams **66** and **68** acting through the whippletree **61** controls the speed of retraction of the electrode mounting carriage **24**. It is noted that this arrangement automatically controls the speed of retraction of the carriage **24** in a manner dependent upon the relative vertical positions of this carriage and the pressure applying ram **50** and that the movements of these two members are interdependent and directly related. The manner in which the ram **50** and the carriage **24** are directly related will, of course, depend upon the camming surfaces provided to regulate the servo valve **76**. To change the relationship between these two members to effect different upset patterns the operator need only adjust the cam mechanism **65** to change the angular and/or lateral position of the cam **66**. If this adjustment does not provide the necessary change the cams **66** and **68** can be easily detached and replaced by other cams which will give the desired inter-related movement of the carriage **24** and the ram **50**. The exact point of pivotal connection between the whippletree **71** and the clevis-like fitting **74** will depend upon the required movement of the servo valve spool.

In order to provide an extremely versatile and flexible machine we have included means controlling and adjustably regulating the pressure applied by and the speed of the ram **50** during an upsetting operation. In the present instance the pressure is controlled by regulating the pressure supplied to the fluid upsetting cylinder **58** and the speed by regulating the volume of fluid supplied to this cylinder.

To regulate the speed at which the ram **50** descends a cam mechanism **81** is mounted on the right hand side of the plate **60** and this cam mechanism, like the cam mechanism **65**, is adjustable both laterally and angularly. The cam mechanism detachably mounts a cam **82** having a downwardly sloping camming surface that is adapted to be traversed by a cam follower roller **83**. The cam follower roller **83** is journaled at the end of a spring-biased operating lever **86** and this lever is supported for sliding movement by the brackets **87** extending from the framework **15** of the hot upsetting machine. The rear end portion of the operating lever **86** mounts a small rack **88** which is adapted to mesh with a gear **89**. As shown in Figures 6 and 7 of the drawing, the gear **89** is adjustably bolted, by means of bolts **90** and slots **91**, to an adaptor plate **92** having the general configuration shown so that the same may be mounted on the adjusting screw of a flow control valve **93**. The arrangement is such that upon movement of the ram **50**, and consequently the plate **60** and cam **82**, the follower roller **83** will move causing longitudinal and rotary movement of the rack **88** and gear **89**, respectively. The rotary movement of the gear **89** will in turn cause movement of the adjusting screw of the flow control valve **93** to thereby regulate the volume of fluid delivered to the upsetting cylinder **58**. Obviously, to change the speed of the downward movement of the ram **50** for different upsetting operations the relative position of the cam **82** can be adjusted or an entirely new cam provided.

For controlling the pressure applied to the workpiece another cam mechanism **94** which is adjustable both laterally and angularly and detachably carries a cam **95** having a downwardly sloping camming surface is attached on the left hand side of the plate **60**. The sloping surface of the cam **95** is adapted to be engaged by a roller **96** mounted on the lower end of a spring-biased lever **97** that is pivotally mounted from the framework **15**. The lever **97**, intermediate the ends thereof, engages the protruding ends of a plunger **98** slidably mounted in a fitting **99** and is adapted to push against the plunger of a fluid pressure reducing valve **80** to thereby regulate and control the fluid pressure exerted by the upsetting cylinder **58** on the ram **50** and, consequently, the workpiece.

From the above discussion it will be seen that by adjusting or altering the shape of any of the above mentioned cams, the speed of retraction of the electrode members **22** and **23**, the upsetting speed of the ram **50** and the upsetting pressure exerted by this ram can all be independently and infinitely adjusted to meet the requirements of any given upset operation. Such a machine is ideally suited for applications, such as in a laboratory, for example, where it is necessary to have an extremely versatile and flexible pattern of operation.

Referring now to Figure 10, illustrating a simplified

schematic diagram for use in connection with the apparatus heretofore described, and considering the operation of the machine, it will be assumed that initially the ram 50 is in the up position while the electrode carriage 24 is in the down position with the electrode members 22 and 23 opened. A workpiece is initially positioned between the electrode arms with one end thereof resting on the anvil electrode 18. It is, of course, within the scope of the invention to incorporate automatic feeding and positioning apparatus with the hot upsetting machine, such as the type disclosed and claimed in the above identified Hansen and Pearson patents. With the workpiece initially positioned it is necessary to supply fluid to the head ends of the clamping cylinders 41 and 42 to cause the electrode members 22 and 23 to move into clamping relation with the workpiece. This is accomplished by providing a four-way valve 100 for each of these clamping cylinders and actuating these valves, either manually or in response to some mechanical function, to supply fluid to the head ends thereof.

