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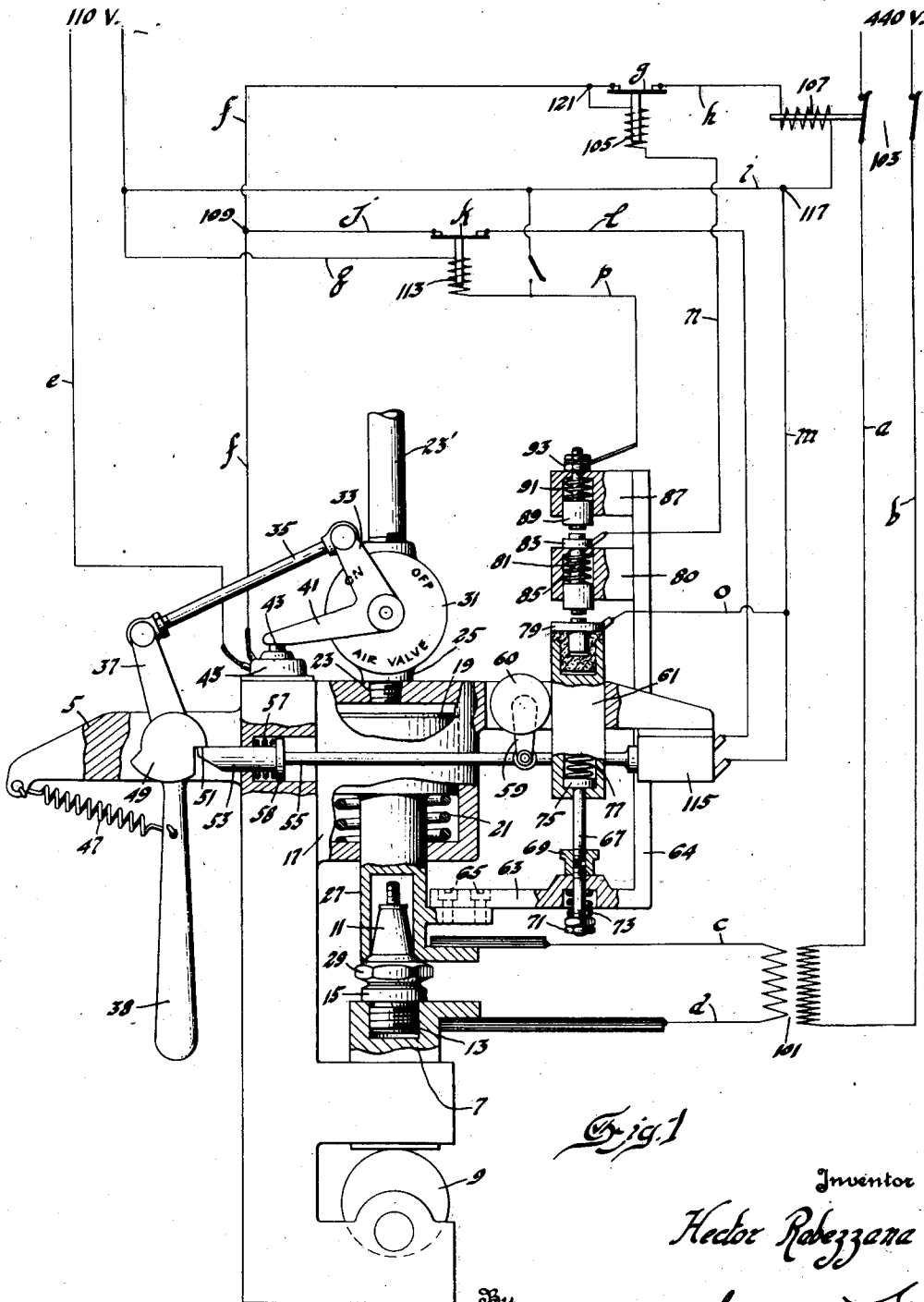
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1,848,905

