

Feb. 13, 1940.

C. HOLMES

2,190,153

GUN FOR SPRAYING METAL

Filed April 13, 1937

2 Sheets-Sheet 1

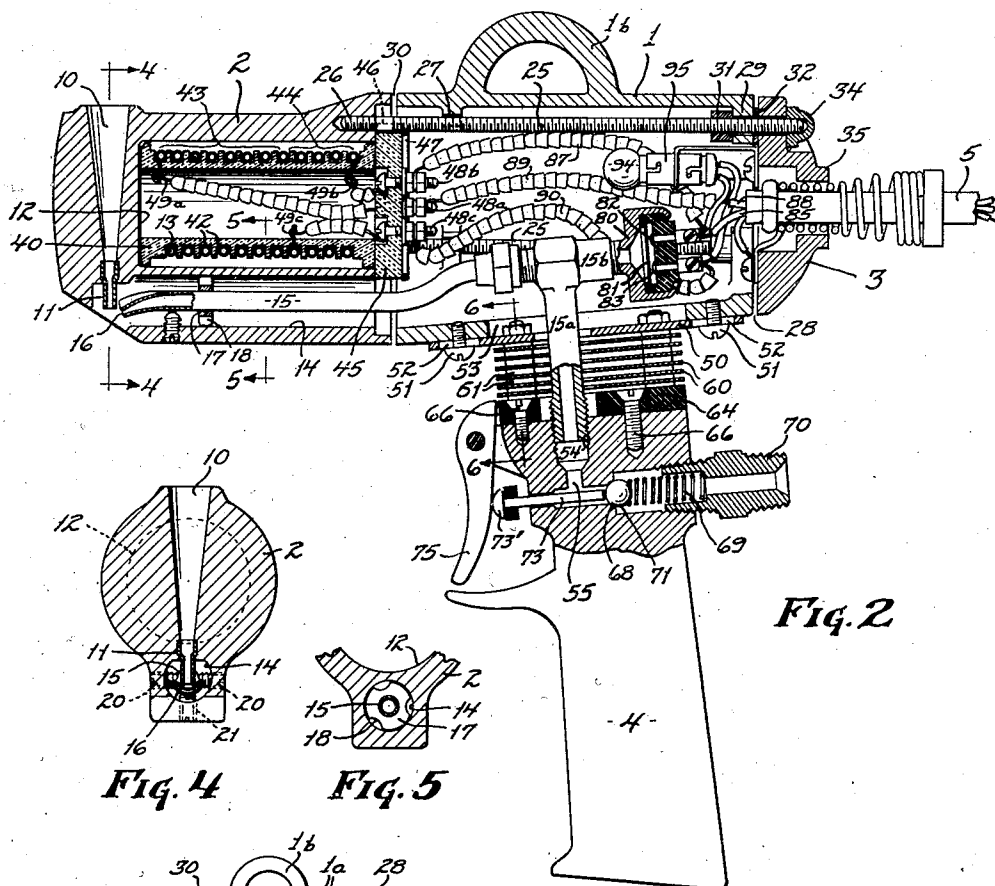


Fig. 2

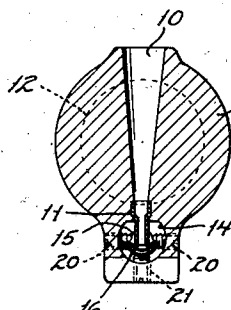


Fig. 4

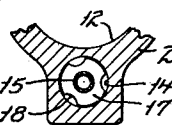


Fig. 5

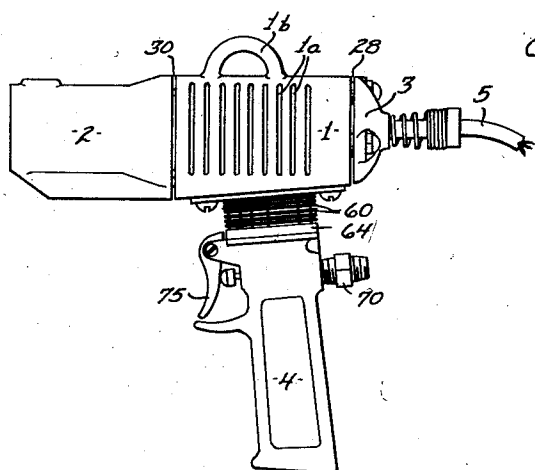


Fig. 1

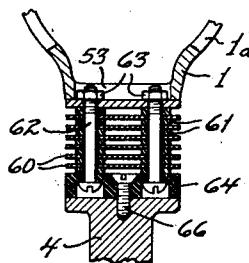


Fig. 6

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2 Sheets-Sheet 2

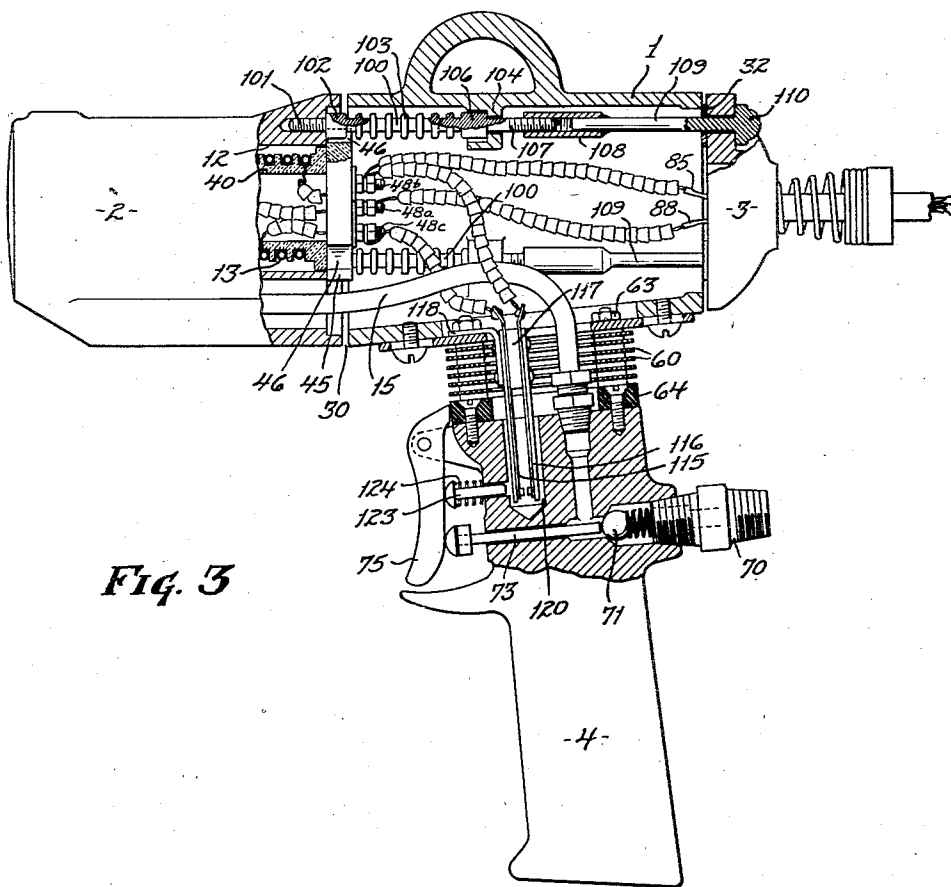


Fig. 3

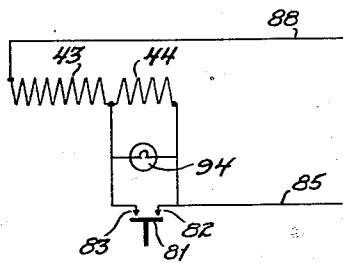


Fig. 7

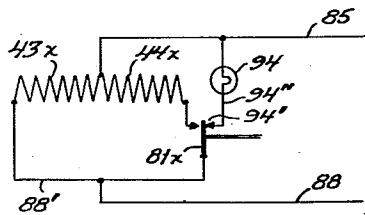


Fig. 8

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GUN FOR SPRAYING METAL

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Application April 13, 1937, Serial No. 136,644

4 Claims. (Cl. 91—12.2)

This invention relates to a gun for spraying metal, and more especially to a gun of the nature of a pistol having a crucible or well for receiving and discharging the metal stock, and means for melting and spraying the metal. As in the prior application of Carl G. Neidhardt, Serial No. 106,138, filed October 17, 1936, owned by the assignee hereof the present gun has a heating head on the muzzle end of its barrel, the head containing an electrical resistance heating element in operative association with the crucible or well, the latter being arranged vertically and with its outlet at the lower side of the head. Spraying fluid is supplied by means of a tube having a crescent-shaped orifice directed across the discharge outlet of the crucible or well. Current is supplied through a hollow frame or barrel portion aligned with the head, and there is a breech cap for supporting one end of a suitably insulated electric service cord. A downwardly projecting handle is secured to the underside of the hollow frame or barrel member mentioned, and air is supplied to the tube through a suitable valve located in the handle.

