

Aug. 30, 1932.

A. L. BAUSMAN ET AL

1,874,158

FORGING MACHINE

Filed July 14, 1927

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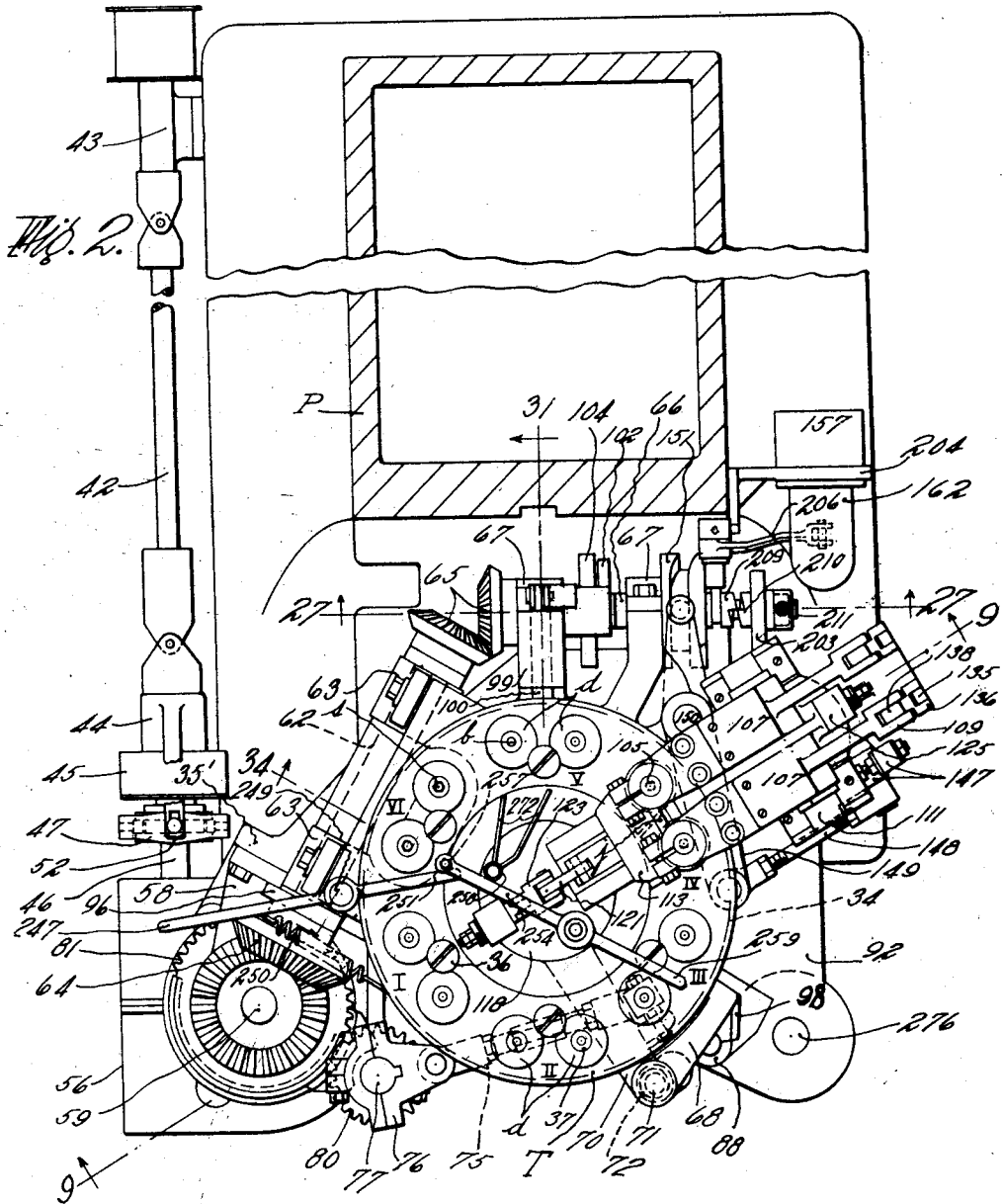
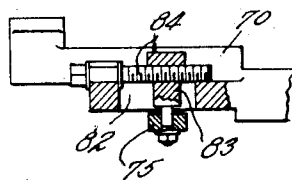


Fig. 3.



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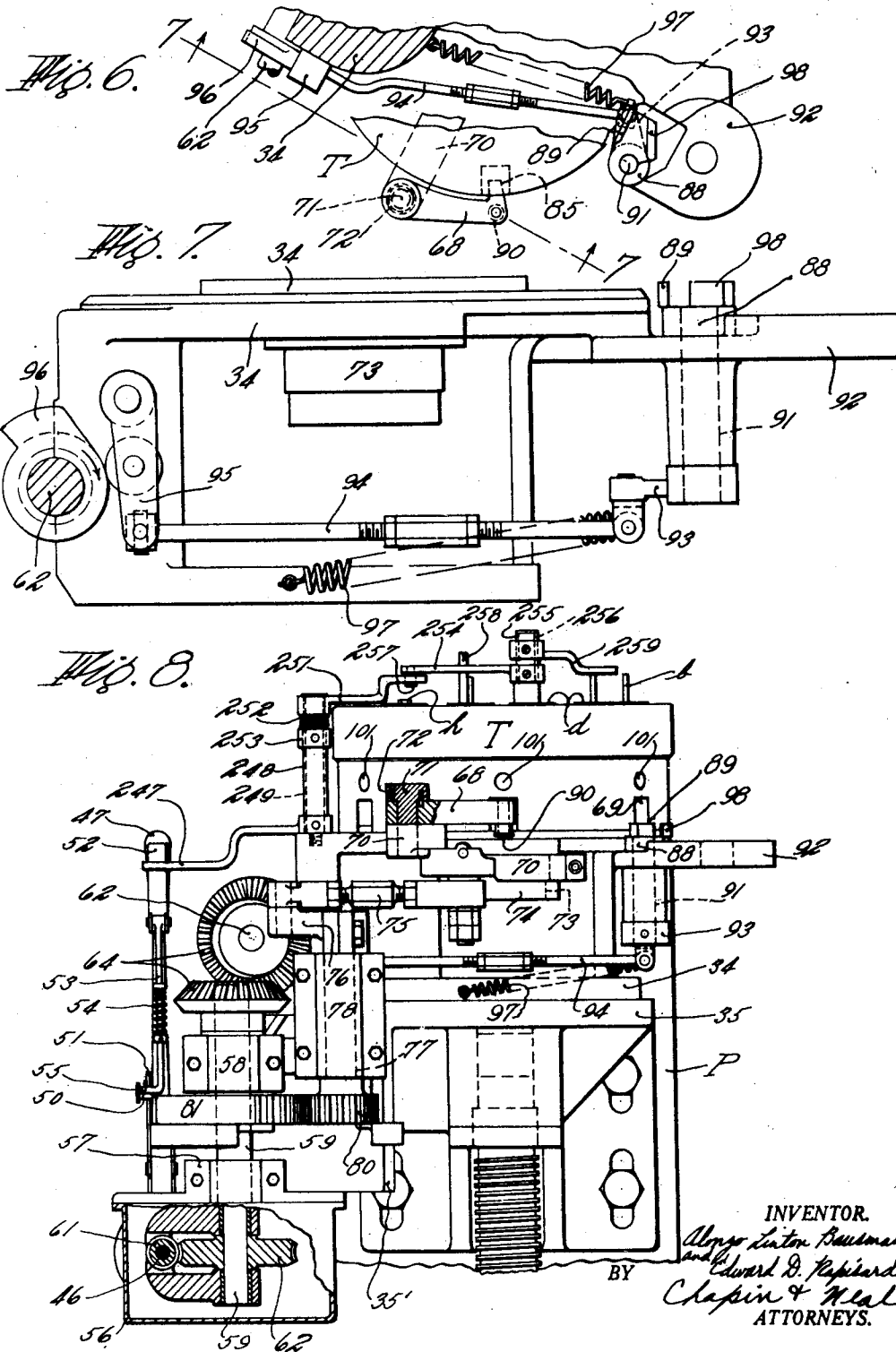
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FORGING MACHINE

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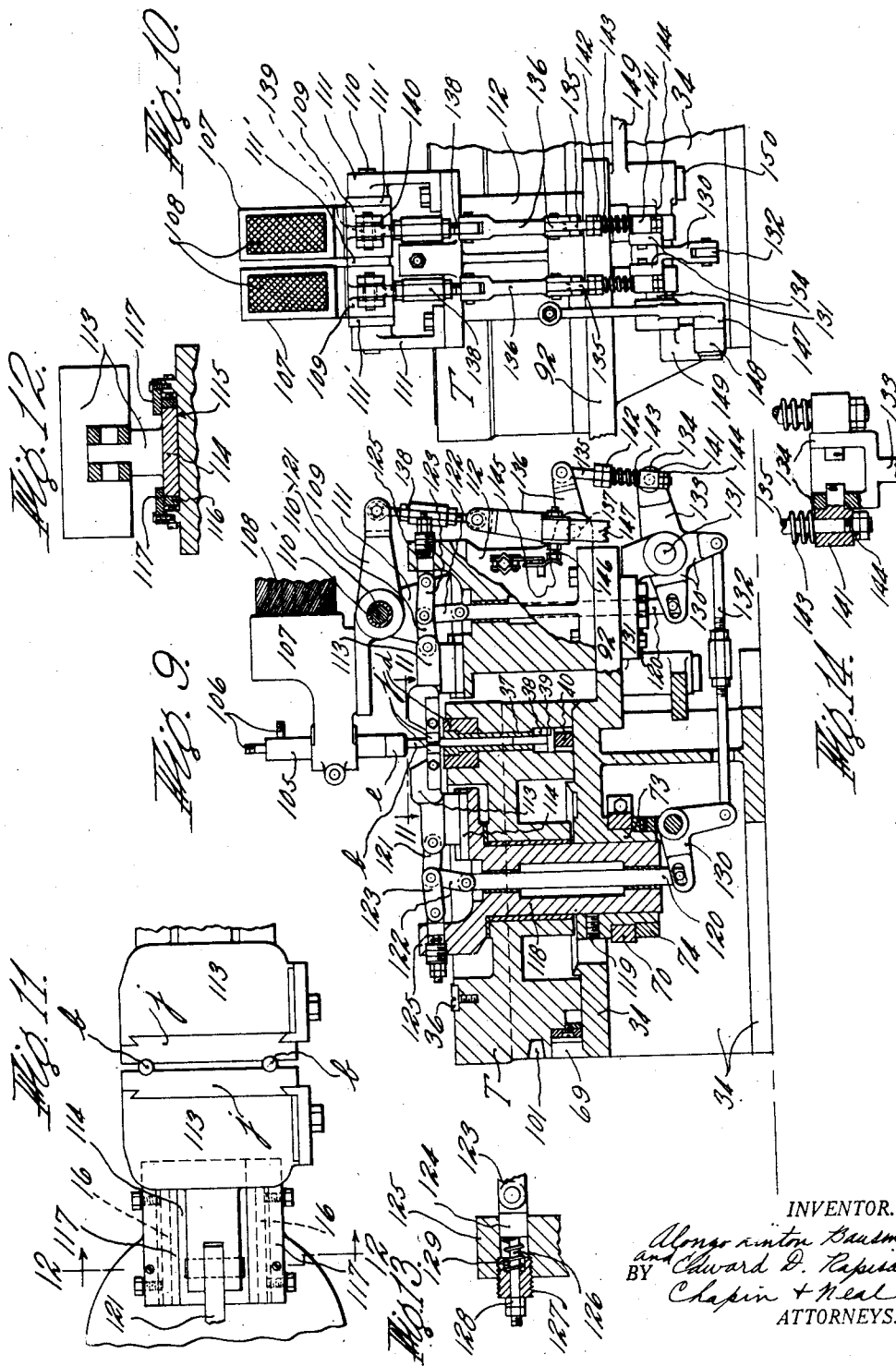
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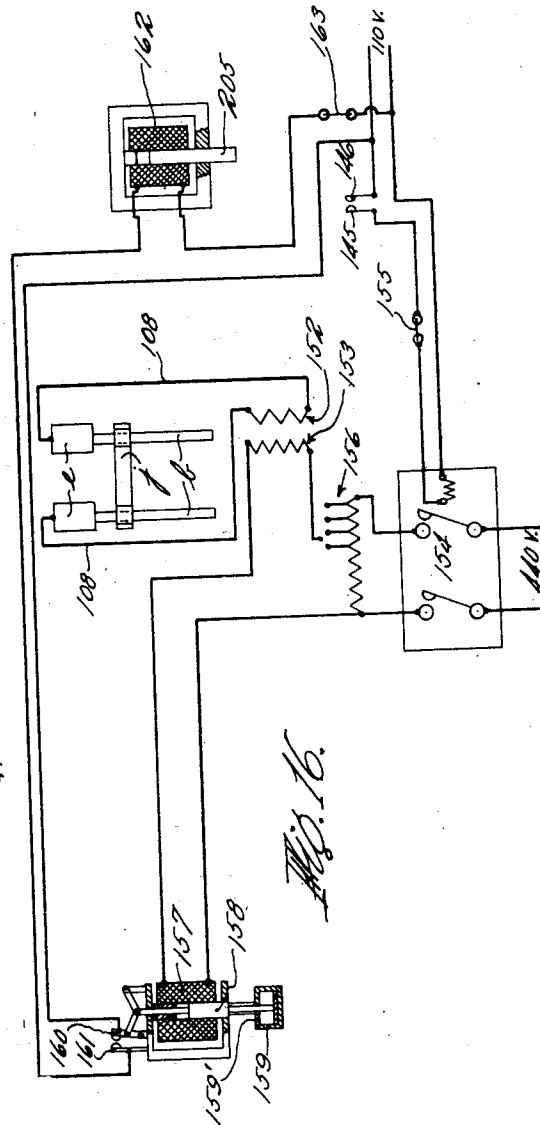
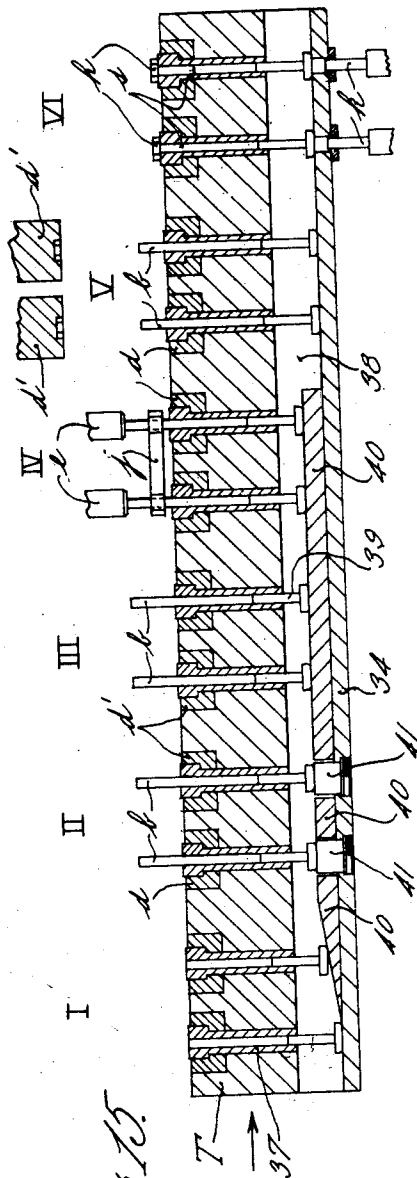
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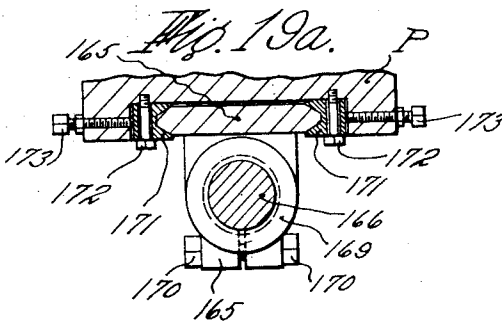
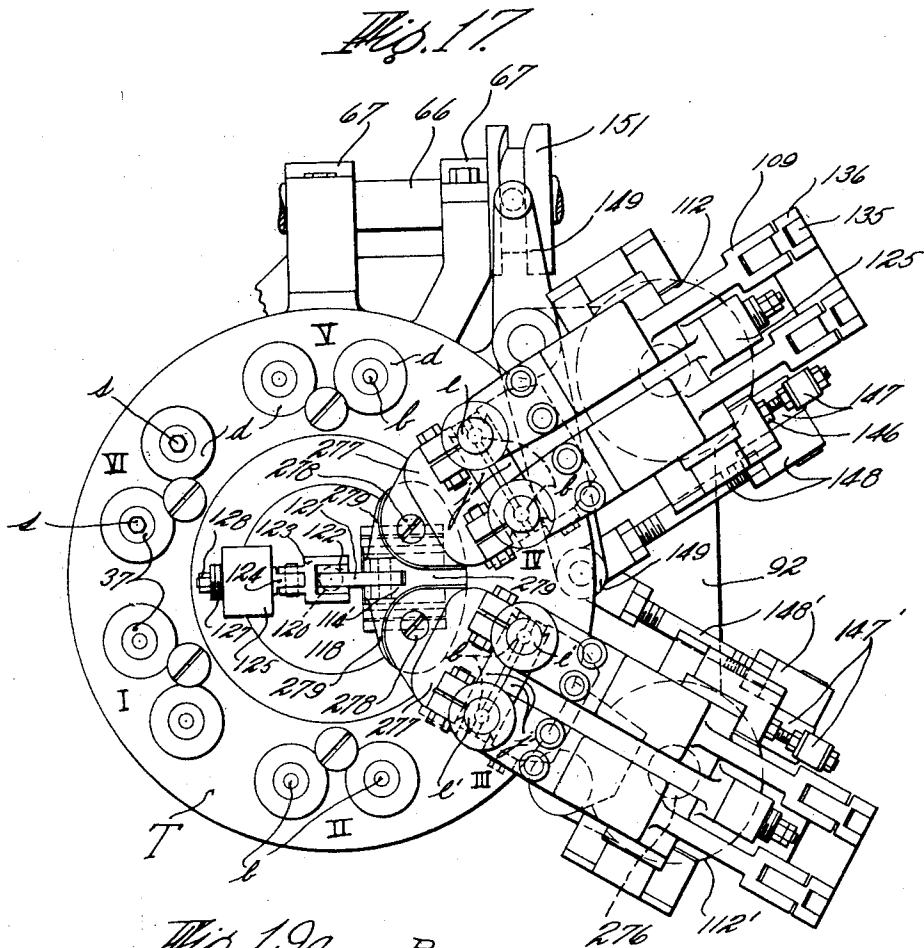
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FORGING MACHINE