As the electrode members are moved into clamping relation with the workpiece, a limit switch, not shown, is closed, energizing solenoid 101 and deenergizing solenoid 102. The latter solenoids cooperatively control a four-way valve 103, and upon conditioning of the solenoids as above described the valve shifts so that pressure fluid is directed from the pump M to the upper end of the upsetting cylinder 58 causing the ram to be lowered into contact with the workpiece.

Lowering of the ram 50 causes the workpiece to be brought into pressure engagement with the anvil electrode 18, whereupon there is a sudden increase of fluid pressure in the upper end of the upsetting cylinder 58. This sudden increase in pressure causes a pressure switch PS to close which, operating through suitable apparatus, energizes a solenoid 104 which controls by-pass valve 105 in the fluid circuit of the cylinder 58 so that fluid from the lower end of cylinder 58 is exhausted through the flow control valve 93. Thereafter the cylinder operates against a certain back pressure and is caused to move at a controlled rate of speed in a manner dependent upon the shape of cam 82 operating through the rack and gear 88 and 89, respectively.

At this time power is supplied to the transformer 16 so that heating current is caused to flow in the workpiece. Although any suitable electrical power control means may be employed we prefer to use the control circuit disclosed and claimed in the co-pending patent application of Joseph J. Riley and Forbes A. Hurcomb, Serial No. 601,152, filed July 31, 1956, entitled "Control Circuit for Hot Upsetting Machines," and assigned to the assignee of the present invention. This specific control circuit allows infinite adjustment of the heat level in the workpiece throughout a hot upsetting operation and, when coupled with apparatus of the present application, provides a machine adapted for almost any type of upsetting operation.

As the material of the workpiece begins to soften and yield, gathering between the electrode members 22 and 23 and the anvil electrode 18, the ram 50 descends and in so doing the pressure applied thereby is regulated and controlled by the cam 95 operating through the lever 97 which in turn operates the plunger of the pressure reducing valve 80 in the manner hereinbefore described.

With the application of heating current to the workpiece a solenoid 106 is energized which controls a four-way valve 107 in such a manner that fluid is supplied to the rod end of the carriage retracting cylinder 26. This causes the carriage 24 to move upwardly, retracting the electrode members 22 and 23 away from the anvil electrode 19 in a manner dependent upon the actuation of the proportioning device or servo-valve 76 as clearly set forth above with the differential between the cams 66 and 69 operating through the whippletree 71 accomplishing this end.

As the upsetting operation proceeds, the ram 50 descends at a controlled rate of speed applying a controlled upsetting pressure and the carriage 24 retracts at a controlled rate until the workpiece has obtained its desired shape. The heating current is stopped and suitable contacts, not shown, close to deenergize solenoid 102 and energize solenoid 101 so that fluid is directed to the rod end of the upset cylinder 58. Exhausting of the upper end of cylinder immediately opens the pressure switch PS and deenergized solenoid 107 of a by-pass valve 108 so that the controllable flow control valve is shunted or by-passed out of the fluid circuit leading to the lower end of cylinder 58 so that the ram 50 may be rapidly retracted.

At the end of the upward movement of the carriage 24 the various solenoids controlling the four-way valves 100 are reversed to cause the clamping cylinders 41 and 42 to retract. This opens the electrode members 22 and 23 so that the workpiece can be removed. The carriage 24 can then be returned to its initial starting position and the hot upsetting machine is ready for another cycle of operation.

It should thus be apparent we have accomplished the objects initially set forth. We have provided a highly advanced hot upsetting machine which is characterized by its extreme flexibility and versatility.

One of the most important features of the invention is the provision of new and novel means for independently regulating the speed of retraction of the electrode members, the speed of the upsetting ram and the pressure applied by this ram throughout the upsetting operation. By either adjusting and/or replacing the various cams employed it is possible to obtain an infinite number of upsetting patterns to meet the requirement of any given workpiece or desired product.

Another important feature of the invention is the specific fluid circuit and components thereof arranged in such a manner and utilized to allow the control and regulation discussed above.