MACHINE FOR SPARK PLUG MANUFACTURE

Filed Sept. 26, 1929

2 Sheets-Sheet 1



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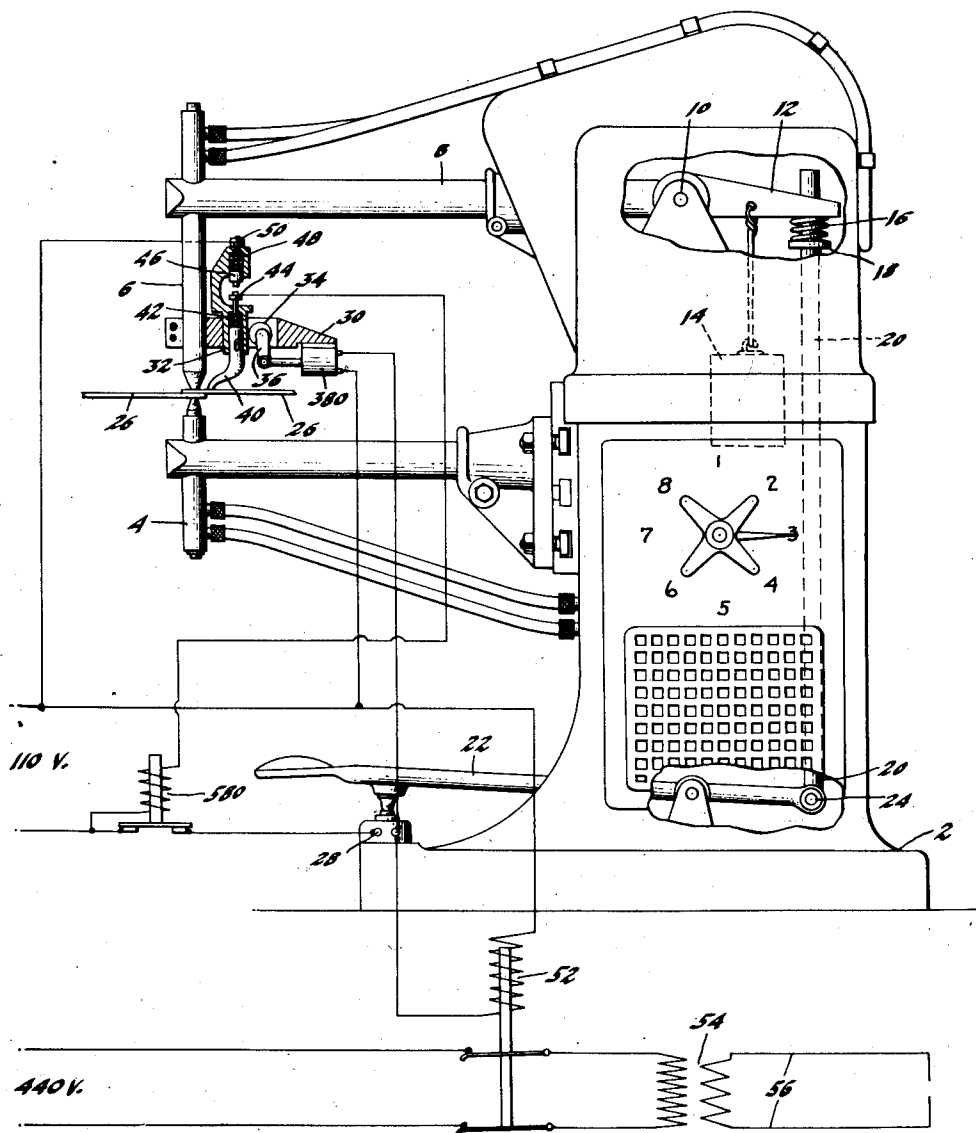


Fig. 2

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UNITED STATES PATENT OFFICE

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MACHINE FOR SPARK PLUG MANUFACTURE

Application filed September 26, 1929. Serial No. 395,279.

This invention relates to spark plug manufacture.