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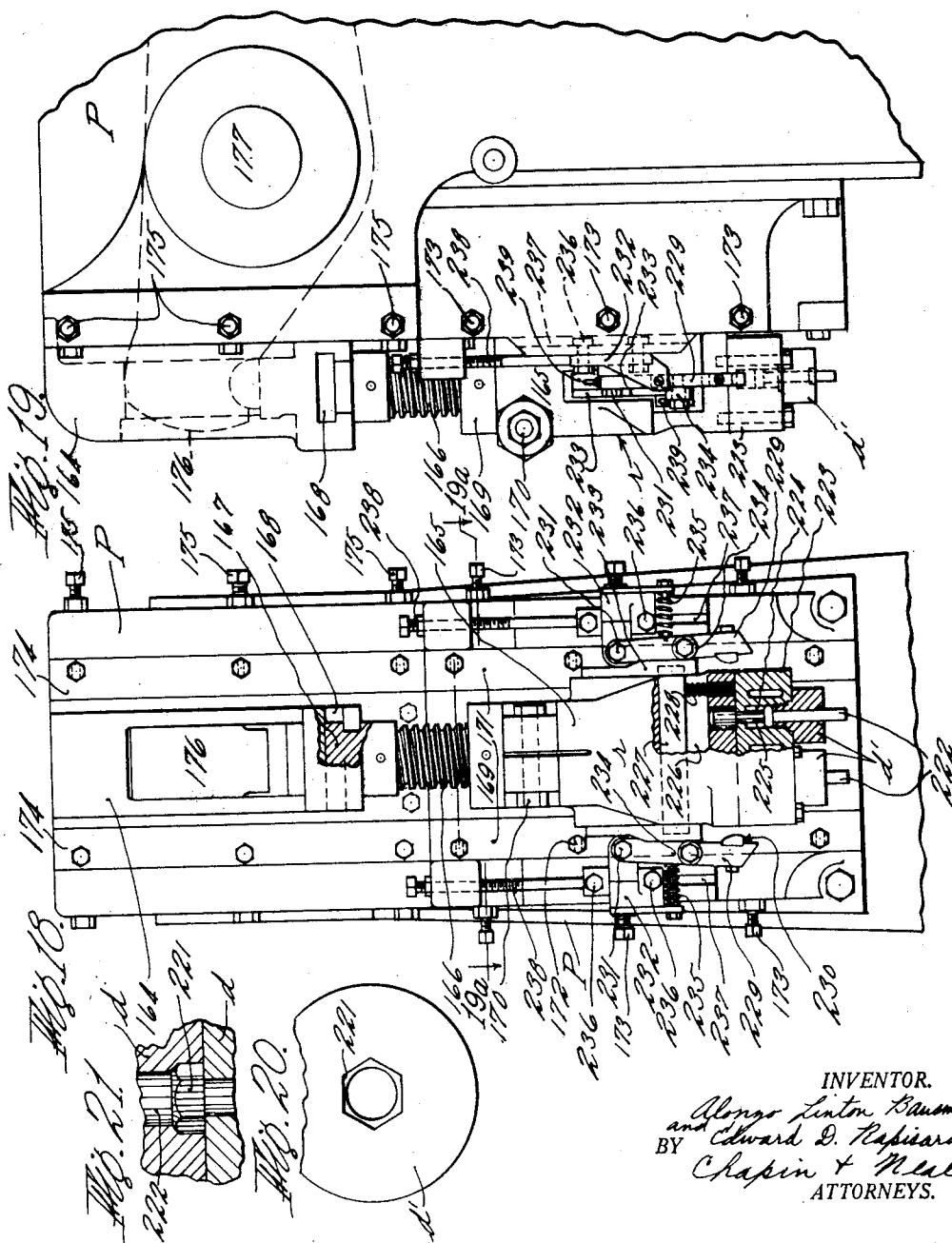
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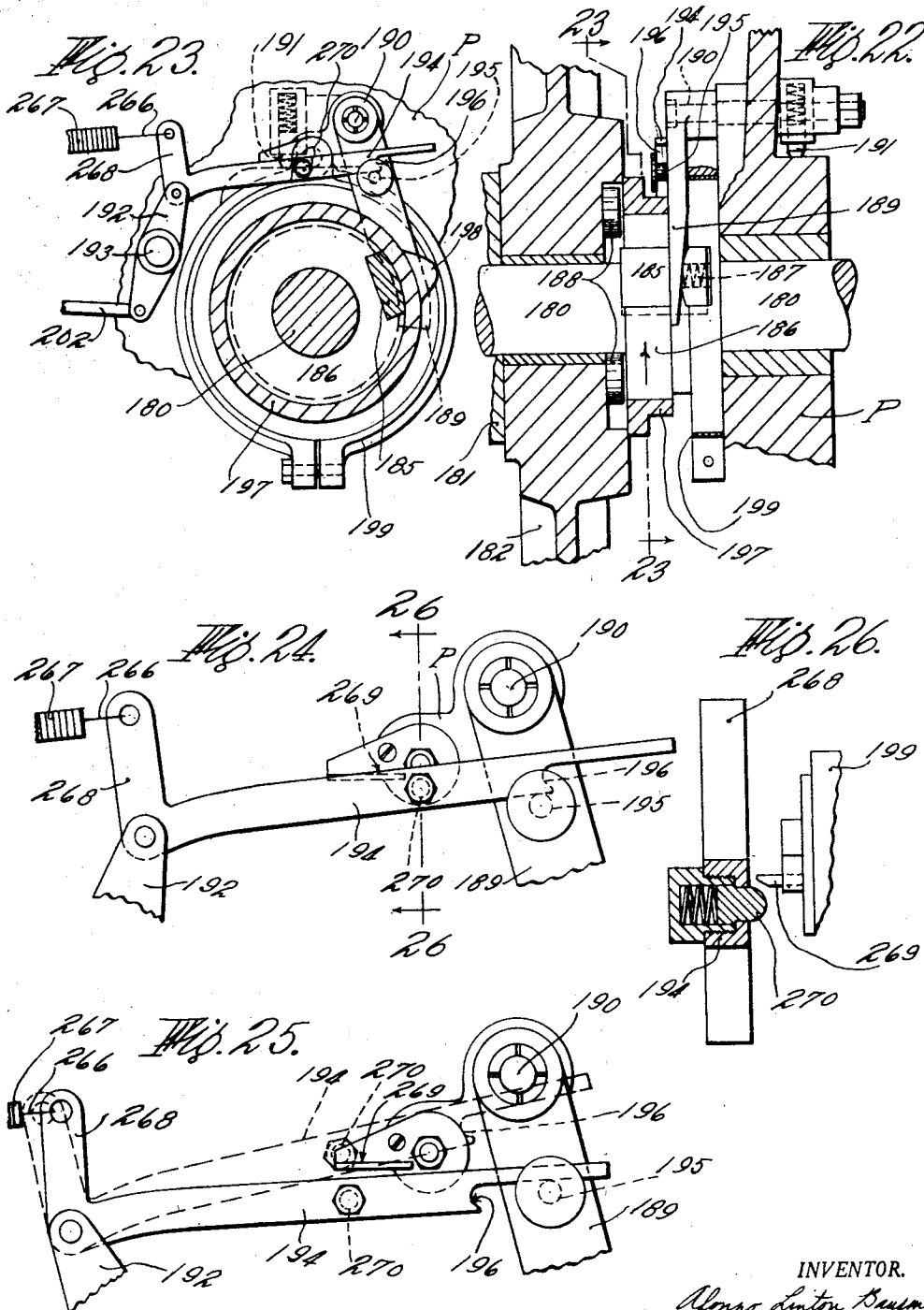
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FORGING MACHINE

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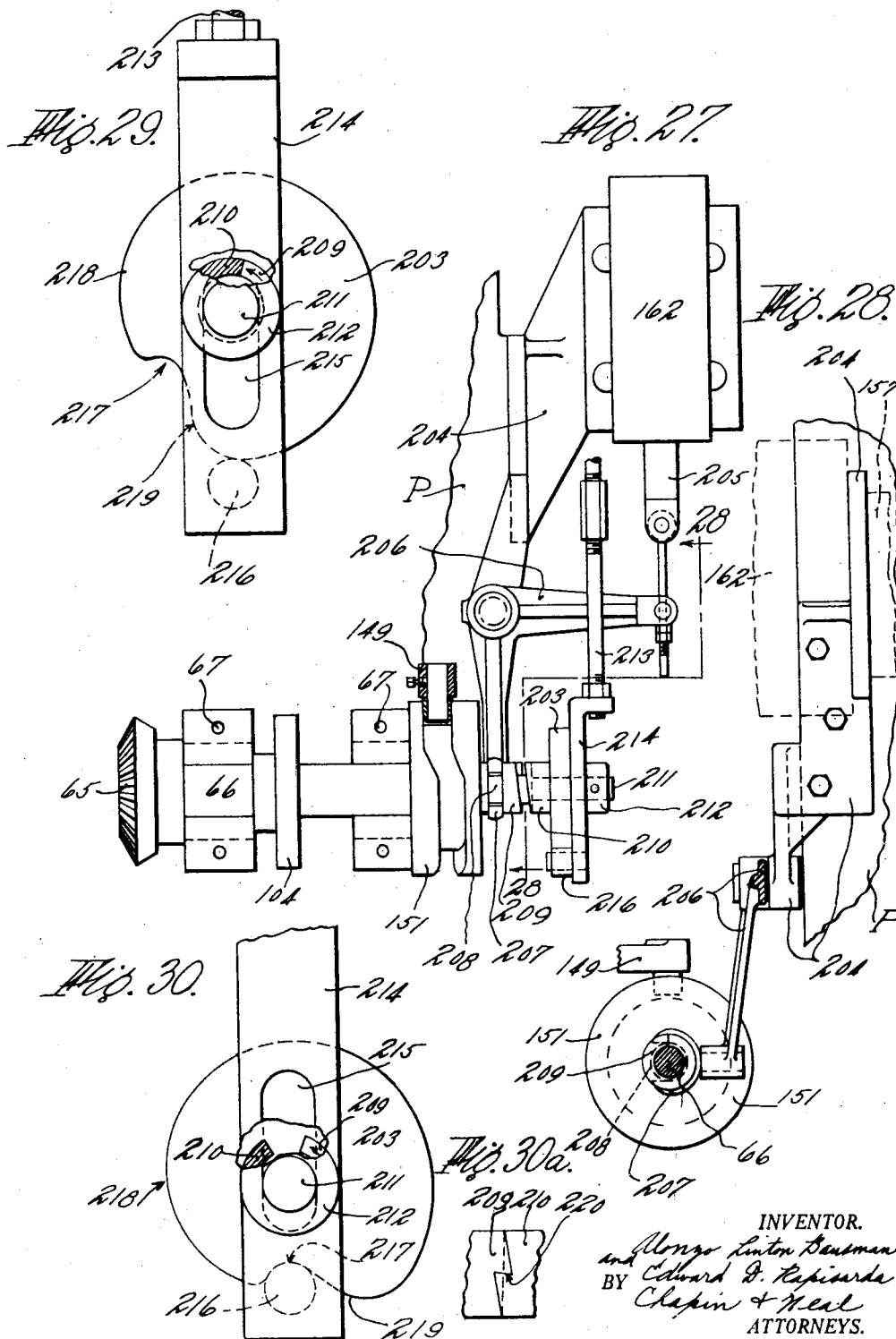
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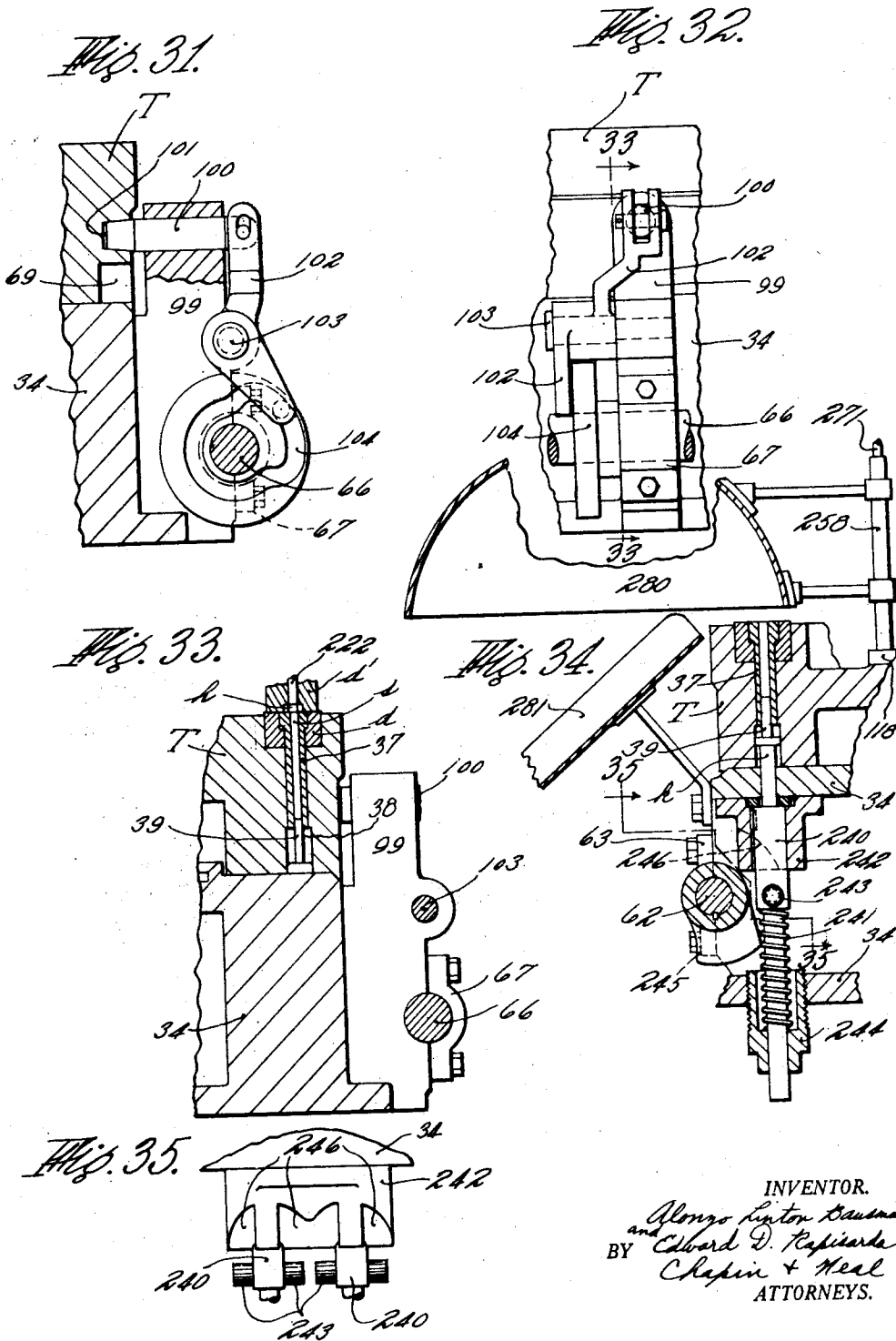
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FORGING MACHINE