The invention also provides an improved machine of rugged construction well adapted for continued and sustained usage in carrying out hot upsetting operations where it will be understood that the mechanical functions thereof must be carried out in a precise manner to produce an acceptable product. Both the electrode carrying carriage and the pressure applying ram are accurately guided and mounted by anti-friction bearing rollers so that the same are easily moved in response to the actuation of the cylinders associated therewith. In addition, the electrode members are adapted for movement toward and away from each other in an improved manner.

Our invention also includes other important features contributing to a highly improved hot upsetting machine. It should be understood, however, that the embodiment herein illustrated and specifically described is intended to be illustrative only. Reference should therefore be had to the following appended claims in determining the true and full scope of the invention.

We claim:

1. In apparatus for hot upsetting metal workpieces including a framework, spaced electrode means for engaging a workpiece at spaced points, ram means movable along the principal axis of said apparatus in a first direction to apply pressure to the workpiece to cause deformation thereof between said electrode means, and means to move one of said electrode means along said principal axis in a second direction; the improvement in said last mentioned means comprising an electrode mounting carriage movable in parallel relation with respect to said axis, said carriage mounting one of said electrode means, a fluid cylinder for moving said carriage, means to supply fluid to said fluid cylinder, and said means to supply being continuously operative and controllable throughout an upsetting operation in response to the relative instantaneous position of said ram means and

said carriage whereby the speed of movement of said carriage in said second direction is dependent upon said relative instantaneous position of said ram means and said carriage.

2. Apparatus according to claim 1 further characterized in that said means to supply fluid further comprises a servo valve, and means responsive to the relative positioning of ram means and said carriage for operating said servo valve.

3. Apparatus according to claim 2 further characterized in that said means responsive comprises separate cams mounted on said ram means and said carriage, cam follower means adapted to engage said cams, said cam follower means being relatively stationary with respect to the movement of said ram means and said carriage, and said cam follower means being operatively connected with said servo valve.

4. Apparatus for the hot upsetting of metal workpieces comprising a framework, spaced electrode means for engaging a workpiece, means for supplying electrical energy to said electrode means, ram means movable along the principal axis of said apparatus in a first direction to apply pressure to the workpiece to cause deformation thereof between said electrode means, means for moving said ram means in said first direction, one of said electrode means being movable along the principal axis of said apparatus in a second direction, means for moving said one of said electrode means, said last mentioned means being continuously actuated and controlled throughout an upsetting operation in response to the relative instantaneous position of said ram means and said one of said electrodes, means to control said means for moving said ram means whereby the speed of movement of said ram means may be continuously varied throughout an upsetting operation, said means to control operating in response to the instantaneous position of said ram means, means to control said means for moving said ram means whereby the pressure applied thereby may be continuously varied throughout a hot upsetting operation and said last mentioned means to control being operative in response to the instantaneous position of said ram means.

5. Apparatus for the hot upsetting of a metal workpiece comprising a framework, spaced electrode means for engaging a workpiece, means for supplying electrical energy to said electrode means, ram means movable along the principal axis of said apparatus to apply pressure to the workpiece to cause deformation thereof between said electrode means, means for moving said ram means, means to control said means for moving whereby the speed of movement of said ram means may be varied continuously throughout an upsetting operation, and said means to control being operative in response to the instantaneous movement and position of said ram means.

6. Apparatus according to claim 5 further comprising second means to control said means for moving said ram means whereby the pressure applied thereby may be varied throughout a hot upsetting operation, and said second means to control being operative in response to the movement and position of said ram means.

7. Apparatus according to claim 5 further characterized in that said means to control comprises cam means detachably mounted on said ram means, cam follower means adapted to engage said cam means and being mounted stationarily with respect to said ram means, said means for moving said ram means comprising a fluid cylinder, a flow control valve in the supply circuit of said fluid cylinder, and said flow control valve being operated in response to the movement of said cam follower means.

8. Apparatus according to claim 7 further characterized in that said cam follower means further comprises an operating rod, said operating rod carrying a rack portion, a pinion gear adapted to mesh with said rack portion, and said gear operatively coupled with said flow control valve whereby the amount of fluid supplied to said fluid cylinder depends upon the rotative position of said gear.

9. Apparatus for the hot upsetting of metal workpieces comprising a framework, spaced electrode means for engaging a workpiece, means for supplying electrical energy to said electrode means, ram means movable along the principal axis of said apparatus to apply pressure to the workpiece to cause deformation thereof between said electrode means, means for moving said ram means, means to control the pressure exerted by said ram means whereby the same may be varied continuously throughout an upsetting operation, and said means to control being operative in response to the instantaneous movement and position of said ram means.