One difficulty encountered in the use of metal-spraying guns, arranged as above described, arose from the practical necessity of making the barrel portions of the gun (the head and/or frame) out of very light metal, such as aluminum. Such has an enormous advantage in reducing fatigue on the part of the operator, it being manifest that if the gun can be made as light as possible the operator will be able to control it and direct it better over long periods of time. However, aluminum has a relatively low melting point, as compared to bronze and other heavier metals that might be used for the head and/or other gun and barrel parts. Heretofore it was considered necessary to limit the heating capacity of the heating element in order not to damage the gun by melting or partially melting the metal of the head. This necessarily limited the operating period, i. e. the time during which metals of relatively high melting point could be continuously sprayed.

With the above in view, an object of the present invention includes the provision of an electrically heated gun for spraying metal, which can be safely operated for continuous spraying. Another object is to provide a gun for spraying metal, wherein, during non-operating periods, the effective temperature of the gun may be safely maintained sufficiently high to melt or nearly melt the metal to be sprayed, and where- in sufficient heat to enable continuous spraying

may be applied without substantial loss of time (as in waiting for the gun to heat up) whenever it is desired to use the gun for spraying. Another object is to provide an improved electrical heating element for guns adapted to spray metal.

Another object is to provide a gun which will automatically superheat whenever an attempt is made to use it for spraying. A specific object is to provide an automatic control for superheating in connection with supplying spraying fluid, such as air, to the spraying nozzle of the gun.

Another object is to provide an alarm device which will inform the operator when a predetermined temperature change has taken place, and specifically to enable the operator to know definitely when it is safe to lay the gun aside or hang it up, for use later.

Another object is to provide a cooling system for a gun of the type above outlined, whereby air is automatically passed through certain portions of the gun during its operation to spray metal.

Another object is to provide a simple and convenient means for detachably securing a heating element in place in operative association with the crucible or receptacle for metal to be sprayed.

Another object is to provide for facilitating the assembly and disassembly of guns of the type shown.

Another object is to provide an improved and simplified means for adjusting and locating a tube or jet for spraying fluid such as air, relative to the discharge outlet for the metal to be sprayed.

Other objects include the provision of a more effective means for preventing overheating of certain parts of the gun by conduction of heat from one part to another.

Other objects and features of the invention will become apparent from the following description, relating to the accompanying drawings, which show the preferred forms. The essential characteristics are summarized in the claims.

Referring to the drawings, Fig. 1 is a side elevation, showing the improved gun in one form; Fig. 2 is a central, longitudinal, sectional view of said gun; Fig. 3 is a view similar to Fig. 2 showing a modified construction; Figs. 4 to 6 are transverse, sectional views taken as indicated by the lines 4—4, 5—5 and 6—6, respectively, on Fig. 2; and Figs 7 and 8 are diagrammatic views showing different electrical hook-ups.

The barrel parts of the gun, as shown in Figs. 1 to 3, comprise a hollow body member 1 (hereinafter called a frame) which is generally cylindrical in form, and adapted to be made of cast

aluminum or other light metal. This has a series of slots 1a (e. g. saw cuts) in both sides which assist in keeping the frame cool. A heating element housing or head 2 (also preferably cast aluminum) is attached to the frame in alignment therewith but preferably spaced from it to reduce conductivity of heat to the frame. A breech closure 3 for the frame is located opposite the heating head and is arranged to support an electric cord 5 connected with the heater as will later be shown. A pistol-type handle or stock 4 is insulatingly secured to the frame, and the handle is also made preferably as an aluminum casting. The cord 5 has, of course, a suitable plug or connector (not shown) for attachment to an electric service supply fitting.

The head 2, as shown, has a substantially vertically disposed tapered bore 10, near its outer end, which bore serves as a crucible or well for the metal to be melted and sprayed. The lower end of the well has a restricted discharge tip 11 shown as a separate piece inserted in the lower end of the bore 10. The tip is preferably Monel metal and may be peened or screwed into place. The aluminum of the casting 2 may be spun or headed over the top rim of the tip to hold it.

Directly behind the bore 10 the head 2 is bored or cored as at 12 to form a pocket for receiving the heating element 13. The element will be later described more in detail. Beneath the pocket 12, and parallel to it, is a through bore 14, which receives the outer end portion of a tube 15 for spraying-fluid, such as air or other gas, the tube being spaced from the walls of the bore 14, and having a generally crescent-shaped discharge orifice 16 properly related to the discharge orifice of the metal discharge tip 11, so as to spray metal therefrom in the form of a trough. Other shapes for the spray nozzle may, of course, be used.