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UNITED STATES PATENT OFFICE

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FORGING MACHINE

Application filed July 14, 1927. Serial No. 205,815.

This invention relates to an automatic forging machine, of the class wherein articles may be successively heated and forged and the forged articles ejected.

The machine of this invention, while capable of other uses, is especially suitable for upsetting work, as for example, for forming heads on the blanks or stock fed into the machine. It will be disclosed, by way of illustrative example, as adapted to form cap screws,—the upper end of a cylindrical blank of metal being first electrically heated and then upset and shaped between cooperating dies to form the cap screw head.

The general object of the invention is to provide an improved machine for doing work of the above described, or of an analogous character, with precision and at a rate high enough to meet practical production requirements and in an otherwise commercially satisfactory manner.

The invention also has for an object the provision of various features, capable of use independently or in conjunction, which are directed to making the machine as nearly as possible fool-proof in operation. In particular, the machine, which involves electric heating means and a press for forging the heated articles, is so arranged that the press cannot be tripped to forge the articles unless and until the same have been heated to proper forging temperature. The control of the tripping of the press is made dependent on the operation of the electric heating means.

Another feature is in the provision of means for automatically stopping the machine in the event that a blank of more than the required length is fed into the machine or in the event that a blank, even if of proper length, is improperly positioned in its die, whereby damage to the machine, due to acts of carelessness in the feeding of blanks, is avoided. A further feature consists in provisions effective to stop the machine in case a forged article is not ejected from its die at the proper time. A still further feature lies in an arrangement for guarding against the possibility of the press being tripped and caused to strike articles which, while initially properly heated for forging, have cooled below

forging temperature by reason of the stopping of the machine.

The invention also has for an object to provide an improved turret, having article holding dies, for carrying the articles successively into position for heating, forging and ejection and to provide improved means for intermittently moving the same step by step and for locking it against movement while at rest.

Another object of the invention relates to the electric heating means and especially to an improved construction and arrangement of those parts of the heating circuit which serve to couple the article to be heated to the latter, while the turret, or other intermittently operable carrier, is at rest.

Other objects of the invention relate to improved provisions in connection with the forging dies,—especially to means for stripping the forged pieces therefrom and preventing them from sticking to the dies after the forging operation and to improved means for cooling such dies after each forging operation.

A further object relates to the provision of improved means for ejecting the forged articles, characterized by its ability to impart a quick sharp blow to dislodge the articles from and throw them out of their dies.

These and many other objects, which require for their understanding a consideration of considerable detail, will appear from the following description and will be pointed out in the appended claims.

The invention will be disclosed with reference to the one illustrative embodiment of it in the accompanying drawings, in which:—

Fig. 1 is a side elevational view of a machine embodying the invention,—the electrodes and associated clamping jaws together with their operating connections having been removed to avoid confusion and to clearly show the relationship between the turret and the press;

Fig. 2 is a sectional plan view, taken on the line 2—2 of Fig. 1 and drawn to a larger scale, showing the turret, its actuating mechanism and the relationship between the turret and the electrodes, clamping jaws and associated parts;

Fig. 3 is a fragmentary view, with parts in section, showing a detail of the turret operating mechanism;

Fig. 4 is a fragmentary elevational view, taken from the opposite side of the machine from Fig. 1 and drawn to a larger scale, showing the main driving mechanism, its controlling means and the relationship between the latter and the safety stop mechanism;

Fig. 5 is a fragmentary view, partly in section, showing the construction of the operating pawl for the turret and the manner in which it engages in the pockets of the turret;

Fig. 6 is a fragmentary plan view, with parts broken away, of the turret operating pawl and the locking and unlocking device therefor;

Fig. 7 is a fragmentary elevational view taken on the line 7—7 of Fig. 6 showing the operating means for the pawl unlocking device;

Fig. 8 is a front elevational view of the lower part of the machine,—the electrodes and clamping jaws having been removed for the sake of clearness and to avoid needless confusion of parts;

Fig. 9 is a sectional elevational view taken on the line 9—9 of Fig. 2 and showing the electrodes and jaws and associated mechanism;

Fig. 10 is a fragmentary elevational view taken at right angles to Fig. 9;

Fig. 11 is a fragmentary plan view taken on the line 11—11 of Fig. 9;

Fig. 12 is a cross sectional view taken on the line 12—12 of Fig. 11;

Fig. 13 is an enlarged view of a detail shown in Fig. 9;

Fig. 14 is an enlarged view, partly in section, of a detail shown in Fig. 10;

Fig. 15 is a schematic view, showing conventionally the operations effected at the various positions of the turret;

Fig. 16 is a diagrammatical view of the electrical heating circuit and associated parts;

Fig. 17 is a fragmentary plan view, taken similarly to Fig. 2 and showing the manner in which the electric heating equipment may be duplicated to provide for two-stage heating of the work;

Figs. 18 and 19 are front and side elevational views of the upper part of the machine showing the reciprocable ram of the press, the upper dies and the stripper devices therefor;

Fig. 19a is a sectional plan view taken on the line 19a—19a of Fig. 18;

Fig. 20 is a bottom plan view of one of the upper dies;

Fig. 21 is a fragmentary sectional view showing an upper and a lower die in the relative positions which they occupy at the in-

stant of completion of the forging operation;

Fig. 22 is a longitudinal sectional view illustrative of the clutch of the press;

Fig. 23 is a cross sectional view taken on the line 23—23 of Fig. 22;

Figs. 24 and 25 are fragmentary views, taken similarly to Fig. 23 but drawn to a larger scale and showing the clutch tripping device in its inactive position and in its "cocked" position, respectively;

Fig. 26 is a sectional view taken on the line 26—26 of Fig. 24;

Fig. 27 is a sectional elevational view taken on the line 27—27 of Fig. 2;

Fig. 28 is a cross sectional view taken on the line 28—28 of Fig. 27;

Figs. 29 and 30 are fragmentary elevational views, taken from the right hand end of Fig. 27 but drawn to a larger scale and showing the cam for effecting the tripping of the clutch of the press in the respective positions which it occupies at the start and end, respectively, of the tripping interval;

Fig. 30a is a fragmentary elevational view showing the detail of the clutch elements shown in Fig. 27;

Fig. 31 is a cross sectional view taken on the line 31 of Fig. 2;

Fig. 32 is a view taken from the right hand end of Fig. 31;

Fig. 33 is a sectional view taken on the line 33—33 of Fig. 32;

Fig. 34 is a sectional elevational view taken on the line 34—34 of Fig. 2; and

Fig. 35 is a view taken on the line 35—35 of Fig. 34.

The machine shown in the drawings, while capable of other and various uses, will be disclosed with reference to merely one of its specific uses, viz., the forming of cap screws, such as shown at *s* in Fig. 15, from cylindrical blanks *b*. The blanks *b* are fed by hand, or in any other suitable manner, to dies *d*, carried by a turret *T*, (Figs. 1 and 2) which is turned intermittently in step by step fashion. The dies are preferably arranged in pairs so that two blanks may be treated simultaneously in each of the several stages of operations which ensue while the turret is at rest. As shown, there are six pairs of dies, each pair of which successively comes to rest in six positions, during each revolution of the turret. In Fig. 15 the turret is shown diagrammatically in developed form and the six positions are designated I to VI inclusive. These same designations appear in Fig. 2 but the general work performed will be more clearly understood from Fig. 15. The blanks may be fed to the dies when they occupy positions I or II, usually the latter. Position III is provided to enable the use of a preliminary stage of heating, when necessary or desired. When the preliminary stage of heating is not used, blanks may be fed at this position also. The

final and often the only stage of heating is performed when the dies come to rest in position IV. In this position, the upper ends of both blanks are simultaneously and electrically heated. Two electrodes *e*, connected to the terminals of a suitable transformer as will appear, descend into contact with the upper ends of the two blanks. At the same time the two blanks are electrically connected together at a lower level which is just above dies *d*, by being clamped between a pair of copper jaws *j*, whereby the upper ends of the two blanks are included in series in the electric heating circuit. Current is then supplied to the transformer and the blanks are heated to the desired degree. The blanks, having been suitably heated, are then advanced by the next step of movement of the turret into position V. The dies *d*, containing the heated blanks, are brought in under a pair of dies *d'* carried by the vertically reciprocable ram *r* (Fig. 1) of a well known type of press, the frame of which is designated P. This press includes mechanism which when tripped, causes the ram to make one complete reciprocation and then stop. Thereby the pair of dies *d'* are moved rapidly downward from their upper and inactive position into engagement with the heated ends of the blanks in the dies *d*, whereby such ends are upset and forged between the mating dies to form the finished heads *h* of the cap screws. This forging operation, having been performed, the ram *r* returns to its upper position and dwells there until the press is again tripped. As the ram rises, the turret advances another step into position VI, in which the forged pieces are ejected,—this operation being performed by vertically reciprocable ejectors *k*.

The machine, in general, includes the following distinct mechanisms, viz., mechanism for actuating the turret in a step by step manner; mechanism for locking the turret against rotation while at rest and subsequently unlocking it; an optional and auxiliary mechanism for locking the turret while at rest and intended also for the purpose of resisting the vertically upward strains imposed on it when the dies *d'* are stripped from the forged cap screw heads; the electrodes *e* and clamping jaws *j*; mechanism for moving these electrodes into and out of contact with the blanks and at the same time moving the jaws *j* into and out of clamping relation with the blanks; mechanism for opening and closing the electrical heating circuit; the press P; mechanism for controlling the tripping of the press; the forging means comprising dies *d'*; mechanism for stripping the heads of the forged pieces from dies *d'*; and mechanism for actuating the ejectors *k*. These several mechanisms function automatically in proper timed relation under the control, directly or indirectly, of a

common driving means. In addition, there are a number of important safeguards which are essential to insure proper operation of the machine and make it as nearly fool proof as possible. For example, means are provided for automatically stopping the machine in the event that a blank *b* projects more than a certain distance above its die *d*, either because the blank is too long or because it is not properly seated in its die. Means are also provided to automatically stop the machine on failure of the ejectors to completely eject the finished work. Another safety feature consists of mechanisms to prevent tripping of the press in the event of either of two conditions, viz., in the event that the blanks are not heated to the desired degree either from failure of current or because of poor contact between the blanks and electrodes or copper jaws and in the event that the machine is stopped for any reason so that blanks, which were initially heated properly, have by the lapse of time become too cool to forge.

The turret

The turret is mounted for rotation about a vertical axis and its lower face (Fig. 9) rests upon, and is turnable upon, a circular upper part of a bracket 34, which in turn rests upon and is secured to the vertically adjustable table 35 of the press as shown in Figs. 1 and 8. Said circular face is chamfered, as shown in Fig. 9, and the turret has an interiorly bevelled, depending rim to engage the chamfered part,—the arrangement preventing the entrance of dust and dirt between the cooperating bearing surfaces of the turret and bracket 34. The dies *d* consist of hardened cylindrical blocks which are set into the upper face of the turret, each pair being held in place by a single screw 36, as shown in Fig. 2. The dies of each pair are equally spaced and the six pairs of dies are equally spaced and arranged in a circular series. Each die includes and has set into it, a hardened hollow cylindrical bushing 37 (Fig. 9) having a head and an extension of less diameter depending therefrom. The hole through the bushing is of the proper size to receive a blank *b*. Most of the wear on the die comes at its central portion wherefore such portion,—the bushing 37,—is made removable so that the replacement of only a small part of the die is necessary in the event of injury or wear.

The several bushings open at their lower ends into a common annular groove 38 formed in the bottom face of the turret. Slidable in the lower part of the opening in each bushing is a hardened pin 39, having at its lower end a head which is adapted to slide at times on the upper face of bracket 34 (Fig. 33) and at other times upon a trackway 40 (Fig. 9) fixed to said face. The trackway and its purpose are best illustrated in Fig. 15, where-

in the arcuate trackway has been shown diagrammatically as straightened out and in developed form. As there shown, the trackway starts at the level of the upper face of bracket 34 at station I and extends upwardly on an incline, reaching its highest level just before it reaches station II, and continues at such level through stations III and IV, and between stations IV and V drops abruptly to the level of the upper face of brackets 34. Each time the turret moves, a pair of pins 39 are caused to ride up the inclined part of the trackway, whereby they are forced upwardly in their bushings to a predetermined level, and thereafter this set of pins is held at such level until the heating operation has been completed. As the turret swings to carry a pair of heated blanks from heating to forging position, the pins are allowed to drop until their heads engage the upper face of bracket 34. The blanks *b* are supported upon the upper ends of pins 39 and the latter thereby serve to properly locate the blanks *b* vertically in their dies *d*. Each pin 39, when riding on trackway 40, holds its blank so that a considerable portion of the upper end thereof is projected above the top face of its die. Thus, the requisite amount of the upper end of a blank *b* can be heated while held out of contact with its die, thereby saving the die from the deleterious effects of the intense heat to which it would otherwise be subjected. After the heating, the pins 39 drop, as described, and the blanks drop down in their dies until just enough of each blank projects above the die *d* to form the finished head *h*.

Cap screws of other lengths may be made by removing the pins 39 and replacing them with similar pins of other lengths. To enable this to be done, removable sections are provided in the trackway, as best shown in Fig. 15. At station II, two plugs 41 are secured to bracket 34 in a manner to permit convenient removal from below the bracket. The upper ends of these plugs normally function as parts of the trackway 40. When, however, pins 39 are to be removed, the plugs 41 are removed and two openings are left through which the two pins 39 at station II may drop out. By turning the turret step by step, the other pairs of pins drop out successively as they come in line with the aforesaid openings.