10. Apparatus according to claim 9 further characterized in that said one of said electrode means is movable along said principal axis in a direction opposite to that of said ram means, means to move one of said electrode means, means to control the movement of said one of said electrode means whereby said one of said electrode means may be moved in accordance with a predetermined pattern, said last mentioned means to control being operated continuously in response to the instantaneous relative positioning and movement of said ram means and said one of said electrode means.

11. Apparatus according to claim 9 further characterized in that said means to control comprises cam means detachably mounted on said ram means, cam follower means adapted to engage said cam means and being mounted stationarily with respect thereto, said means for moving said ram means comprising a fluid cylinder, a pressure reducing valve in the fluid supply circuit for said fluid cylinder, and said pressure reducing valve being operated in response to the movement of said cam follower means.

12. Apparatus for the hot upsetting of metal workpieces comprising a framework, spaced electrode means for engaging a workpiece, means for supplying electrical energy to said electrodes, ram means movable along the principal axis of said apparatus to apply pressure to cause the deformation thereof between said electrode means, one of said electrode means being movable along said principal axis in a direction opposite to that of said ram means, means for continuously controlling the speed of movement of said one of said electrode means, said means for controlling operative in response to the instantaneous relative position of said ram means and said one of said electrode means, means for continuously controlling the speed of movement of said ram means, said last mentioned means being operative in response to the instantaneous position of said ram means, means for continuously controlling the pressure applied by said ram means, and said means for controlling the pressure being operative in response to the instantaneous position of said ram means.

13. Apparatus for the hot upsetting of metal workpieces comprising electrode means adapted to engage a workpiece, pressure applying means for exerting a force on the workpiece to cause deformation thereof, one of said electrode means being adapted for movement along the principal axis of the apparatus, a fluid cylinder for moving said one of said electrode means, a fluid supply circuit for said cylinder, said circuit comprising a proportioning device adapted to proportion the flow of fluid to said cylinder, and said proportioning device being actuated in a predetermined manner continuously during an upsetting operation in response to the relative instantaneous positions of said one of said electrode means and said pressure applying means.

14. Apparatus according to claim 13 further characterized in that said pressure applying means and said one of said movable electrode means each mount cam means, cam follower means adapted to engage said cam means,

and said cam follower means being operatively connected to said proportioning device.

15. Apparatus according to claim 14 further characterized in that said cam follower means comprises a whippletree, said cam follower means further including a pair of cam follower rollers mounted on the opposite ends of said whippletree, and an operating rod pivotally interconnected with said whippletree intermediate the ends thereof and being operatively connected to said proportioning device.

16. Apparatus for hot upsetting a metal workpiece comprising electrode means adapted to engage a workpiece at spaced points, pressure applying means for exerting a force on the workpiece to cause the deformation thereof including a movable ram, a fluid cylinder for moving said ram, a fluid supply circuit for said ram, a flow control valve in said circuit, a pressure reducing valve in said circuit, means for controlling said valves whereby the amount and pressure of fluid supplied to said cylinder may be varied continuously during an upsetting operation, and said means for controlling being operated in response to the instantaneous movement of said ram.

17. Apparatus according to claim 16 further characterized in that said means for controlling comprises cam means for each of said valves, said cam means being mounted on said pressure applying means, cam follower means for each of said cam means, and each of said cam follower means being operatively coupled with one of said valves whereby the speed of and pressure exerted

by the pressure applying means is varied in accordance with a predetermined pattern.

18. Apparatus for the hot upsetting of metal workpieces comprising a framework, spaced electrode means for engaging a workpiece, means for supplying electrical energy to said electrode means, ram means movable along the principal axis of said apparatus in a first direction to apply pressure to the workpiece to cause deformation thereof between said electrode means, means for moving said ram means in said first direction, one of said electrode means being movable along the principal axis of said apparatus in a second direction, means for moving said one of said electrode means, said last mentioned means being actuated and controlled by cam means associated with said apparatus, means for controlling said means for moving said ram means including second cam means associated with said apparatus to vary the pressure applied by said ram means during an upsetting operation, and other means for controlling said means for moving said ram including third cam means associated with said apparatus to vary the speed at which the pressure is applied by said ram means.

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