An object of the invention is to provide a mechanism operating automatically to perform a plurality of steps in the making of a spark plug. More specifically, the automatically operated mechanism is designed to place the spark plug under compression and to then heat the shell of the plug to an extent wherein it contracts or collapses under the applied pressure. The automatic mechanism then cuts off the heat after collapse has reached a predetermined amount, the pressure remaining effective. After a further contraction or shrinkage, due to cooling and pressure, the mechanism at a second predetermined point of collapse cuts off the pressure and disengages the parts to permit the plug to be removed from the machine. The invention is intended, as indicated above, more particularly for the manufacture of spark plugs corresponding to those described in my Patent No. 1,609,735. However, it will be understood that the invention involves principles of operation having other fields of usefulness. In addition to other uses, the invention is well adapted to spot welding.

In the drawings, Figure 1 is a diagrammatic view showing one embodiment of the invention.

Figure 2 is a view in elevation of a machine wherein the invention is used in connection with spot welding.

Referring by reference characters to the drawings, numeral 5 represents a fixed frame relative to which a movable base, 7, may be raised or lowered. Any assembly arrangement may be provided for raising and lowering base 7 relative to frame 5, there being shown an eccentric, 9, which may be rotated by any convenient means to lift the base to the position shown in the figure or to lower it relatively to the frame in a manner which will be obvious. When the base member, 7, is in its lowered position an opportunity is afforded for the insertion or removal of a spark plug, 11, in a recess, 13, of the movable base. Preferably the flange, 15, of the plug rests on the surface of the base, 7.

The fixed frame, 5, includes a cylinder, 17,

preferably rigid therewith within which moves a plunger, 19, beneath which is a spring, 21, and above which the cylinder is closed except for an opening, 23, communicating with a pipe, 23', for the passage of fluid under pressure. The plunger stem, 27, extends through the lower wall of the cylinder and is bored out to surround the upper end of the spark plug and to engage the plug at a position adjacent to and just above the hexagonal portion, 29. It may be explained that if the plug is of the kind described in my patent referred to above, there will be a thin wall portion of the shell between the upper and lower gaskets to be softened by heat while the pressure is being applied to the upper part of the shell. A thin part of the plug becomes plastic and the pressure reduces the linear dimension of the plug and makes the gaskets tight.

It has been customary to insert the assembled plug including the shell having the well-known thin wall portion between the gaskets upon a suitable support and to then apply pressure to the upper end of the shell above the upper gasket and to heat the shell. The thin wall portion softens under the heat, and the pressure reduces the linear dimension of the plug making the gaskets gas tight. While the plug is red hot, the operator determining the proper amount of heat, both the heat and the source of pressure are cut off and the red hot plug is removed. Among the limitations of this process is the obvious one of dependence upon the personal element. The operator must decide each time when to shut off the heat and pressure. A lack of uniformity in the final product is quite possible. If too much heat is given the plug the shell may be so weakened that the pressure will crush the gaskets to a very thin section which reduces the gas tightness of the plug at high temperatures because of a reduction in the elasticity of the gaskets. On the other hand, if the heat is not sufficient, the plugs are not completely sealed in the region of the gaskets and they are obviously defective. It is of the essence of this invention to remove the human element and to secure uniform results. It is designed to control the operation, not by tem-

perature, not by current strength, nor by voltage of the heating energy, nor by the length of time such heating is continued. It is proposed to provide a control dependent upon the change in thickness of the gasket itself under the influence of the applied pressure and heat. It is possible to assemble the plugs and by the practice of this invention to be sure that the gaskets in each and every case will be compressed to a predetermined extent, for example, .007"—no more, no less. In accordance with this invention, there may be manufactured plugs having a heretofore unknown uniformity in gas tightness and this may be accomplished with a saving of time, for, heretofore there has been a tendency to continue the heat and pressure somewhat longer than is absolutely necessary to make sure that the gaskets are gas tight, and this, at the risk of breaking down the gaskets, as explained above.