The driving mechanism

The main drive shaft is shown in Figs. 2 and 4 at 42. It is rotatably supported in brackets 43 and 44 secured to the base portion of the press frame P and may be driven from any suitable source of power by the pulley shown. Shaft 42 drives through any suitable clutch 45 an alined shaft 46. The clutch has been indicated only in conventional form as its particular construction is not important. As best shown in Fig. 4, it is operated

by a lever 47 through the medium of a clutch collar 48. When the lever is positioned as shown in Fig. 4, the clutch is "in" and shafts 46 and 42 are connected and when it is positioned as shown in Fig. 2, the clutch is "out" and said shafts are disconnected. Lever 47 is pivoted to bracket 44. It is also connected to the bracket by a spring 49, which tends to swing the lever to the left and throw out the clutch so that shaft 46 no longer turns with shaft 42. Lever 47 carries a roll 50 which is adapted to be engaged by the shouldered portion of a latch 51, pivoted to bracket 44, whereby the lever, when moved to throw in the clutch, is held in its moved position by the latch. Lever 47 has pivoted thereto a bell crank lever 52, to which is pivotally connected one end of a rod 53, slidably mounted in lugs on the lever and yieldingly held in the illustrated position by a spring 54. The lower end of rod 53 is bent at right angles, as at 55, to underlie the free end of latch 51. When bell crank 52 is moved toward lever 47, rod 53 is elevated and the part 55 lifts latch 51 high enough to release it from roll 50, whereupon the spring 49 then moves lever 47 to throw out the clutch. The bell crank 52 may be operated manually in the ordinary way whenever the attendant desires to stop the machine. However, certain safety provisions are made for automatically stopping the machine and these provisions effect the result by automatically actuating the bell crank 52, as will later appear.

Referring again to the drive shaft 46, the latter extends into a gear box 56 (Figs. 4 and 8) and is rotatably supported therein as indicated. The cover, or top wall of the gear box, is formed as part of a bearing bracket 57 which is fixed to a depending flange 35' of the table 35 of the press P (Figs. 1 and 4). A second bearing bracket 58 is also fixed to said flange but at a point above the bracket 57 and these two brackets rotatably support a vertical shaft 59 (Fig. 8), the lower end of which enters gear box 56 and carries a worm gear 60, which is driven by a worm 61 on shaft 46. Shaft 59 forms one section of a master or control shaft. A second section 62 (Figs. 2 and 4) is horizontally disposed and mounted to turn in bearings 63 provided on one sidewall of bracket 34. The forward end of shaft 62 is connected by bevel gears 64 to the upper end of shaft 59 and the rear end of shaft 62 drives by bevel gears 65 a third section 66 of the control shaft,—the latter section being located in back of the turret and between bracket 34 and the press and being rotatably supported in bearings 67 provided on bracket 34. The several sections 59, 62 and 66 are geared together to turn at equal speeds and they are the equivalent of a single master or control shaft. All of the various mechanisms are driven or con-

trolled, directly or indirectly, from this control shaft, whereby they are coordinated and caused to work in proper timed relation. Each mechanism, driven or controlled therefrom or thereby, is caused to perform one complete cycle of operation during each revolution of such shaft.

The turret operating mechanism

with the same degree of accuracy even after the parts have become worn through long use. Also, it is desired to so construct the pawl that it may of itself serve as a means for locking the turret against turning movement during the interval of rest, although other means may be provided for this purpose as will later appear.

For the purpose of securing close accuracy in the throw of the pawl, which throw in the present case should be exactly sixty degrees, the connection between the link 75 and the pawl-carrying lever 70 is made adjustable. The detail of this adjustment is shown in Fig. 3. The lever 70 is provided with a slot 82 in which a block 83 of square cross section is slidably received. To the lower end of this block the link 75 is pivotally connected. The upper end of block 83 is threaded to receive a screw 84, which is mounted to turn in the lever 70 but is held against axial movement relatively thereto. By turning the screw 84, the block 83 may be moved in or out in its slot 82 and the throw of lever 70, and thus the throw of the pawl, may be varied in an obvious manner. With the turret held accurately in any one of its six positions of rest, crank 76 is turned to that one of its dead center positions in which the lever 70 and pawl 68 are retracted as in Fig. 8. Link 75 is then adjusted until pawl 68 accurately fits into the adjacent notch 69. The crank 76 is then turned to its other dead center position, thereby advancing the turret, and screw 84 is adjusted until the throw of the pawl is exactly right to advance the turret into exactly the desired position.

In order to minimize wear, the end 85 (Fig. 5) of the pawl is hardened and the notches in which such end engages are formed in hardened blocks 86 which are set into recesses in the periphery of the turret. Each such block is held in place by a screw 87. Viewing the pawl in plan, the center line 85' of part 85 is an arc struck from the center of stud 71 and thus from the center of oscillation of the pawl. The sides of the part 85 are likewise curved but not from the aforesaid center. These curved sides are made to converge inwardly, with respect to the center line referred to, and the sides of the openings 69 are correspondingly formed, converging inwardly. The end 85 of the pawl fits like a tapered plug into each socket 69. In this case, however, the center line of the socket and plug, instead of being straight, is curved from the pawl's pivot point, whereby the plug end 85 may swing clear of its socket when withdrawn from the same. Due to this arrangement, when the sides of the pawl or the sides of the sockets wear, the pawl is simply thrust more deeply into its socket and thus compensation for such wear is effected without affecting the accuracy of positioning of the turret.

The turret is intermittently moved step by step by a specially constructed oscillating pawl 68 which moves successively into and out of a series of six notches 69 formed in the periphery of the turret T at equally spaced angular intervals. Pawl 68 is supported on the free end of a lever 70 and is pivotally connected thereto by a stud 71 which is fixed to lever 70. The stud 71 is recessed to receive a torsion spring 72, one end of which is fixed to the stud and the other to the pawl as best shown in Fig. 8. Spring 72 tends at all times to move pawl 68 toward the periphery of turret T. The lever 70, as best shown in Figs. 8 and 9, is mounted to turn on a centrally located hub 73 depending from the lower face of bracket 34, being held against axial movement thereon by a collar 74. Lever 70, at a point intermediate its ends, is connected by a link 75 (preferably adjustable as to length as indicated) to a crank 76 (Figs. 2 and 8), which is fixed to the upper end of a short vertical shaft 77. The latter is rotatably mounted in a bearing 78 formed as a part of the bearing bracket 58, heretofore described. The lower end of shaft 77 carries a pinion 80 (Figs. 2 and 8) which is adapted to be driven by an intermittent gear 81, fixed to the described section 59 of the control shaft. The arrangement is such that during one half revolution of the control shaft, the crank shaft 77 is turned one complete revolution and so that during the remaining half revolution of the control shaft, the crank shaft is held stationary in the position illustrated in Fig. 2. That is, the pawl comes to rest in its advanced position and remains engaged in a notch 69 of the turret during substantially all of its interval of rest, being moved out of the notch at or about the end of said interval. The pawl is then drawn back to the position shown in Fig. 8 until it comes in line with another notch 69, whereupon spring 72 engages the pawl in the notch. The pawl then immediately starts forward to advance the turret by another step.

The mechanism, as thus far described, is of simple form but this ordinary type of mechanism is not sufficient in itself for present purposes. For one thing, the turret feeding mechanism must be capable of positioning the dies with close accuracy in relation to the several mechanisms which operate on the work contained in the dies and for another thing, it must repeatedly do this work

The mechanism for locking and unlocking the turret

With a pawl of this type, means are required for withdrawing it from a socket prior to the start of its return stroke. Such means comprises a short lever 88 (Figs. 5 to 8) with which the forward part of the pawl moves into overlying relation when it nears the forward end of its stroke. Lever 88 is provided with an upstanding flange 89. Depending from the lower face of the pawl is a roll 90, which lies in the path of flange 89 and, when the lever 88 is swung outwardly from the turret in a clockwise direction, this flange engages the roll and thereby moves the pawl enough to completely withdraw the end 85 from the socket 69. Flange 89 is long enough so that roll 90 will remain in engagement with it during the initial part of the return stroke of the pawl, whereby the end 85 is positively held from reentering or catching on that socket from which it has just been withdrawn during its return stroke. As the pawl moves back on its return stroke, roll 90 finally rides off the bevelled end of flange 89 and thereafter the end face of part 85 engages the periphery of the turret and rides thereon until it reaches and enters another socket 69.

The lever 88 is fixed to the upper end of a short vertical shaft 91 (Figs. 6 and 7), rotatably mounted in a hub depending from a flange 92, which projects horizontally outward from bracket 34 beyond its turret-supporting part. The lower end of shaft 91 has fixed thereto a lever 93, which is connected by a link 94 (preferably adjustable as to length as indicated) to the lower end of a lever 95. The latter, at its upper end is pivoted to bracket 34 and intermediate its ends carries a roll to ride on the periphery of a cam 96, fixed to the section 62 of the control shaft and disposed between one of the bevel gears 64 and the adjacent bearing 63 (Figs. 2 and 4). A relatively strong spring 97 connects the lever 93 to bracket 34 and serves to hold the roll on lever 95 against cam 96 as well as to resist easy outward displacement of the lever 88, the latter action being necessary, as will shortly appear, because lever 88 is also made to perform the function of causing the tapered pawl end 85 to be thrust tightly into its socket 69. The cam 96 is constructed so as to cause lever 88 to be swung outwardly away from the turret at almost the very end of the interval of rest thereof. This motion of lever 88, which withdraws the pawl and unlocks the turret, is very rapid as will be seen from an inspection of the contour of the cam. Following this motion, the cam next causes the lever 88 to dwell in its outer position during the initial part of the return stroke of pawl 68, after which the cam allows lever 88 to be rapidly moved back by

spring 97 into its inner and illustrated position.

Referring now to Figs. 5, 6 and 8 it will be seen that lever 88 is provided with a second upstanding flange, designated 98, and this flange is utilized as a stationary cam which is adapted to be engaged by roll 90 near the end of the advance stroke of pawl 68, whereby to force the tapered end 85 thereof into close engagement in its socket 69. While the crank motion by which pawl 68 is reciprocated provides for a gradual acceleration and a gradual retardation of the pawl, the heavy turret acquires appreciable momentum, tending to keep it in motion. As the pawl is retarded near the end of its advance stroke, the turret tends to continue in motion and there is a tendency for the pawl end 85 to be moved outwardly in its socket. However, the cam flange 98 being held stationary by the strong spring 97, will force roll 90 and thus the tapered end 85 inwardly. Thus, the tendency for the part 85 to move outwardly in its socket is overcome by the cam 98 and, not only this, but the part 85 is forced tightly into its tapered socket in the turret, thereby accurately positioning the turret when it comes to rest. The spring 97 enables the lever 88 to yield, if and when necessary, but it is so strong as not to yield until the end 85 is thrust tightly home. This spring 97 supplies a heavy tension to hold the pawl end 85 in its socket and to securely lock the turret in position while at rest. It would not be feasible to provide enough tension in the spring 97 for this purpose. Thus, the latter can be made relatively light and yet function properly at all times, except at the end of the advance stroke of the pawl and at such time the necessary heavy tension is automatically brought into play and only at the time when it is needed.

Auxiliary locking mechanism for the turret

If necessary or desirable, an auxiliary mechanism may be provided for locking the turret in position while at rest and such mechanism may be used as an alternative to that above disclosed or as supplementary thereto or merely for the purpose of resisting the upward strains imposed upon the turret at the time when dies d' move upwardly at the end of the forging operation. Experience, thus far, has shown that the auxiliary locking mechanism is seldom needed to supplement the locking effected by the pawl and it is disclosed herein primarily as a means for resisting upward strains imposed on the turret under the conditions just mentioned.

Referring to Figs. 31 and 32, the bracket 34 is provided at the back thereof with an integral part 99 which extends upwardly above but behind the turret T and slidably receives a plunger 100. The latter is mounted to slide in a horizontal path and is adapted to move

radially in and out with respect to turret T. A series of holes 101, corresponding in number and angular location to the pawl receiving recesses 69, are provided in the periphery of turret T and these holes are located above the recesses 69. As shown, the holes 101 are frusto-conical in shape, tapering inwardly, and the free end of plunger 100 is correspondingly formed. The other end of the plunger has a pin and slot connection with the upper end of a lever 102, which is pivotally mounted at a point intermediate its ends on a stud 103, fixed to the part 99 of bracket 34. The lower end of lever 102 carries a roll to ride in a path cam 104, which is fixed to section 66 of the control shaft. Cam 104 is so constructed as to move plunger 100 radially inward as soon as turret T comes to rest and to cause the plunger to dwell in such position during the interval necessary for the forging operation and to retract the plunger shortly before the turret starts to move. The tapered end of the plunger enters the adjacent hole 101 and resists upward displacement of the turret. The plunger may also serve to lock the turret against rotation although the means heretofore described for the latter purpose are ordinarily sufficient. Plunger 100, however, is capable of use in place of said means or as supplementary thereto. For the vertical locking function the plunger would not have to closely fit all parts of the hole 101 as shown, and would merely have to closely overliesome substantially horizontal part of the turret.

The electrodes

The electrodes *e* and associated clamping jaws *j* are best shown in Figs. 9 to 13. Each of the electrodes *e* consists of a copper block mounted on the end of a copper shank 105. The latter, in practice, is arranged to be cooled and the water pipes 106 are indicative of means provided for this purpose. The shank 105 is clamped in a heavy copper lug 107 in which the conducting cable 108 is soldered. Each lug 107 is secured to one end of a lever 109 and the two levers 109 are pivotally supported intermediate their ends on a common stud 110. The latter is mounted at its ends in a pair of brackets 111 secured to a pedestal 112, which rests upon and is secured to the flange 92 of bracket 34. The levers 109 are suitably insulated from stud 110, as by a fiber bushing 110' (Fig. 9) and the levers are also suitably insulated from each other and from brackets 111 as by fiber washers 111' (Fig. 10). The electrodes *e* are adapted to swing up and down about the pivot 110 and are illustrated in their "down" position. When thus positioned, the lower end face of each electrode *e* is exactly horizontal and squarely engages the upper end of a blank *b*. The electrodes start to swing into the illustrated position just before the turret T comes to rest but do not actually contact with the

blanks *b* until the turret has come to rest. So also, the electrodes, at the end of the heating interval, break contact with the blanks *b* just before the turret starts to move but do not complete their upward movement until the turret gets in motion. In this way, as much as possible of the interval of rest of the turret is utilized for heating.

The clamping jaws *j* are mounted to slide radially in and out with respect to blanks *b* from opposite sides thereof. Each jaw *j* is wide enough so as to engage both blanks *b* of a pair, as clearly shown in Fig. 11, and the two blanks, being clamped between the two jaws, are electrically connected together at points just above the level of the upper faces of dies *d*. The current then flows down one electrode *e*, through the upper end of one blank *b*, across through jaws *j* to the other blank *b* and up through the upper portion of the latter to the other electrode *e*. The jaws *j*, which are preferably of copper, are preferably recessed, as shown to conform to the curvature of the blanks and assure close contact as well as contact of adequate area, with the blanks. Each jaw *j* is mounted in a head 113, preferably in a manner to permit convenient removal in order to facilitate repair and renewal, when necessary. Each head 113 has a slide 114 formed thereon which is received in ways 115 (Fig. 12). The sides of the latter are formed by adjustable side pieces 116 which not only permit adjustment to compensate for wear but enable the jaws to be accurately lined up with blanks *b*. The slide 114 is held in place in ways 115 by gibs 117. One set of ways 115 is formed in the flanged upper end of a post 118 (Fig. 9), which extends downwardly through a central hole in turret T and through the described centrally depending hollow hub 73 on bracket 34. The flanged upper end of post 118 rests on the upper face of the central recessed portions of turret T and both the face of this flange and the periphery of the post have bearing engagement with turret T. Post 118 is held stationary by a set screw 119 and it functions as a central guiding bearing for turret T. The other set of ways are formed in the upper end of the described bracket 112.