The tube 15 may be made of relatively hard non-corrosive metal, which will not warp under intense heat; Monel metal being preferred in seamless, thin walled tube form. The tube may be located centrally of the bore 14 by means of one or more discs 17, say of insulation material such as lava, each centrally apertured to receive and substantially fit the tube and having its outer marginal portions cut away, as at 18, (see Fig. 5) so that circumferentially spaced portions of the disc contact with the bore and maintain the tube centered in the bore, while the cut-away portions 18 provide free passage for air from one end of the bore 14 to the other. Additional means for locating the extreme end of the tube 15 may comprise a suitable arrangement of adjusting screws; for example, two horizontally extending screws 20, one on each side of the body bore, and a bottom screw 21 which bears upwardly against the free portion of the tube near its end. The screws may tightly fit their threaded openings, for locking effect when adjusted to position the crescent-shaped discharge orifice of the tube properly relative to the discharge orifice of the tip 11.

The purpose of insulating the tube 15 from the heat of the metal body 2 is partly to reduce the tendency for it to warp or be damaged. Furthermore, if the spraying fluid is maintained at a low temperature, then the metal to be sprayed is deposited cold a few inches away from the nozzle, and thus will not injure the surface upon which the metal is deposited, irrespective of its character. When the gun is operated, the fluid projected from the crescent-shaped nozzle has a

Venturi action on the air adjacent the nozzle and surrounding the tube 15 and draws air through the bore 14 and passages 18 from the interior of the frame 1, thus not only cooling the interior of the frame, but also keeping the wall of the tube comparatively cool.

As shown in Fig. 2, the rearward end of the head 2 is secured to the barrel member 1, by means of three rods 25 which are preferably threaded for their entire length, partly to provide heat radiating fins on the rods. The outer threaded ends 26 of the rods are tightly screwed into appropriate threaded openings on the rear face of the head 2. The shanks of the rods radially abut notches in inwardly extending ear portions 27, formed on the inside of the frame 1 intermediately of its ends, thus locking the head against turning with reference to the frame by substantially a minimum of heat-conducting contact between parts of the head and the frame, near the head. The rearward threaded ends of the rods 25 may slide through parallel openings in inwardly extending ears 29 of the frame, adjacent the breech closure; the said ends extending outwardly at the rear face of the frame 1, for supporting the breech closure 3.

In order to provide for adjustably spacing the head from the hollow frame 1 as indicated at 30, Figs. 1 and 2, the rods carry collars 31, tightly threaded on the rods and adapted outwardly to abut the ears 29. The space at 30 is preferably $\frac{1}{2}$ " wide. The collars are mounted on the rods before the rods are inserted into the outer end of the frame 1, and the rods are slightly sprung inwardly in order to move the collars past the ears 27. The collars are drawn tightly against the ears 29 when the breech closure 3 is mounted on the frame.

The breech closure or cord support 3 may be secured in spaced relation to the rear face of the frame 1, providing an air gap 28, as by washers 32, interposed between the closure and frame ears 29. The closure is appropriately apertured slidably to receive the rear threaded ends of the rods, and is clamped in place as by nuts 34, one for each rod. The electric cord 5 extends through a central boss 35 on the cap 3, and may be supported by the usual coiled wire ferrule embracing the cord and mounted in the breech closure.

Referring again to the heating element 13, this preferably comprises a porcelain or lava spool 40, having a helical arrangement of grooves 42, to retain coils of resistance wire surrounding the spool. There may be two sets of coils, 43 and 44, each of different size wire and connected, as end to end, so that they may be operated simultaneously in series. If the portion 43 is of lower resistance than the portion 44, and current is supplied to both (in series) for maintaining heat during periods of non-use of the gun, only the higher resistance wire (portion 44) will attain glowing heat. If current is supplied only to the portion 42 then this will attain a much higher temperature than when both receive current, in series. This illustrates one arrangement of obtaining "storage" and "superheat", the control for which will be later described.

The spool 40 may be mounted in the bore 12 by sliding it into place, and may be retained by a lava or porcelain disc 45, the central portion of which abuts the end of the spool. The rim of the disc is notched at 46, adjacent each of the rods 25, so that the disc is held in place against turning and against lateral displacement by the rods. The rods thus maintain uniform air pas-

sages between the rim of the disc and the wall of the frame 1. The disc may be held in place against movement longitudinally of the frame by a snap-ring 47 of the spring wire which engages the threads of the rods when expanded in contact with the disc. The disc carries suitable binding posts 48a, 48b, and 48c, for the conductor leads 49a, 49b and 49c which pass inside the spool and are connected to the different portions of the coil as shown on Fig. 2.