There is another important advantage inherent in this invention. At present the operator simultaneously cuts off the heat and the pressure. The red hot plug therefore cools at atmospheric pressure. If as it cools the shell shrinks to further compress the gaskets, nevertheless when heated in use the expansion offsets any gas tightness due to this shrinking. In accordance with the present invention, the shrinking as a result of cooling may occur before the pressure is removed. Shrinking therefore occurs under pressure and the pressure is acting to compress the plug while it is shrinking due to cooling. The plug is therefore better protected from the expansion which occurs from heat when in use in the engine. If in the manufacture of plugs as now practiced the operator should seek to take advantage of the cooling under pressure as provided for by my invention there is no way to tell how long to delay the relief of pressure. In so continuing the pressure after the heat has been cut off the operator will almost certainly delay longer than necessary and such delay means increase in labor cost. My invention therefore will be seen to provide for a saving in cost of manufacture.

Associated with the inlet pipe, 23', is an air valve, 31, having what is designated as an "on" position for the passage of air or fluid under pressure from any suitable source of supply to the cylinder, 17. There is also an "off" position wherein, as is usual in the case of such valves, the pressure from the cylinder is released. The valve is operated by a lever, 33, connected by a link, 35, to an arm, 37, rotatable about its axis by manually operable lever arm, 38. Lever 33 has a second arm, 41, operating when depressed to close an electric circuit by means of its operation upon a switch, 45, the switch 45 having an operating stem, 43. Movement of the lever, 38, is at times produced by a spring, 47,

attached to the lever and to the frame, as shown. This spring, 47, tends to spring the lever, 33, to the "off" position. The hub, 49, of lever 38, has a notch, 51, to be at times engaged by the end, 53, of a rod, 55. A spring, 57, engages the frame and also a flange, 58, on the rod to normally release the end, 53, from the notch, 51. Rod 55 is connected to an arm, 59, which is connected to and operates upon an eccentric, 60, which latter rotates to lock or release a slider, 61, mounted to reciprocate within the main frame, 5, except when locked thereto by the eccentric, 60. An angular rod, 63, is connected at 65 to the end of the plunger stem, 27. At a position adjacent the angle of the rod, 63, it is apertured to slidably receive rod 67. The downward movement of rod 67 is limited by a nut, 69. A terminal nut, 71, and a spring 73 between the rod 63 and nut 71 completes the assembly. The upper end of rod 67 is flanged as at 75 and a spring, 77, within the slider, 61, resiliently holds the flange, 75, in its lower-most position against the lower end of the slider. Within the upper end of the slider and projecting therebeyond is a contact member, 79. The upwardly directed arm, 64, of the rod, 63, is provided with an apertured block, 80, carrying slidably a contact element, 81, having its downward movement limited by a flange, 83, and held normally downward by a spring, 85. The arm, 64, also carries another block, 87, at its end in which is slidably mounted a third contact member, 89. A yielding spring, 91, holds this contact member in its lowermost position and nuts, 93, limit the downward movement under the influence of the spring. A source of electric energy designated on the drawings as 440 V. is used to operate a transformer, 101, through wires 'a' and 'b' and the switch, 103. The wires 'c' and 'd' from the transformer deliver to parts 27 and 7 of the machine a relatively high amperage, low potential current to heat the shell of the plug. As the plug is first heated, it expands and the plunger 19, rises against the fluid pressure. The part 63, movable with the plunger rises also. Since the slider 61, at this stage in the operation is locked to the frame 5, as will be explained below, the spring, 77, yields as rod 67 rises, being carried upward by the moving rod, 63. The two blocks 80 and 87 also rise with arm, 64, the space between contacts 81 and 89 remaining constant and the space between the contacts 79 and 81 increasing inasmuch as contact 79 is held stationary. For closing the circuit from the 440 V. source of supply there may be used the ordinary 110 V. service current as indicated in the drawings. From this 110 V. source, a wire, 'e', leads to the switch, 45. A wire, 'f', from the switch is connected to the movable part, 'g', of a magnetic relay, 105. In wire 'h' from the relay is connected a magnetic switch, 107, and a