Each of the jaw carrying heads 113 is moved in and out by a toggle mechanism, actuated by a vertically reciprocable plunger 120. One of these plungers extends centrally through post 118 and the other through bracket 112. The outer end of each head 113 is pivotally connected to one end of a link 121 and to the other end of the latter is pivotally connected a substantially vertical link 122 and a substantially horizontal link 123. The link 122 is pivotally connected to the upper end of plunger 120 and the link 123 is pivotally connected to a plunger 124, which is slidable in an upstanding lug 125, formed

in one case on post 118 and in the other case on bracket 112. Each plunger 124 has a stem 126 (Fig. 13), which is slidable through a bushing 127, adjustably fixed as by screw threads, in lug 125. The end of the stem 126 is threaded to receive an adjustable abutment in the shape of a nut 128 (preferably also having a lock nut as shown). A spring 129, coiled around stem 126, acts between the bushing 127 and plunger 124 tending to separate these two elements to the extent permitted by nut 128. The plunger, when moved downwardly, tends to straighten out the toggle links 121 and 123 and move head 113 and its jaw toward blanks *b*. The plungers 124 function at first as stationary abutments because the springs 129 are relatively strong and yield only when necessary and only after the blanks *b* have been clamped together under requisite pressure. The provision for yielding affords a safety device which may function to prevent breakage of parts in case of an obstruction (larger than blanks *b*) between the jaws *j*. It also permits overtravel of plunger 120. Some extra travel in plunger 120 is required to insure effective clamping of blanks *b* between the jaws *j* even after the same have become worn and the spring 129 yields to take care of this extra travel. This overtravel is also desired for other reasons, as will later appear.

Each plunger, at its lower end, has a pin and slot connection with one arm of a bellcrank lever 130, which in one case is pivotally supported from collar 74 and in the other case is fixed to a shaft 131, rotatably mounted in a bracket 131 fixed to the under side of flange 92. The other arms of these two bellcranks are connected by an adjustable link 132, whereby the two plungers are made to work in unison. The arrangement is also such that both plungers are moved equally. The outer bellcrank 130 is provided with an arm 133, the outer end of which is forked to form two laterally spaced ears 134 (Fig. 14). Each ear 134 is connected by a link 135 to one arm of a bellcrank lever 136 one for each electrode lever 109 and disposed therebelow. Both these bellcranks are pivotally supported from a common stud 137 mounted in a central lug near the base of bracket 112. The other arm of each bellcrank 136 is connected by an adjustable link 138 to the overlying electrode lever 109. The levers 109 are suitably insulated from their links 138, as by fiber bushings 139 and washers 140. Thus, the electrodes *e* are made to move simultaneously with the clamping jaws *j*. Preferably, provision is made for yielding somewhere in the transmission from lever 133 to lever 109. As shown in Fig. 14, the lower end of stem 135 is slidably received in a block 141, which is pivoted to ear 134. Encircling stem 135 and acting between the upper face of block 141 and an adjustable abutment 142 on the stem

is a spring 143. This spring normally holds the block and abutment separated to the extent permitted by a nut 144 threaded on the lower end of the stem 135 and adapted to engage the lower face of block 141. This arrangement takes care of any overtravel in the operating bellcrank 136 and functions in a manner generally similar to that described in connection with spring 129.

Mechanism for operating the electrodes and jaws and heating circuit switch

It will be seen that the electrodes *e* and both clamping jaws *j* will be simultaneously operated by turning shaft 131. This shaft also serves at the same time to operate a switch for closing the electric heating circuit. Such switch comprises relatively fixed and movable contacts 145 and 146, respectively, the former being mounted on and suitably insulated from bracket 112 and the latter being carried by and suitably insulated from the upper end of a lever 147. Lever 147 is fixed, at a point intermediate its ends, to one end of the shaft 131 as shown in Fig. 10. The latter is operated from the lower end of lever 147, which is connected by an adjustable link 148 to the outer end of a lever 149 (Fig. 2). Lever 149 is mounted intermediate its ends on a stud 150 fixed to bracket 34. The other end of lever 149 overlies a barrel cam 151, which is fixed to section 66 of the control shaft, and carries a roll to ride in the groove of said cam. Cam 151 is constructed so as to start to turn shaft 131 just shortly before the turret *T* comes to rest and to complete its movement shortly after the turret comes to rest, so as to cause the electrodes *e* to move into contact with the blanks *b* and the jaws *j* to move into clamping relation with blanks *b* and contacts 145 and 146 to close as soon as possible after the turret comes to rest. The cam is also constructed to hold the electrodes *e* in contact and the jaws *j* in clamping relation with blanks *b* and to hold contacts 145 and 146 closed during the greater part of the interval of rest of the turret and to cause the electrodes *e* and jaws *j* to move out of engagement with blanks *b* and the contacts to open just shortly before the end of said interval of rest. The cam then holds the contacts open and the electrodes *e* raised and the jaws *j* withdrawn while the turret is in motion.

It is important to note another reason for the provision of overtravel in the movement of the electrodes *e* and copper jaws *j*. By reason of such overtravel the electrodes and jaws will make contact with the blanks *b* before the contacts 145 and 146 close. These contacts are closed at nearly the very end of the movement of shaft 131 and before they come into engagement the electrodes and jaws will have engaged the blanks and considerable pressure will have been built up so

that firm contact will be made with the work before the current is turned on. This avoids any arcing and consequent burning of the blanks and electrodes and jaws, which might otherwise occur but for the provisions described. It will also be apparent that the contacts 145 and 146 will be separated, and the heating current thereby cut off, before the electrodes and jaws are disengaged from the work, which is important for the same reason as just above set forth.

The heating circuit

The heating circuit is shown merely in diagrammatical form in Fig. 16. The two electrodes *e*, the two blanks *b*, and the copper jaws *j* are included in a series circuit with the secondary 152 of a heating transformer, the primary of which is designated 153. The primary 153, as shown, is connected to a 440 volt supply circuit, which is controlled by a magnetic switch 154. The latter is operated from a 110 volt circuit, which is controlled by the switch comprising the contacts 145 and 146, above described. The opening and closing of these contacts causes the opening and closing of switch 154. A manually operable switch 155 may also be included in the 110 volt circuit to enable one to shut off the heat independently of the automatic mechanism, when desired. The supply to the primary 153 is preferably through the intermediary of an auto transformer 156, by means of which the voltage supplied to the primary may be varied as desired. Included in the primary circuit is a solenoid 157, the plunger 158 of which is moved upwardly against the restraining action of a dash pot 159 and, when lifted, causes a contact 160 to move into engagement with a contact 161. Contacts 160 and 161 constitute a switch which controls a 110-volt supply circuit to a solenoid 162. A manually operated switch 163 is preferably also included in the circuit to solenoid 162. The solenoid 162 has a function in controlling the tripping of the press, as will later appear. For the present, it will suffice to state that solenoid 162 cannot be energized until current flows in the heating circuit and not then unless and until sufficient current flows to effect the desired degree of heating of the blanks within the time interval available for the heating function. The position of the plunger 158 and the area of the "leak" 159' in the dashpot 159 determine the amount of current necessary to flow in solenoid 157 (and thus in the heating circuit) to cause a closing of the contacts 160 and 161.

The press

The press may be of any suitable type which will function when tripped, to cause the ram *r* to make one complete reciprocation, and then come to rest. As shown in Figs. 18

and 19, the ram *r* is, for convenience, made in upper and lower sections 164 and 165, which are interconnected by a screw 166 in such a manner that the sections 164 and 165 may be moved the one relatively to the other to vary the vertical position of dies *d'* and adjust them relatively to dies *d*. The screw is threaded into the upper and vertically split part of the lower section 165 and its upper end is provided with a circular flanged head 167 adapted to turn and to slide laterally in a T-slot 168 formed in the lower part of section 164. The screw may be turned from its upper end to effect the adjustment and, once the adjustment is made, it is preserved by a check nut 169 and the clamping bolt 170. The section 165 has V-shaped edges (Fig. 19a) which are slidably mounted in correspondingly shaped grooves in a pair of gibs 171. The latter are fixed to frame P by cap screws 172 which pass through slotted holes in the gibs, whereby the same may be adjusted laterally, as by screws 173, which thread into frame P and bear against the sides of the gibs. By means of this adjustment the dies *d'* may be exactly alined with dies *d*, the head 167 of screw 166 sliding in T-slot 168 to permit the lateral adjustment of section 164 relatively to section 165. The latter is mounted for vertical sliding movement in a pair of similar gibs 174 both of which are fixed to frame P but only one of which (the right hand one as viewed in Fig. 18) is adjustable. The adjustable gib 174 is movable by screws 175.

The ram *r* is reciprocated by means of a lever 176, (Fig. 1) which is located within frame P and mounted intermediate its ends to turn on a shaft 177, supported in the frame. The forward end of lever 176 engages the upper section 164 of the ram and is received in a recess in such section as shown in Fig. 18. The rear end of lever 176 is connected by a link 178 to a crank 179 (Fig. 1) on a crankshaft 180. The latter is rotatably supported in frame P and extends beyond one side of the latter, its outer end being supported in a bracket 181 secured to the frame. Disposed between said side and the bracket is the driving gear and clutch for the crankshaft. The driving gear, which is shown at 182 and which is driven by a pinion 183 from the main drive shaft 184 of the press, is free to turn on crankshaft 180.

The clutch is of a well known standard type and is best shown in Figs. 22 and 23. It includes a key 185 which is slidably mounted in a collar 186, fixed to the crankshaft 180 and which is adapted for movement in a direction parallel to the axis of the latter. A spring (conventionally indicated at 187) tends to move key 185 to the left (as viewed in Fig. 22) and, when permitted, to project the left hand end of the key into the path

of one of a plurality of pins 188 which are fixed in circular series to an end face of gear 182 and which project axially outwards therefrom. Collar 186 is circumferentially grooved. Key 185 is transversely grooved in such a manner that some portion of its groove always communicates with the circumferential groove in collar 186. A pawl 189, fixed to a shaft 190 mounted in frame P, is yieldingly held in these grooves by a spring pressed plunger 191, also fixed to shaft 190. The pawl has a wedge-shaped lower end which cooperates with the groove in key 185 to retract the same. When pawl 189 is swung to the right (Fig. 23), it is moved out of the groove and releases the key so that the latter becomes engaged with one of the pins 188, whereby crankshaft 180 is driven from gear 182.

The pawl 189 is moved in and out of its groove in collar 186 by the following mechanism. A rocker arm 192, pivotally mounted at a point intermediate its ends on a stud 193 fixed to frame P, is pivotally connected at its upper end to a bar 194. The other end of the bar is supported on a pin 195 fixed to pawl 189. Bar 194 has a shoulder 196, which when bar 194 is drawn back (to the left as viewed in Fig. 23) will drop down behind pin 195 (see Fig. 25). Consequently, when bar 194 is later moved forwardly the shoulder 196 will strike pin 195 and move pawl 189 out of the groove in collar 186, allowing the latter to turn in the illustrated direction. Encompassing part of collar 186 is a ring 197 which carries a cam 198. After shaft 180 has turned a short ways, cam 198 will engage the lower side of bar 194 and will lift the same high enough to disengage the shoulder 196 from pin 195, whereupon pawl 189 is moved back into the groove in collar 186 by the spring pressed plunger 191. As the shaft 180 continues to turn and nears the end of one revolution, the wedge like lower end of pawl 189 rides into the groove in key 185 and forces the latter to the right, disengaging it from the pins 188 on gear 182 whereupon shaft 180 comes to rest. A brake band 199 is provided to engage a part of collar 186 as a drum to insure that the shaft 180 stops as soon as it is disconnected from gear 182.

The rocker arm 192, by means of which the clutch is "tripped", is moved forwardly to effect the tripping by a spring 200 (Fig. 1), which connects one arm of a bellcrank lever 201 to frame P. This bellcrank is pivotally supported on frame P and its other arm is connected by a link 202 to the lower arm of rocker arm 192. Spring 200 normally holds bar 194 in its forwardly projected position. It is periodically placed under tension and subsequently released and allowed to drive arm 194 forwardly to trip the clutch, by means now to be described.

Mechanism controlling the tripping of the press

This mechanism, so far as its general location is concerned, is shown in Figs. 1 and 2 but for the details of the mechanism reference is made to Figs. 27 to 30 inclusive. This mechanism includes a cam 203, the function of which is to first place spring 200 under stress and to then quickly release the latter to enable it to trip the clutch. It also includes means for periodically coupling or uncoupling the cam to or from a driving means, according to whether or not the blanks *b* are being adequately heated. The driving means is the section 66 of the control shaft, heretofore described, and the coupling of the cam to this shaft is controlled by the solenoid 162 which, as heretofore described, is energized only in the event that sufficient current is flowing through the blanks to enable them to be heated to the proper degree during the time interval available for this purpose. The solenoid 162 is mounted on a bracket 204 fixed to frame P adjacent cam 203. The solenoid has a plunger 205 which is adjustably connected to one arm of a bellcrank lever 206, pivotally mounted on bracket 204. The other, and vertically depending arm of lever 206 carries a clutch fork 207. The latter is swivelled at one end in the lever and projects laterally therefrom with its other and forked end engaged in the circumferential groove 208 of a clutch element 209, which is slidably keyed to shaft 66 and has but a single tooth. The cam 203 has fixed thereto a mating, one-tooth clutch element 210 and these two connected parts are mounted to turn freely on the shouldered down end portion 211 of shaft 66,—being held from axial displacement between the shoulder at one end of the portion 211 and a collar 212 fixed to the latter near the other end thereof. When solenoid 162 is energized the clutch element 209 will be moved axially toward the element 210 and, under certain conditions, the result will be a coupling of the cam to shaft 66 such that the cam will be turned thereby. Rotation of the cam, however, does not necessarily, or always, follow when the solenoid 162 moves the clutch element 209 toward clutch element 210 as will later appear.

Considering, for the present, that cam 203 is driven when clutch element 209 is moved axially toward its mate 210, the cam will cause a stressing of the described spring 200 by means of the following mechanism. A link 213 (adjustable as to length) is connected at one end to the horizontal arm of the bellcrank 201 to which spring 200 is connected, as already described. This link at its other end is fixed to a slide 214 which is slidably received between collar 212 and the adjacent face of cam 203 and which has a

guide slot 215 therein through which the shaft section 211 passes. The lower end of slide 214 carries a roll 216 which rides on the periphery of cam 203 and is yieldingly held thereto by the described spring 200. The cam has a pronounced depression 217, constituting its low point and in which roll 216 is normally positioned when the cam is at rest, as shown in Fig. 30. Cam 203 also has a gradual rise portion 218 and a steeply pitched inclined portion 219 which connects the high point of the rise portion 218 to the low point 217 of the cam. The cam, when driven, turns in the direction of the arrow shown in Figs. 29 and 30, thereby forcing roll 216 out of the depression 217 and forcing it downwardly until the peak of rise portion 218 is reached. This causes the bell-crank 201 to be turned in such direction as to move the clutch tripping bar 194 rearwardly in position to subsequently engage pin 195 and at the same time stresses spring 200. As soon, however, as roll 216 rides onto the inclined and steeply pitched portion 219 of the cam, the spring 200 is released and bar 194 is driven forwardly to trip the clutch, as above described. The upward pull of the spring acting through roll 216 on the cam causes the roll, as it engages the portion 219, to turn the cam rapidly ahead on shaft 211 in the direction of its rotation, causing disengagement and angular separation of the clutch jaws. A quick movement of the roll results without the sharp impingement resulting from the radial drop portion of an ordinary knock off cam. The recess 217 limits the rapid ascending movement of roll 216 caused by spring 200 and brings the cam 203 to rest always in a definite position, being that shown in Fig. 30. A comparison of Figs. 29 and 30, will make the action clear. These two figures show the beginning and the end, respectively, of the rapid ascending movement of roll 216. The angular position of shaft 211 and the driving clutch jaw 209 are substantially the same in both figures. Thus, the shaft has not turned but the cam has turned relatively thereto and caused the substantial angular separation of the clutch jaws shown in Fig. 30.

The solenoid, it will be recalled, is energized only when a predetermined degree of current flows in the heating circuit. This heating circuit is closed at or about the time when roll 216 rides into recess 217 so that this is the earliest time in the revolution of shaft 211 at which solenoid 162 can be energized. This condition is shown in Fig. 30 and it will be noticed that there is a space of about 50 degrees between the driving jaw 209 and the driven jaw 210. If at any time during the next 50 degrees of turning movement of shaft 211, good contact is made between the electrodes *e* and blanks *b* and between the clamping jaws *j* and blanks *b* so that an ade-

quate degree of current flows in the heating circuit, then solenoid 162 will be energized and cause jaw 209 to be axially shifted into the path of jaw 210, whereby it will eventually engage jaw 209 and drive it. If, however, good contact is not established during this interval, then the subsequent energization of the solenoid will cause jaw 209 to be shifted as before but this jaw will have passed the angular position at which it can pick up and drive jaw 210. Therefore cam 203 will not be driven.

The proper heating of the blanks depends on two factors,—first, the amount of current passing through them and, second, the time during which such current flows through the blanks. Both these factors enter into the controlling mechanism for the press. The solenoid 162 functions to effect one step in coupling cam 203 to the drive shaft and the relative angular disposition of the clutch jaws functions to permit the final step of coupling only in the event that there is sufficient time available in which to adequately heat the blanks with the amount of current available for the purpose. The press, therefore, is not tripped unless the blanks have been heated enough to permit subsequent forging. It is to be noted that the arrangement admits of a variation in the effective heating interval of the blanks. That is, good contact might be made immediately on closing of the heating circuit or not until near the end of the 50 degree interval described. The 50 degree interval is chosen with respect to this particular machine as affording a safe allowable variation in heating of the blanks. If heating of the blanks commences at the beginning of this interval, the blanks will not be heated to too high a degree and if heating does not commence until the end of the interval, the blanks will still be heated enough to permit forging.

The heating circuit is closed at or about the time roll 216 drops into recess 217 as described. The cam 203 cannot begin to turn until the lapse of said 50 degree interval. The heating circuit is closed during an interval of 235 degrees of each rotation of shaft 211. Therefore, the solenoid 162 will become deenergized after cam 203 has been turned 185 degrees from the position shown in Fig. 30. Since the weight of the plunger 205 of the solenoid tends to move jaw 209 out of engagement with jaw 210, uncoupling of the cam from its drive shaft might result prematurely. To prevent separation of the jaws after solenoid 162 is deenergized, the one jaw of each clutch element is slightly undercut as shown at 220 in Fig. 30a. The undercut jaws when engaged and under load cannot move axially relatively to one another. This, however, makes necessary some means for separating them angularly before the axial separation can be effected and the prerequisite

angular separation is effected by the above described arrangement, whereby roll 216 when engaged with portion 219 of cam 203, throws the latter ahead. The throwing ahead of the clutch jaw 210 and the resulting angular separation of the clutch jaws affords also a certain degree of leeway for the establishment of good contact of the members *e* and *j*, with the blanks.

The cam 203, when conditions are right to permit it to be driven, starts to turn after the turret has been at rest for about one quarter of its dwell period and continues to turn during the remainder of the dwell period and during all of the interval of movement of the turret, completing its cycle of movement during the early part of the next succeeding interval of rest of the turret. Thus, the cam causes the press to be tripped to forge the same blanks, the heating of which controls the initiation of the rotation of the cam.

The forging and stripping means

The forging means comprises the dies *d'* (Fig. 20) which cooperate with the upper faces of dies *d*, as shown in Figs. 21 and 33, to shape the head *h* on each blank *b*. In this case each die *d* acts an anvil for the forging tool *d'* although this is not necessarily essential for all purposes. As shown, the die *d'* is recessed as shown at 221 in Figs. 20 and 21 to the desired configuration, herein shown as that of a cap screw head. The coaction of the two dies to form the head is clearly shown in Fig. 21. A part of each die *d'* is movable,—such part consisting of a hardened steel stripper pin 222 of cylindrical shape, which is mounted centrally and coaxially in its die and capable of vertical sliding movement relatively thereto. At the time when the dies *d'* engage dies *d*, the pins 222 are positioned as shown in Fig. 21 with their lower end faces forming the upper walls of the die recesses 221. The dies *d'* are secured, as by the screw thread connection shown in Fig. 18, to a block 223 which is jacketed as shown to permit circulation of a cooling medium therein. Block 223 is secured, by the cap screws shown, to the lower face of the lower section 165 of ram *r*. Each stripper pin 222 has a flanged head at its upper end which head is slidable in a recess 224 formed in block 223. This head normally rests on top of its die and prevents the pin from falling out. The lower face of section 165 of ram *r* is recessed to slidably receive the heads of two pins 225, one for each of the stripper pins 222. These pins 222 and 225 are mounted in axial alinement and the lower ends of pins 225 enter recesses 224 and normally rest on top of the heads of the stripper pins 222. Section 165 of ram *r* is transversely slotted, as at 226, and a cross bar 227 is mounted for vertical movement in this slot. Bar 227 is normally held at the upper

end of slot 226 by a pair of springs one of which is shown at 228. Bar 227 remains in its elevated position during the downward stroke of ram *r*. Consequently, the stripper pins 222, which will engage the tops of blanks *b* before the dies *d'* do, are free to rise until their heads abut the upper ends of recesses 224, at which time the lower ends of these pins are positioned as shown in Fig. 21.

Means are provided for forcing bar 227 downwardly in its slot 226 during part of the upward stroke of ram *r* and, as a result of this action, the pins 225 will force the stripper pins 222 downwardly and cause them to push the heads *h* of the finished cap screws *s* out of dies *d'*,—thereby preventing the screws from being lifted with these dies as might otherwise happen. Such means comprise two latch arms 229, arranged one on each side of the path of travel of section 165 of ram *r*. The latch arms 229 are provided with latch shoulders 230 against which the projecting ends of bar 227 engage at a certain point in the travel of ram *r* and by which the bar is arrested and held from travelling upwardly with the ram for an interval sufficient to effect the stripping operation. Each latch arm 229 is pivotally connected at its upper end by a stud 231 to a bracket 232 for swinging movement toward and away from the sides of ram *r*. Such sides carry cams 233 upon which ride rolls 234 carried by the latch arms 229. Each roll is yieldingly held against its cam by a spring 235 which acts between the latch arm and a lug on bracket 231. Each bracket is mounted for vertical adjustment, being held to frame P by bolts 236, the heads of which ride in T-slots 237 (Fig. 19) on the frame. A pair of adjustable stop screws 238, each threaded into a lug on frame P, bear against the upper ends of brackets 232 and prevent upward displacement thereof,—once the adjustment of the brackets has been made. The cams 233 are also mounted on ram *r* for vertical adjustment, each having a pair of lugs 239 which are connected by the screw and slot connection shown in Fig. 19 to the ram.

The cams 233 normally hold the latch arms 229 out of the path of the projecting ends of bar 227. However, as ram *r* descends, each roll 234 rides off the high part of its cam allowing the shoulders 230 of the latch arms 229 to swing into the path of the projecting ends of bar 227. This occurs near the end of the downward travel of the ram, say for example, after it has travelled down about three quarters of its stroke. The latch shoulders 230 are at such time still located below the upper edge of bar 227 but as the ram continues to descend the ends of bar 227 ride onto the bevelled approaches to shoulders 230 and cam the latch arms 229 outwardly, allowing the bar to pass. The latch arms are then snapped inwardly by springs 235 and the shoulders

230 are carried into overlying relation with the upper edge of the projecting ends of bar 227 at or about the very end of the downward travel of the ram. The ram immediately starts its ascending movement but the shoulders 230 prevent bar 227 from moving with the ram during the initial part of this stroke. Thus bar 227 acts as an abutment and causes pins 222 to push the forged pieces free from dies *d'*. This having been accomplished, the rolls 234 ride up on the high parts of their cams and disengage the shoulders 230 from the projecting ends of bar 227 just in time to prevent it from striking on the lower wall of slot 226, whereupon springs 228 raise bar 227 into the illustrated position.

Ejecting mechanism

On completion of the forging operation, the finished pieces, by reason of the stripping operation just described, are left in the dies *d* and on the next interval of movement of the turret they are carried to station VI and are positioned for ejection. The ejecting mechanism is best shown in Fig. 34. The ejectors *k*, above referred to, are formed on the upper ends of plungers 240 which are normally held in the illustrated position by springs 241. Each plunger 240 is slidable in a bearing 242, secured to the lower face of the turret bearing portion of the described bracket 34. Each plunger is keyed to its bearing, as indicated, to prevent it from turning, and is also slidably supported near its lower end in a bushing 244, which is secured to the lower part of bracket 34 and affords a seat for the impelling spring 241. Each plunger also carries two rolls 243, which are located on opposite sides thereof and in the path of cams 245. The latter are fixed to section 62 of the described control shaft. The bracket 242 is milled out as at 246 (see also Figs. 4 and 35) to provide clearance for the cams. There are three cams 245, as shown in Fig. 4, and the middle cam is wide enough to engage the two inner and adjacent rolls 243, while the other two cams each engage an outer roll. The cams are constructed to engage rolls 243 just before the turret starts to move and to move them downwardly, thereby stressing springs 241 and lowering the ejectors, until their upper ends are below the upper and turret bearing face of bracket 34. The cam completes its function of stressing springs 241 during the early part of the interval of movement of the turret, holds them stressed during the remainder of said interval and releases them shortly after the turret comes to rest. The cams 245 are shown in Fig. 34 at the instant when the rolls 243 are released. As soon as these rolls are released, springs 241 drive the plungers 240 upwardly, causing each ejector *k* to engage the head of the overlying pin 39 with a hammer blow

which kicks the forged pieces out of the die *d*. The forged pieces, thus thrown upwardly, may be directed by a suitable deflector, such as 280, into a chute 281. After the ejecting operation has been effected, the cams 245 will again engage rolls 243 and initiate the downward movement of the ejectors *k* just before the turret is given another step of movement.

Automatic safety stop mechanism

This mechanism, which is best shown in Figs. 2, 4 and 8, has for one purpose to guard against possible failure of ejection of the forged pieces. This mechanism operates, in the event of failure of ejection of a forged piece, to move the above described bellcrank lever 52 and thereby cause the release of the clutch shifting lever 47 so that it will be automatically moved by spring 49 to throw out clutch 45 and stop the machine. Such mechanism includes an arm 247 fixed at one end to the lower end of a sleeve 248 which is turnably mounted on a vertical stud 249, secured to the upper face of bracket 34 closely adjacent the path of travel of turret T. The other end of arm 247 is so disposed as to engage and move lever 52 when swung to the left from the position shown in Fig. 4. A spring 250 normally holds arm 247 in the last named position. The upper end of sleeve 248 is shouldered down to receive the hub of an arm 251 which is free to turn relatively to the sleeve and which is connected by a stiff torsion spring 252 to a collar 253 fixed to the sleeve. Arm 251 extends inwardly in overlying relation with the turret and initially at a level just above that of the upper faces of dies *d*, so as to be engaged and moved by the head *h* of any forged piece which passes the ejecting station without being removed from its die *d*. Thus, arm 251 will, through spring 252 and collar 253, turn sleeve 248 and arm 247 in the proper direction to move the bellcrank lever 52. The spring 252 is provided, as a part of the transmission described, to permit yielding if and when necessary, to take care of any over-travel in arm 251.

The arm 251 is also adapted to be actuated to effect the release of the clutch-shifting lever 47, in the event that the blanks *b*, as fed manually or otherwise to dies *d*, project too far above the upper faces thereof, either because the blanks are too long or because the blanks are not properly seated in their dies. To effect this result, an arm 254 is provided, which is fixed at one end to a sleeve 255, mounted to turn on a stud 256, fixed to the upper end of the described central post 118. The other end of arm 254 carries a depending pin 257 which abuts the upwardly offset end of arm 251. A pin 258, fixed to post 118 projects upwardly and acts as a stop for arm 254 and indirectly as a stop for arm 251, defining the position to which the latter can

be moved by spring 250. Also fixed to sleeve 255, and capable of both vertical and angular adjustment, is an arm 259 which projects outwardly overlying the path of travel of dies *d*. The height of the lower face of arm 259 is, by adjustment, set to the proper level so as to just clear the tops of blanks *b* when the same project the desired distance above dies *d*. Consequently, if a blank projects more than such distance, it will on rotation of the turret engage arm 259, and swing it, causing arm 254 to swing arm 251, whereby arm 247 will be swung so as to move the lever 52 and release the clutch shifting lever 47. As shown in Fig. 2, arm 259 is set so that it extends between a pair of dies *d* when the same are at rest in station III, thereby insuring against the described trouble arising from blanks fed to the dies at stations I and II or at the first half of station III. The arm may, however, be set in other angular positions and when a second stage of heating is employed at station III, the arm would, of course, be angularly shifted towards station II far enough to permit the second stage heating mechanism.

Safety mechanism for preventing tripping of the press

It will be recalled that the action of the press tripping mechanism is initiated at a time when a pair of blanks is being heated at station IV. This action, once initiated, will unless prevented by special means, cause the press to be tripped after the control shaft has been turned a certain angular distance. Therefore, it is possible that blanks which were being properly heated so as to initiate the action of the press tripping mechanism, might later cool if the machine is stopped. If the machine is stopped for any reason, it is therefore essential that the press be prevented from tripping to prevent the dies *d* from striking blanks which have cooled.

Stoppage of the machine can only occur by throwing out clutch 47. This can be effected automatically, as just above described, or it can be effected manually but, in any event, the clutch lever 47 will have to be moved to effect stoppage of the machine. Therefore, a linkage is provided from this lever to the spring-actuated, press-tripping bar 194, whereby when the lever is moved for any reason into position to stop the machine, the bar 194 will be moved out of the path of the pin 195 on the clutch releasing finger 189. Thus, although the bar 194 will be released and propelled forwardly by spring 200, as heretofore described, when the machine is again started, it will not strike pin 195 and will not therefore trip the clutch of the press.

Referring to Fig. 4, lever 47 is connected by a link 260 to one arm of a bellcrank 261

pivoted to frame P. The other arm of this bellcrank is connected by a link 262 to an overlying arm 263, which is fixed to one end of a shaft 264 mounted to turn in frame P. Referring now to Fig. 1, the other end of shaft 264 has fixed thereto an upstanding arm 265, which is connected by a flexible member 266 (preferably including an interposed spring 267) to an upstanding arm 268 formed on the rear end of the bar 194. The flexible member 266 permits the bar 194 to be moved freely back and forth in the normal manner under normal operating conditions by lever 192 but, if lever 47 is moved to stop the machine, then member 266 will be pulled to the left enough to raise the bar 194 and cause its shoulder to travel in a path too high to strike pin 195.