return wire, 'z' completes the circuit to the main source. It will be seen that the closing of switch 45 by the arm 41 subsequent to the opening of the fluid pressure into the cylinder 17 closes the circuit described and the magnetic switch 107 renders the 440 V. circuit active to operate through the transformer 101 to heat the plug. Simultaneously from a point, 109, on the wire, 'f', a wire 'j' leads to the movable member 'k' of a second relay, 113, and a wire, 'l', leads from the relay 113 to a solenoid, 115. From the solenoid a wire, 'm', leads to a point 117 on the return wire 'z'. In this way the solenoid is actuated when the switch 45 is closed to push rod, 55, to the left, against the pressure of spring, 57. This movement locks the hand lever 38 by the engagement of the end, 53, in the notch, 51. At the same time the movement of rod, 55, to the left rotates arm 59 and causes the eccentric, 60, to lock the slider, 61, to the frame. This locking of the slider to the frame makes possible the relative movements of the contact members whereby the necessary current breaks may take place to cut out the heat current and subsequently to release the action of the solenoid as herein-after explained.

The coil of relay, 105, is connected to wire, 'f', at 121, and by a wire, 'n' to the second contact member, 81. When under the influence of the heat the plug becomes plastic and under the fluid pressure exercised by the plunger 19 collapses, contact member 81 moves downwardly into contact with contact member 79. There then occurs a current flow through the main switch, through the coil of relay 105 and through wire 'n' to the second contact member. The current continues through the first contact member and wire 'o' to wire 'm' which engages the return wire 'z' at point 117. This current flow energizes the relay 105 and withdraws the part 'g' to break the circuit first described. In this way the 440 V. heating source ceases to operate. The fluid pressure, however, remains active on the plug as the plug cools after the heating source is disconnected. The contraction of the plug as it cools (the pressure being maintained) causes contact point 89 to engage contact member 81 after a predetermined movement. When these points contact a new circuit is established as follows: The current from the 110 V. source through the switch and the first relay 105 to the second contact member now continues through contact member 89 by a wire 'p' to the relay 113 and thence by a wire 'q' and the return wire 'z' to the source. This energizes the relay 113 and moves the removable part, 'k', whereby the electric current operable upon the solenoid 115 is broken. Thereupon the spring, 57, forces back the rod, 55, permitting spring 47 to open switch 45 and to swing the valve to "off" position relieving the pressure with-

in cylinder 17. At the same time the movement of rod 55 rotates the eccentric 60 and permits slider 61 free reciprocable movement relative to the frame. Spring 21 then raises the plunger 19. Thereupon the block supporting member 7 may be lowered by rotating the eccentric 9 and the plug removed and another inserted.

It will be seen that the adjustment of the contact members may be made by the nuts, 69 and 93. Obviously the adjustment of 93 changes the relation of contact member 89 to 81. It is also clear that the adjustment of 69 will change the position of the slider 61, carrying contact member 79, when the eccentric 60 is released. The closing of the contacts which cut off the heat current and subsequently cut off the air pressure are determined solely by the spacing of the contact members which may be adjusted as described. Regardless of the thickness of the gaskets the heat current is cut off when a definite collapse of the plug takes place, the amount of collapse desired being regulated at will by adjusting the spacing between the contact members 79 and 81. Thereafter the fluid pressure is cut off and the machine automatically released by shrinkage, the amount of shrinkage to be allowed being determined at will by adjustment of the gap between contact members 81 and 89. The slider is provided to automatically provide for differences in plug dimensions. The first action is to apply pressure and move the plunger down to a point where it firmly engages the plug. Varying plug dimensions obviously mean varying positions of the contact members. If contact member 79 were fixed in position during this first step in the operation as it would be if the slider were permanently fixed the gap between 79 and 81 would be variable with plug variations. However, by making the slider reciprocable in the frame and resiliently connecting it to rod 63 by rod 67, the predetermined gap between contact member 79 and 81 remains fixed whatever be the dimensions of the plug. Subsequent to the introduction of the pressure the main switch which closes and the current through the circuits described simultaneously heat the plug and lock the slider. The contacts are automatically broken after predetermined movements as explained above. During the first period of the heating when the plug expands it will be seen that the plunger may move upwardly and this upper movement is provided for by the use of spring 77 as will be obvious from the drawings. The downward movement of arm 64 after the heating current is cut off and when contact members 81 and 79 are engaged is provided for by a spring 85. By the construction described plugs of varying dimensions are sealed with substantially uniform gas tight gaskets. The whole operation is

automatic and since nothing is left to the personal element, there is a great saving in time.

Figure 2 shows how the invention may be used in connection with a spot welding machine. At 2 is a frame having a fixed electrode, 4. A second and movable electrode, 6, is carried by a lever, 8. This lever 8 is pivoted at 10 to the frame and has a short arm, 12, which is normally actuated in one direction by a weight, 14. The lever may be rotated in an opposite direction by a spring 16, engaging the end, 12, and also engaging an abutment, 18, on rod 20. This rod is pivoted to lever 22 at 24. Lever 22 is to be manually operated and serves to raise rod 20 and through the instrumentality of spring, 16, rock lever 8 and press the upper electrode 6 toward the lower electrode 4. The work 26 which is to be welded is firmly compressed between the electrodes in this operation. A switch 28, is also closed by lever 22 subsequent to the action described. The upper movable electrode 6 carries a block 30 through which reciprocates a slider 32, which may be locked to the block by an eccentric 34, the arm, 36 of which is rotated by a solenoid, 380, carried by the block. Within the slider there reciprocates a finger, 40, held downwardly by a spring 42, carrying a contact member 44 and its lower end in contact with the work. The upper end of the slider carries a second contact member 46. This second contact member 46 is slidable toward the first and is held in its downward position by a spring 48, its movement being limited by a nut 50. When the lever 22 is depressed it first brings the parts to be welded firmly together. The finger 40 contacts the work before a firm contact of electrodes with the work has been effected and has a relatively upward movement. The spring 42 is designed strong enough to carry upward slider 32 (without further compression) until the latter has been locked in reference to block 30 by eccentric 34. The predetermined spaced relation between the contact members is therefore not changed regardless of the thickness of the work. When the switch 28 closes, it closes the 110 V. source of electrical energy and this through the magnetic switch 52 closes the 440 V. source of energy to operate, through a transformer shown diagrammatically at 54 and the low tension leads 56, the electrodes 6 and 4 to heat the work 26. At the same time the solenoid 380 is actuated to rotate the eccentric and lock the slider 32 in block 30 so that relative movement between the electrodes will cause relative movement between the contact members. When collapse of the work occurs due to plasticity under the influence of heat and pressure, the contact members are brought together and a new circuit is established through relay 580 which functions to open the

110 V. supply and thereby interrupt the heat current from the higher voltage source. Owing to the sliding connection between the slider and the upper electrode together with the eccentric lock device, the gap between the contacts is the same regardless of the thickness of the work to be welded. A given collapse, (predetermined as desirable), of the work therefore determines the interruption of the heating current whatever be the thickness of the work. It will be observed that the closing of the heating circuit subsequent to the application of pressure, together with the automatic interruption of the heating current before the release of pressure avoids any danger of arcing.

In common with the method of making spark plugs, the welding device provides first, firmly applying pressure before introduction of heat; second, automatic cutting off of heat prior to the release of pressure; third, an automatic interruption of the heating current dependent upon a given collapse of the work regardless of its thickness.

It may be added that while it is preferred to cut off the heat prior to the pressure release in making the plugs and for the reasons stated, the invention is not to be understood as restricted to this sequential order of steps. For example, these steps may be performed simultaneously.