To complete the safety device, means are provided for insuring that the bar remains elevated until its cycle of operation has been completed. Although the movement of the lever 47 in throwing out the clutch will cause an elevation of bar 194, it will likewise allow it to drop again when lever 47 is moved to throw in the clutch and start the machine. Therefore, the raising of bar 194 is not, of itself, enough to prevent the trouble. To effect the desired result, a horizontal trackway 269 (Figs. 24, 25 and 26) is fixed to frame P adjacent one side of bar 194 and the latter has mounted thereon a spring pressed button 270. This button normally underlies trackway 269 but, when bar 194 is elevated as described, the rounded forward end of the button engages the bevelled lower face of the trackway, forcing the button inwardly to allow the bar to be lifted and then being forced outwardly over the trackway after bar 194 has been raised. The button 270 then rides on trackway 269 and holds bar 194 raised. When bar 194 is thus raised, shoulder 196 is raised so high that it cannot engage pin 195. The trackway 269 is long enough so as to prevent button 270 from riding off it except at one point and this point is at the very extreme end of the forward stroke of bar 194. In Figs. 25 and 24, bar 194 is shown at the rear and forward ends of its stroke, respectively. If during any part of the rearward stroke of bar 194 or during any part of the ensuing forward stroke, in which shoulder 196 is effective to strike pin 195, lever 47 is moved to stop the machine, then bar 194 will be elevated and it will thereafter be held elevated by button 270 riding on trackway 269 until, as shown in Fig. 24, the shoulder 196 has travelled forwardly beyond the pin 195. The bar can then be allowed to drop into the position shown in Fig. 24 because it can no longer effect a tipping of the press until again drawn back by cam 203 and this, as above described, cannot occur until the heating of another pair of blanks has been commenced under conditions such as will in-

sure that they will be heated to proper forging temperature.

Die cooling means

5 The lower dies d ordinarily require no special cooling means because the upper ends of the blanks are heated while out of contact with the dies and the dies are subjected to intense heat only momentarily during the forging interval. The heat, thus acquired by a die d is dissipated before that die again comes into position for forging. The dies d' , however, function repeatedly once during each cycle of normal operation of the machine, while each die d functions in a forging operation only once during six cycles of operation of the machine. Natural cooling of dies d has been found sufficient although, if it should prove necessary or desirable, the same expedient, used for cooling dies d' and now to be described, may be also used for cooling dies d . Such expedient consists of a jet or jets of air which are directed upon dies d' after the completion of the forging operation. As shown in Fig. 1, the upper end of stud 258, above described, is made hollow and is connected to a flexible air supply pipe 271. Two tubes 272, which are arranged in outwardly diverging relation as shown in Fig. 2 and with a slightly upward inclination as shown in Fig. 1, radiate from stud 258 and communicate with pipe 271. The arrangement is such that jets of air issuing from the two tubes 272 will impinge on the dies d' when the same are in their elevated and inactive position shown in Fig. 1. These jets strike into the die cavities 221 and also impinge on the stripper pins 222. Thus, these parts are cooled during their interval of rest which is a substantial part of their cycle of operation.

The air supply to pipe 271 may be continuous or it may be controlled so as to function only when needed. Such control may be effected by a valve such as that conventionally indicated at 274 in Fig. 1. This valve is of the type which is normally closed and is adapted to be opened by pressing a plunger, such as 275, upwardly. The valve is fixedly supported from frame P with its plunger 275 depending therefrom and in the path of travel of ram r . When the latter nears the upper limit of its stroke it pushes upwardly on plunger 275 and opens the valve, allowing air to pass to the pipe 271, above described.

The preliminary stage of heating

60 A preliminary stage of heating may be effected, if desired, by providing at station III, equipment which is a duplicate of that provided at station IV. Such an arrangement is shown in Fig. 17. A second pair of electrodes e' and a second pair of clamping

jaws j' are provided, and these are or may be, operated simultaneously with the electrodes e and jaws j and by the same mechanism. A bracket 112', carrying the outer set of jaws j' and the electrodes e' together with the operating linkage therefor and associated parts, similar to those provided in connection with bracket 112, is mounted on flange 92 at the location shown. The hole 286 in the flange 92, shown in Fig. 2, is provided for the purpose of receiving an operating rod similar to rod 130, for actuating the outer jaw j' in a manner similar to that in which the outer jaw j is actuated. There is also a main operating lever 147', by means of which the outer jaw j' and the electrodes e' are connected to the power source, as by a link 148' which, like link 48 above described, connects with the cam actuated lever 149. There is, however, no link connection, corresponding to that shown in Fig. 9 at 132 in connection with the heating mechanism at station IV, between the operating mechanism for the inner and outer jaws j' . The operating rod 130 for the inner jaw j is made to actuate the inner jaw j as well. This is accomplished as set forth below.

The slide 114 carrying the inner jaw j is removed from its slideway 115 in post 118 and the latter is turned into the position shown in Fig. 17, so that the center line of the toggle links 121 and 123 bisects the angle made by the two radial center lines of stations III and IV of the turret. A new slide 114', similar to slide 114 except that it is formed to carry both the inner jaw j and the inner jaw j' is mounted in the ways 115 and connected to toggle link 121 as before. Each of these inner jaws is mounted in a holder 277 which is pivotally connected to slide 114' at 278. This permits swinging movement of the inner jaws in a horizontal plane but such movement is restricted by upstanding flanges 279 formed on the slide and arranged to abut the holders. The idea is to allow just enough swinging movement to enable the inner jaws to find perfect bearings with the blanks b as they are thrust outwardly by the toggle links.

The electrical circuits may be duplicates of those provided for the heating mechanism at station IV and the electrodes e' and jaws j' may, for example, be connected in parallel with electrodes e and jaws j .

Operation

The blanks b are positioned in any suitable manner in the dies d of the turret, while the latter is at rest in stations I or II. As the turret moves step by step, the blanks, carried by the dies d are first raised to the proper height therein and then brought successively in pairs to the heating stations III or IV or both. The heating at station IV is typical of that at station III. Shortly before the tur-

ret comes to rest, the electrodes *e* start to descend and the inner and outer jaws *j* start to move toward one another, so that contact with a pair of blanks *b* can be effected as promptly as possible after the turret comes to rest. As soon as such contact has been made, the low tension switch 145, 146, is closed which causes the closing of the high voltage switch 154 and the energization of coil 153 of the step-down heating transformer, whereupon current should flow from coil 152 of said transformer through the heating circuit which includes the cables 108, electrodes *e* blanks *b* and jaws *j*. The upper portions only of blanks *b* are included in the heating circuit and these portions are held (by track 40 and pins 39) projected above the upper faces of their dies, whereby the intensely heated portions of the blanks are held from contact with the dies.

While current should flow in the heating circuit following the gripping of the blanks between the jaws *j* and electrodes *e*, this does not always follow. For various reasons there may be failure to secure good electrical contact with the blanks *b*. Also the establishment of good contact may be delayed and contact, which was initially poor because of some foreign substance lodged between the contacting parts, may later become good if and when such foreign substance breaks down under the pressure imposed on the electrodes *e* and jaws *j*. To guard against these conditions and the delivery of forging blows to blanks which have not been properly heated, for the reasons stated above or any other reasons, the control of the tripping of the press is made dependent on the establishment of a predetermined amount of current in the heating circuit within a predetermined interval after the electrodes *e* and jaws *j* have moved to engage the blanks *b*. If adequate current flows in the heating circuit, solenoid 157 will close switch 160, 161 and cause the energization of solenoid 162. The latter will then shift clutch element 209 towards its mating element 210 and if this shifting occurs before the one clutch jaw on element 209 has passed the one jaw on element 210, cam 203 will be coupled to the control shaft and be driven thereby but not otherwise. Assuming that conditions are right for the coupling, cam 203 causes the stressing of spring 200 and draws back bar 194 so that its shoulder 196 is carried behind pin 195 and so positioned as to engage the latter when cam 203 later releases spring 200 and allows the same to drive bar 194 rapidly forward. This occurs when roll 216 rides onto the part 219 of the cam and the cam is, as a result, then driven ahead as described, to angularly separate the clutch jaws and allow axial separation of the same with consequent disengagement of cam 203 from its drive shaft.

The bar 194, when projected forwardly, moves pawl 189 out of engagement with key 185, whereupon the latter is projected by spring 187 into the path of one of the pins 188 on gear 182. The latter then drives the crankshaft 180 of press P through one complete revolution, after which it is uncoupled because of pawl 189 riding into the groove of the key 185 and wedging back the same, as heretofore described in detail. The one revolution of the crankshaft causes one complete reciprocation of ram *r* and this reciprocation starts very shortly after the turret comes to rest and the heated articles are brought into position beneath dies *d'*. The latter descend on the heated upper ends of the blanks and shape them into the form of the die recesses 221 and then immediately ascend. At or near the end of the downward stroke of ram *r*, the latches 229 move inwardly so that their shoulders 230 overlie the upper edge of the projecting ends of the bar 227, wherefore as ram *r* rises, the bar is held stationary momentarily for the purpose of driving the stripper pins 222 downwardly in dies *d'* to force out the heads of the forged pieces, thereby insuring that the finished pieces are left in dies *d*. As ram *r* continues to rise, cams 233 force the latches outwardly and release bar 227, permitting it to again travel with ram *r*. As the ram *r* nears the upper end of its stroke, it engages the plunger 275 of air valve 274, causing compressed air to be admitted to nozzles 272 and to be directed by the latter against dies *d'* and its stripper pins 222 for the purpose of cooling the same. This action continues during all of the internal of motion of the turret.

Shortly after the completion of the cycle of operation of ram *r*, the turret moves one step forward and carries the forged pieces to station VI and in position for ejection. The ejectors *k* are drawn down downwardly and their springs 241 are compressed by cams 245. These cams initiate this action just before the turret starts its interval of motion and complete the action before the turret comes to rest. Thus, as the pins 39 of dies *d* come into position vertically above the ejectors *k*, the latter are in readiness to be propelled upwardly as soon as released by cams 245. This release occurs shortly after the turret comes to rest and, as a result, ejectors *k* shoot upwardly, each imparting a quick sharp blow to its pin 39, which drives the forged pieces upwardly out of the dies, against deflector 280 and thence into chute 281.

In case the articles are not ejected for any reason, they will, on the next step of movement of the turret, strike the arm 251 and thereby cause the release of the clutch shifting lever and the stopping of the machine. Also if the blanks *b* are not properly posi-

tioned vertically, when fed to dies *d* or if blanks, which are too long, are fed to dies *d'*, such blank or blanks will, on rotation of the turret, strike arm 259 and swing the same, causing a movement of arm 251 and a release of the clutch shifting lever and a stopping of the machine as before. If the machine is stopped by either of the two safety devices, just referred to, or if it is stopped manually, the press tripping member 194 will be lifted out of its normal path of reciprocation and held out of said path until its cycle of movement has been completed. This prevents the press from being tripped shortly after the machine is again started up and prevents the dies *d'* from impinging on blanks *b* which have become cool due to the stoppage of the machine. In other words, that cycle of movement of member 194, which is initiated during the heating of a pair of blanks, is rendered ineffective to trip the press unless the heated articles are carried into forging position without any intervening stoppage of the machine.

The invention affords an automatic machine for electrically heating and forging articles and for ejecting the finished work, which is characterized, among other things, by its capacity for rapid production. The illustrated machine is adapted to turn out sixty finished cap screws per minute and can be speeded up to secure even greater production. With a second stage of heating (as disclosed in Fig. 17) the machine can easily turn out at least one hundred cap screws per minute. These figures are not intended in any sense as limits for with blanks of greater or less diameter a longer or shorter time, respectively, will be required for heating and the production will therefore be less or greater, respectively. For heavier work, the second stage of heating can be used, which will enable the production rate to be maintained even though the time required for heating is greater. Also the number of dies at each station of the turret may be increased so that more than two articles are worked at one time, whereby the rate of production may be increased if necessary or desired.

Other important features of the invention relate to the turret operating mechanism, especially the arrangement whereby the turret is brought to rest accurately in the desired positions, even after wear in the parts has occurred. This insures precision in the location of the dies *d* with respect to the heating, forging and ejecting mechanism and is essential to cause the dies *d* to become precisely aligned with their cooperating dies *d'* and insure work of uniform accuracy. The provisions for locking and unlocking the turret are also thought to be important, especially the arrangement whereby the operating pawl is made to serve as a lock for the

turret. The particular arrangement of electrodes, whereby the article is engaged at two points, both above the top of its holding die, and thereby heated independently of and while out of contact with the die, is also important, as is the arrangement for clamping jaws *j* against the blank,—especially the use of the toggle mechanism and the spring relief device. While the illustrated arrangement affords a convenient means for heating two blanks by coupling them in series, the invention is not limited thereto because it is obvious that the blanks may be otherwise coupled to the circuit. The series heating, while important and desirable, is by no means absolutely essential. The forging mechanism has important features in the arrangement for cooling the forging dies and the arrangement of the stripper pins and the means for actuating them. There is also thought to be novelty in the ejector mechanism especially in the arrangement for the sudden release of the spring actuating means therefor, whereby a sharp blow is administered to kick the forged articles out of their dies.

The various provisions, whereby the machine is made as nearly fool-proof as possible, are most important. These include, not only the arrangements for stopping the machine on failure to eject an article or on feeding an article which projects too high above its die, but also the even more essential provisions for controlling the tripping of the press and for preventing the tripping of the same unless the articles are in proper heated condition to be forged. The control of the press tripping mechanism by means responsive to the current flowing in the heating circuit is considered unique and especially important and advantageous. There are, of course, many other ways, whereby the control may be made responsive to the current flowing in the heating circuit and that disclosed is given merely as a representative example of one of many ways which have been found suitable.

The invention has been disclosed herein, in an embodiment at present preferred, for illustrative purposes but the scope of the invention is defined by the appended claims rather than by the foregoing description.

What we claim is:

1. In a forging machine, a press operable when tripped to forge the articles, means for heating the articles, means for moving the heated articles from the heating means into operative relation with the press, and means controlling the tripping of the press and dependent for its operation on the heating of said articles by said means.

2. In a forging machine, a press operable when tripped to forge the articles, means for electrically heating the articles, means for moving the heated articles from the heating

means into operative relation with the press, and means controlling the tripping of the press and effective to trip the same only in the event of a predetermined degree of current flowing through said heating means.

3. In a forging machine, a press operable when tripped to forge the articles, means for electrically heating the articles, means for moving the heated articles from the heating means into operative relation with the press, and means controlling the tripping of the press and responsive to the current flowing through said heating means and the time available for such current to heat the articles.

4. In a forging machine, a press operable when tripped to forge the articles, an electric heating circuit including movable means for contacting with the articles and coupling the same in said circuit, means periodically operable to carry heated articles from the heating means into operative relation with said press, and means for controlling the tripping of the press, said controlling means responsive to the current flowing in said heating circuit.

5. In a forging machine, a press operable when tripped to forge the articles, an electric heating circuit including movable means for contacting with the articles and coupling the same in said circuit, means periodically operable to carry heated articles from the heating means into operative relation with said press, and means for controlling the tripping of the press, said controlling means responsive to the current flowing in said heating circuit and effective to trip the press only on the establishment of a predetermined degree of current therein.

6. In a forging machine, a press operable when tripped to forge the articles, an electric heating circuit including movable means for contacting with an article and coupling the same in said circuit, intermittently operable mechanism for successively carrying articles from a position adjacent said means to a position wherein the articles are in operative relation with the press, means for moving said means operable to engage the articles and adapted to establish contact with the same at a predetermined time after said mechanism comes to rest, and means for controlling the tripping of the press effective only when a predetermined degree of current is established in said circuit within a predetermined interval after the time set for contact of said first named means with the articles.

7. In a forging machine, a press operable when tripped to forge the articles, an electric heating circuit including movable means for contacting with an article and coupling the same in said circuit, intermittently operable mechanism for successively carrying articles from a position adjacent said means to a position wherein the articles are in op-

erative relation with the press, means for moving said first named means so that the latter and the articles engage after said mechanism comes to rest, driving means for coordinating the operation of said mechanism and last named means, a member adapted to be coupled to said driving means and when coupled thereto to control the tripping of the press, and means responsive to the current flowing in said heating circuit to effect the coupling of said member and driving means.