I claim:

1. In a machine for applying pressure and heat to an object, means to subject said object to pressure and heat and independent means rendered operative by a predetermined collapse of said object under the influence of pressure and temperature to cut off the source of heat and of pressure.

2. In a machine for applying pressure and heat to an object, means to successively subject the object to pressure and to heat and independent means rendered operative by a predetermined collapse of said object under the influence of pressure and temperature to automatically cut off the source of heat and of pressure.

3. In a machine for applying pressure and heat to an object, means to successively subject the object to pressure and to heat and other means rendered operative by a predetermined collapse of said object under the influence of pressure and temperature to automatically and successively cut off the source of heat and of pressure.

4. In a machine for applying pressure and heat to an object, means to successively introduce the pressure and the heat, other than automatically operable mechanism rendered operative by a predetermined collapse of said object under the influence of said pressure and of its plasticity from the heat to cut off said heat, and additional means operable as the result of a further predetermined shrinkage due to cooling to cut off said pressure.

5. In a machine for collapsing an object by subjecting it to the influence of pressure, means to subject said object to pressure, and independent automatic means responsive to a predetermined collapse of said object to cut off the source of pressure.

6. In a machine for applying pressure and heat to an object, means to successively apply pressure and heat, electrical means operable automatically to cut off said heat, said electrical means including parts relatively movable into contact and mechanism operable simultaneously with said heat application to lock one of said relatively movable parts to render said means operable to cut off heat.

7. The invention defined by claim 6, together with other mechanism associated with the said means to cut off heat to subsequently automatically cut off pressure.

8. The invention defined by claim 6, together with other mechanism including an electrical circuit and a relay to cut off pressure subsequent to the cutting off of heat, said locking means being automatically released simultaneously with the release of pressure.

9. In a machine for assembling spark plugs, a frame, a base movable relative to said frame to permit the insertion of a spark plug, a plunger movable relative to said frame, to engage and compress said plug, fluid means to actuate said plunger, electrical means to heat and soften said plug, a second electrical means including a relay to render active said first mentioned electrical means, operable means to successively render active said fluid pressure means and said second electrical means, automatically operable means dependent upon a pre-determined degree of collapse of said plug, to cut off said first mentioned electrical means to thereby cut off said heat while the pressure remains applied.

10. The invention defined by claim 9 together with other and automatically operable means acting after a further shrinkage due to cooling of said plug to release said pressure.

11. The invention defined by claim 9 together with other automatically operable means acting upon a subsequent shrinkage of said plug due to cooling to release said pressure and to restore said operable means to its release position.

12. In combination, a frame, a base member movable relatively thereto to permit the insertion of an article, a plunger reciprocable relative to said frame to engage and compress said article, fluid pressure means to actuate said plunger, electrical means to heat said article, operable means to render active said fluid pressure means and said electrical means, a contact member movable with said plunger, and a contact member movably mounted in said frame, means to lock said last mentioned contact member in fixed relation to said frame, other electrical means

rendered active automatically by said contact members to operate to cut off the aforesaid heating current after a predetermined collapse of said article.

13. The invention defined by claim 12, said locking means being electrically operated and said operable means functioning, in addition to rendering active said electrical heating means, to render active said electrically operated locking means.

14. The invention defined by claim 12, said locking means being electrically operated and said operable means functioning, in addition to rendering active said electrical heating means, to render active said electrically operated locking means, together with another electrical contact member and a relay to release said electrical locking means after a second and further predetermined shrinkage of said article due to cooling under pressure.

15. In combination, a frame, a spark plug support adjustable relative thereto, a fluid cylinder rigid with said frame, a plunger having a stem engageable with said plug, a valve to admit fluid under pressure to said cylinder above said plunger, an electrical switch adjacent said valve, a lever to open said valve and subsequently to close said switch, electrical means controlled by said switch to heat said plug and to lock said valve in open position, relatively movable contact members to cut off said electrical heat after a pre-determined collapse of said plug due to softening of the metal under heat and pressure.

16. The invention defined by claim 15, one of said contact members being carried by said plunger and the other reciprocable in said frame and electrical means actuated by said switch to lock said frame contact member to said frame.

17. The invention defined by claim 15 together with other relatively movable contact members and an electric circuit including a relay actuated by said last mentioned contact members, to release said valve locking means after a further contraction of said plug due to cooling under pressure.

18. In combination, a frame, a spark plug supporting member adjustable relative thereto, a fluid cylinder, a plunger in said cylinder, said plunger having a rod engageable with said plug, a valve to admit fluid under pressure to said cylinder and to exhaust said cylinder, an electrical switch adjacent said valve, a manually operable lever, yielding means to normally hold said lever in its "off" position, a solenoid and means controlled thereby to lock said lever in its "on" position with said switch engaged, a spring to release said lock, electrical means controlled by said switch to both heat said plug and actuate said solenoid, relatively movable contact members to engage after a predetermined

movement of said plunger relative to said cylinder, an electric circuit including a relay operated by said contact members to cut off said electrical heating, other contact members engageable upon a further collapse of said plug, another electric circuit and relay actuated by said last mentioned contact members to cut out said solenoid whereby the spring member releases the lever lock whereby the yielding means may restore the lever to open the switch and to move the valve to its "off" position to thereby permit the cylinder to exhaust.

19. The invention defined by claim 18, one of said contact members being reciprocable in said frame, the other being carried by said plunger as it moves, means operable by said solenoid to lock and release said frame carried contact member.

20. The invention defined by claim 18, one of said contact members being reciprocable in said frame, the other being carried by said plunger as it moves, means operable by said solenoid to lock and release said frame carried contact member, together with mechanism movably connecting the frame carried contact member with the plunger whereby the frame carried contact member may be moved by and with the plunger when the fluid pressure is applied and before the solenoid is actuated and relatively to the plunger after the solenoid is actuated.

21. In combination, a frame, having a part to support a spark plug, a member movable relative thereto to compress said plug, fluid pressure means to actuate said movable member, a contact member slidable in said frame, electric means to simultaneously heat said plug and lock said slidable contact member, an element carried by said movable member, other contact members slidable in said last named element, resilient means to hold said last named contact members in predetermined positions, electrical circuits and relays actuated by said contact members to first break the heating current and subsequently to release the pressure and release the frame carried contact member for sliding movement relative to the frame.

22. In a machine, a pair of electrodes, means to apply pressure to an object between said electrodes, electrical means to heat said object, mechanism comprising a first part mounted for sliding movement, a second part movably mounted relative to said first part, contact members carried by said parts, connections whereby said two parts move as a unit as said electrodes contact said object, and to an extent dependent upon the dimensions of the object, means to lock one of said parts to produce a relative movement between said parts whereby, as the object collapses, said contact members engage, and electrical means actuated by said

engagement of the contact members to cut out the source of heating.

23. The invention defined by claim 22 together with a single manually operable member operable to first actuate the pressure-applying means and thereafter to simultaneously actuate the heating means and locking means.

24. The invention defined by claim 22, said locking means being electrical, together with a single manually operable member operable to first actuate the pressure-applying means and thereafter to simultaneously actuate the electrical heating and locking means.

25. In a machine, a pair of electrodes, means to apply pressure to an object between said electrodes, electrical means to heat said object, mechanism comprising a part slidable relative to one of said electrodes, contact members carried by said part, one of said contact members slidably engaging said part and also engaging said object, electrical locking means to hold said part from movement relative to said one of said electrodes, and electrical means operated by the engagement of said contact members to render inoperative said heating means.

26. A machine for subjecting an object to pressure and heat between a pair of electrodes, having means to cut off the source of heat consequent to a predetermined collapse of the object, said means including contact-carrying parts mutually movable during approach movement of the electrodes, and a locking device to lock one of said parts so that upon a predetermined collapse of said object the contact members engage and effect the cutting off of the heat.

In testimony whereof I affix my signature.

HECTOR RABEZZANA.