8. In a forging machine, a press operable when tripped to forge the articles, an electric heating circuit including movable means for contacting with an article and coupling the same in said circuit, intermittently operable mechanism for successively carrying articles from a position adjacent said means to a position wherein the articles are in operative relation with the press, means for moving the first named means so that the latter and the articles engage after said mechanism comes to rest, driving means for coordinating the operation of said mechanism and last named means, a member adapted to be coupled to said driving means and when coupled thereto to control the tripping of the press, and means responsive to the presence of a predetermined degree of current flowing in said heating circuit to effect the coupling of said member and driving means.

9. In a forging machine, a press operable when tripped to forge the articles, an electric heating circuit including movable means for contacting with an article and coupling the same in said circuit, intermittently operable mechanism for successively carrying articles from a position adjacent said means to a position wherein the articles are in operative relation with the press, means for moving said first named means operable to engage the articles and adapted to establish contact with the same at a predetermined time after said mechanism comes to rest, driving means for coordinating the operation of said mechanism and last named means, a member adapted to be coupled to said driving means and when coupled thereto to control the tripping of the press, said member capable of being coupled to said driving means only within the limits of periodic intervals of the movement of the latter, and coupling means responsive to the current flowing in the heating circuit and effective only if current flows in the heating circuit within the limits of the aforesaid intervals.

10. In a forging machine, a press operable when tripped to forge the articles, an electric heating circuit including movable means for contacting with an article and coupling the same in said circuit, intermittently operable mechanism for successively carrying articles from a position adjacent said means to a position wherein the articles are in operative

relation with the press, means for moving the first named means so that the latter and an article are engaged after said mechanism comes to rest, driving means for coordinating the operation of said mechanism and last named means, a member adapted to be coupled to said driving means and when coupled thereto to control the tripping of the press, a clutch for effecting said coupling, and electro-magnetic means for shifting the clutch and responsive to the current flowing in said heating circuit.

11. In a forging machine, a press operable when tripped to forge the articles, an electric heating circuit including movable means for contacting with an article and coupling the same in said circuit, intermittently operable mechanism for successively carrying articles from a position adjacent said means to a position wherein the articles are in operative relation with the press, means for moving said first named means so that the latter and an article engage after said mechanism comes to rest, driving means for coordinating the operation of said mechanism and last named means, a spring propelled means adapted when released to trip the press, a cam adapted to be coupled to said driving means and when coupled thereto to stress said spring propelled means and then release the same, relatively shiftable clutch elements connected one to said driving means and one to said cam, and electromagnetic means responsive to the current flowing in said heating circuit for relatively shifting said clutch elements.

12. In a forging machine, a press operable when tripped to forge an article, an electric heating circuit including movable means for contacting with the article and coupling the same in said circuit; intermittently operable mechanism for successively carrying articles from a position, wherein said means is effective to contact with an article and cause the same to be heated, to a position wherein a heated article is positioned in operative relation to said press; driving means from which said means and mechanism are operated in coordinated relation, a cam mounted to turn freely on said driving means; said cam having its contour made up of a rise portion, a drop portion and a recess at the base of the drop and the start of the rise portion; reciprocable means having a roll normally engaged in said recess, a spring for holding said roll in the latter and tending to hold the cam against rotation, relatively and axially shiftable clutch elements one on said cam and one on said driving means, means responsive to the current flowing in said circuit for axially shifting said elements the one toward the other to couple said cam to said driving means, whereby the cam is turned and moves said reciprocable means by its rise portion to stress said spring, the latter when said roll rides onto the drop portion acting to turn the

cam relatively to the driving means in the direction of rotation of the latter and angularly separate said clutch elements.

13. In a forging machine, a press operable when tripped to forge an article, an electric heating circuit including movable means for contacting with the article and coupling the same in said circuit; intermittently operable mechanism for successively carrying articles from a position, wherein said means is effective to contact with an article and cause the same to be heated, to a position wherein a heated article is positioned in operative relation to said press; driving means from which said means and mechanism are operated in coordinated relation, a reciprocable member adapted when moved in one direction to trip the press, a spring tending to move said member in said direction, a cam mounted to turn freely on said driving means, relatively and axially shiftable clutch elements one on said driving means and one on said cam, said elements adapted when engaged to remain interlocked under the driving pressure, means responsive to the current flowing in said circuit for shifting the clutch elements toward each other to couple the cam to said driving means, connections between said cam and reciprocable member for moving the latter in the opposite direction to stress said spring, said cam having a part of its contour shaped so as to release said member and permit it to be moved by the stressed spring to trip the press and so that the spring throws the cam ahead in the direction of rotation of the driving means to permit angular separation and axial disengagement of the clutch elements.

14. A forging machine, comprising, an intermittently operable turret rotatable step by step and having a series of angularly spaced holders in which the articles to be forged are placed, means for electrically heating the articles as they are successively brought to rest in a predetermined position by the turret, said heating means including electrodes and means for moving them into contact with an article after the turret comes to rest and subsequently out of contact with the article before the turret again starts to move, means for forging the heated articles as they are successively brought to rest in another predetermined position by the turret, spring actuated means effective when released to impart a hammer blow to the forged articles and eject them from their holders, and means for stressing said spring actuated means in readiness for the ejecting operation and for releasing the same for the ejecting operation when the articles are successively brought to rest in another predetermined position by the turret.

15. In a forging machine, intermittently operable means for carrying the articles to be forged, means for forging the articles operable as they are successively brought to rest

in one position by said means, means for ejecting the articles operable as they are successively brought to rest in another position by said means, driving means for said several means, and means for stopping the driving means on failure of said ejecting means to eject a forged article.

16. A forging machine, comprising, an intermittently operable turret rotatable step by step and having a series of angularly spaced holders in which the articles to be forged are placed, means for electrically heating the articles as they are successively brought to rest in a predetermined position by the turret, said heating means including electrodes and means for moving them into contact with an article after the turret comes to rest and subsequently out of contact with the article before the turret again starts to move, means for forging the heated articles as they are successively brought to rest in another predetermined position by the turret, means for ejecting the forged articles from their holders as the articles are successively brought to rest in another predetermined position by the turret; a common drive shaft from which the movement of said turret, electrodes, forging means and ejecting means are controlled; and means for automatically stopping said shaft in the event of failure to eject the forged articles at the last named predetermined position.

17. A forging machine, comprising, an intermittently operable turret rotatable step by step and having a series of angularly spaced holders in which the articles to be forged are placed, means for electrically heating the articles as they are successively brought to rest in a predetermined position by the turret, said heating means including electrodes and means for moving them into contact with an article after the turret comes to rest and subsequently out of contact with the article before the turret again starts to move, means for forging the heated articles as they are successively brought to rest in another predetermined position by the turret, and means for ejecting the forged articles from their holders as the articles are successively brought to rest in another predetermined position by the turret; a common drive shaft from which the movement of said turret, electrodes, forging means and ejecting means are controlled; and means for automatically stopping said shaft in the event of failure to eject the forged articles at the last named predetermined position, said last named means including an arm adapted to be engaged and moved by that part of the forged article which projects from its holder as the turret moves the article away from the last named predetermined position.

18. In a forging machine, intermittently operable means by which the articles to be

forged are carried and from which they project a determined distance, means for heating the articles as they are successively brought to rest in one position by said means, means for forging the articles as they are successively brought to rest in another position by said means, driving means for said several means, and means for stopping the machine operable by an article which projects more than said distance from the first named means as said article is moved toward said heating position.

19. A forging machine, comprising an intermittently operable turret movable step by step to carry the articles to be forged, a series of angularly spaced holders on the turret in which the articles are partially inserted and from which they project outwardly a predetermined distance, means operable to electrically heat the articles as they are successively brought to rest in one predetermined position by the turret, means for forging the heated articles as they are successively brought to rest in another predetermined position by the turret; a common driving means from which the operation of said turret, heating and forging means is controlled; and means for automatically stopping the driving means in the event that an article projects from its holder more than said predetermined distance.

20. A forging machine, comprising an intermittently operable turret movable step by step to carry the articles to be forged, a series of angularly spaced holders on the turret in which the articles are partially inserted and from which they project outwardly a predetermined distance, means operable to electrically heat the articles as they are successively brought to rest in one predetermined position by the turret, means for forging the heated articles as they are successively brought to rest in another predetermined position by the turret; a common driving means from which the operation of said turret, heating and forging means is controlled; a movable member disposed adjacent the turret and in a plane parallel with the outer faces of the work holder but spaced therefrom by said predetermined distance, whereby if an article projects more than said distance it will, on rotation of the turret, engage and move said member, and means operable by such movement of said member to stop said driving means.

21. A forging machine, comprising, intermittently operable means for carrying the articles to be forged and by which the articles are successively moved into predetermined positions, means for heating the articles as they successively come to rest in one position, means for forging the heated articles as they successively come to rest in another position, driving means for controlling the operation of the first named means

and said heating means, said driving means including means whereby it may be stopped at any time, independent driving means for said forging means periodically operable to
 5 move the latter through one complete cycle and then stop, means periodically operable from the first named driving means to initiate the action of the last named driving means, and means operable when the first
 10 named driving means is stopped to render ineffective the next succeeding action of said initiating means, thereby to guard against the delivery of a forging blow to an article which has become cool by reason of the stop-
 15 ping of the machine.

22. In combination with a press, of the type wherein a clutch when tripped permits a power driven forging tool to make one complete reciprocation and then stop, intermit-
 20 tently operable means for carrying articles to be forged and by which the articles are successively advanced to predetermined positions, means for electrically heating the articles as they successively come to rest in
 25 one of said positions, driving means for controlling the operation of said carrying means and heating means, means periodically releasable by said driving means and movable independently thereof when released in a
 30 predetermined path to trip the clutch of the press and initiate the cycle of operation of said forging tool, means for stopping the driving means, and means operable when the latter is stopped to move said clutch tripping
 35 means out of said path and render it ineffective even when released and moved to trip said clutch.

23. A forging machine, intermittently operable means for successively moving heated articles into position for forging, an inter-
 40 mittently reciprocable forging means operable during an interval of rest of said first named means to move from a position of rest toward the article and forge the same
 45 and then return to said position, means for directing a cooling medium against said forging means while at rest in said position, said last named means including a valve for
 50 controlling the flow of the cooling medium to said directing means, and means controlled by the movement of the forging means into and out of said position for opening and
 closing the valve.

24. In a forging machine, intermittently
 55 operable means for carrying the articles to be forged and by which they are successively moved into position for heating and subsequently into position for forging, said
 60 means including dies in which the articles are inserted with one end projecting outwardly therefrom, means for moving the articles in their dies operable to move the articles out-
 65 wardly in their dies before they come to rest in heating position and to move them in-
 wardly in their dies after they leave said

heating position and before they reach forging position, means for heating the out-
 wardly projected portion of each article, said heating means including movable elements
 70 for successively engaging the articles and at spaced points on each, means operable only after each article comes to rest in heating position, and during its interval of rest in such
 position to first move said elements against the article and subsequently away from the
 75 same and means for forging the heated ends of said articles as they successively come to rest in forging position.

25. In a forging machine, an intermittently operable turret rotatable step by step to
 80 carry articles successively into position for heating and subsequently into position for forging, said turret having a series of angularly spaced dies each having a socket in
 85 which an article is partially inserted leaving a part of the article projecting outwardly from its die, each die having a part movable axially in the inner part of its socket for closing the base of the same, a stationary
 90 trackway for controlling the movement of said parts in their sockets as the turret moves and adapted to move the same outwardly in their sockets to a predetermined position be-
 fore they are successively brought into heat-
 95 ing position and to subsequently cause the same to move inwardly in their sockets a predetermined distance before they move into forging position, whereby the articles are
 projected out of their dies to a greater extent when in heating position than in forging
 100 position, movable heating elements successively engageable with the articles and at spaced points on each as they successively come to rest in said heating position for elec-
 105 trically heating the projecting portions only of the same, means for actuating said heating elements effective only after an article has come to rest in heating position and dur-
 110 ing its interval of rest in such position to move all said elements into contact with the article and subsequently out of contact there-
 with, and means operable successively on the articles as they come to rest in said forging
 115 position for forging the heated portions of the same.

26. In a forging machine, an intermittently operable turret rotatable step by step to
 120 carry articles successively into position for heating and subsequently into position for forging and later into position for ejection, said turret having a series of angularly spaced
 dies each having a socket in which an article is partially inserted leaving a part of the ar-
 125 ticle projecting outwardly from its die, each die having a part movable axially in the inner part of its socket for closing the base of the same, a stationary trackway for con-
 trolling the movement of said parts in their sockets as the turret moves and adapted to
 130 move the same outwardly in their sockets to

a predetermined position before they are successively brought into heating position and to subsequently cause the same to move inwardly in their sockets a predetermined distance before they are brought into forging position, whereby the articles are projected out of their dies to a greater extent when in heating position than in forging position, means operable successively on the articles as they come to rest in said heating position for electrically heating the projecting portions only of the same, means operable successively on the articles as they come to rest in said forging position for forging the heated portions of the same, and ejecting means operable successively on said movable parts as they come to rest in ejecting position to drive the same into their sockets and expel the forged pieces therefrom, said ejecting means including a hammer, a driving spring and means for retracting the hammer and stressing the spring and releasing the hammer and stressed spring for the ejecting operation.

27. In a forging machine, an intermittently operable means movable step by step to carry articles successively into position for heating and subsequently into position for forging, a series of pairs of dies carried by said means in which the articles to be forged are placed with one end of each projecting beyond its die and which are so arranged that when said means comes to rest one pair of dies is positioned for heating, another pair of dies is positioned for forging, an electric heating circuit, movable elements thereof operable during an interval of rest of said means to move into contact with the articles and couple the same to said circuit; said elements including two which are movable in opposite directions against the sides of both articles of a pair to clamp the same therebetween and connect them together at a point closely adjacent the dies, and two others, one for each article of a pair, to engage the outer ends thereof; whereby the outwardly projecting portions of a pair of articles are simultaneously heated; interconnected actuating means for said several elements each including a spring relief device, and forging means operable successively on the pairs of heated articles as they come to rest in forging position to forge the same.

28. In a forging machine, intermittently operable means movable step by step to carry articles successively into position for heating and subsequently into position for forging, a series of pairs of dies carried by said means in which the articles to be forged are placed with one end of each projecting beyond its die and which are so arranged that when said means comes to rest one pair of dies is positioned for heating, another pair of dies is positioned for forging, an electric heating circuit, movable elements thereof operable

during an interval of rest of said means to move into contact with the articles and couple the same to said circuit; said elements including two which are movable in opposite directions against the sides of both articles of a pair to clamp the same therebetween and connect them together at a point closely adjacent the dies, and two others, one for each article of a pair, to engage the outer ends thereof; whereby the outwardly projecting portions of a pair of articles are simultaneously heated; interconnected actuating means for said several elements each including a spring relief device, a switch controlling said heating circuit, a single means for operating the switch and said interconnected elements arranged to close the switch only after the several elements have made contact with the articles to be heated and to open the switch before such contact is broken, and forging means operable successively on the pairs of heated articles as they come to rest in forging position to forge the same.

29. In a forging machine, intermittently operable means for successively carrying articles into position for forging and subsequently into position for ejection, a plurality of dies mounted on said means and each having an opening therethrough adapted to receive one of said articles, means for forging one end of each article as it comes to rest in forging position, an ejector plunger over which the other end of the article is positioned when said means comes to rest in ejection position and by which such article is expelled from its die, a spring adapted to move the ejector plunger toward the article and expel the latter from its die, and power driven means for periodically moving the ejector plunger in the opposite direction and placing said spring under stress before the article reaches said ejection position and for releasing the plunger after it comes to rest in said position.

In testimony whereof we have affixed our signatures.

ALONZO LINTON BAUSMAN.
EDWARD D. RAPISARDA.