Referring now to the handle attachment, this may comprise in part, a plate 50, which is secured as by a pair of screws 51, entering slots 52, in the plate, the slots extending lengthwise of the frame 1, and the screws being threaded into the under side of the frame. The tube 15 has a downwardly extending portion 15a extending through an enlarged opening 53 in the frame, said extension being secured as by threading at 54 into sealed relationship to a valve chamber 55, located in the handle. The plate 50 is rigidly attached to the handle (as by means to be described later) so that when the screws 51 are slightly loosened and the plate shifted longitudinally of the gun, the tube 15 and handle may be moved bodily in a manner to adjust the position of the discharge orifice of the tube closer to or farther away from the axis of the discharge tip 11, thereby to vary the nature of the spray. For instance, when the tube is relatively withdrawn, a wider spray is effected than when the air discharges closer to the tip.

A suitable means for reducing conductivity of heat from the frame 1 to the metal handle may comprise (see Figs. 2 and 6), a plurality of spaced, superposed metal plates 60, the spaces being maintained by rings 61, through which attaching bolts 62 extend, from a block or plate 64 of insulation material upwardly through holes in the plate 50 to which the ends of the bolts may be secured as by nuts 63. The block 64 is attached to the upper face of the handle by separate screws 66 which enter the block from its top side, and being threaded into the top face of the handle.

The valve chamber 55, above mentioned, communicates with a conical port 68, leading to an air inlet 69, into which a tube or sleeve 70, adapted for attachment to a flexible air-hose, is threaded.

The air control valve may comprise a ball 71, arranged to seat in the port 68, being pressed thereagainst as by a coil spring 72, one end of which seats against a counterbore in the tube 70. An operating stem 73 for the ball extends through a suitable bore in the front face of the handle, to a head 73', having a sealing gasket 74 beneath it, which surrounds the stem and seals the opening for the stem when the valve is fully opened. A trigger device 75 suitably pivoted on the handle, serves to release the valve and permit the flow of air into the tube 15 through the transverse tube portion 15a.

For controlling the heating element automatically so that different heating effects are obtained during idle and active periods of the gun, Fig. 2 shows a device which is responsive to a predetermined fluid pressure in the air tube between the control valve and fluid-discharge orifice 16. The device acts to turn on more heat whenever the gun is used and includes a diaphragm housing 80 at the rear end of a branch portion 15b of the air tube. The diaphragm 81 may be made of spring metal and may normally occupy a forwardly sprung position such as illustrated in Fig. 2. The diaphragm is forced rearwardly by

back pressure of air in the tube 15 when air is admitted to the tube as by opening the control valve. This closes an electrical circuit including electrical contact members 82 and 83 at the back of the diaphragm, the contacts being electrically bridged directly by the diaphragm or suitable conductor means operated by it, as desired.

While the electrical connections may be variously arranged depending on the manner in which the element 13 is wired, the connections in case of the large and small resistance wire 43-44, to be used in series, may be as follows:

Service wire 85 of the cord 5 is connected, as by the branch 86, to the diaphragm housing contact 82 and also, as by branch 87, with the post 48b on the element-retaining disc 45. Another service wire 88 of the cord extends as at 89 to the binding post 48a of said disc. Since the two binding posts mentioned are connected respectively to the effective ends of the coil 43-44, plugging in of the cord onto a service line passes current through both portions of the coil. This heats up the portion 44 and the resistance of the wire is of such nature (composition and/or length) that the coil now draws in the neighborhood of 200 watts, or sufficient to maintain the head 2 at melting temperature of the metal to be sprayed, but insufficient to damage the aluminum head of the gun.

The contact 83 of the diaphragm-operated switch is connected as by a line 90 to the post 48c on the disc 45 which, as above mentioned, is connected (by line 49c) to the inner end of the outer portion 43 of the heating coil. By this arrangement, as soon as the back pressure of air in the tube 15 closes the switch 81-82-83, the coil portion 44 is short circuited and rendered ineffective. Thereafter, so long as air pressure, sufficient to spray metal is maintained in the tube 15, appreciable current flow is through the coil portion 43 only. The coil is preferably so proportioned (and/or composed) that it draws in the neighborhood of 500 watts to maintain the condition of superheat, and if it were not for the fact that air is now being supplied through the discharge nozzle 16, drawing air through the bore 14, and also withdrawing considerable heat from the head by removing melted metal from the well 10, the heat of the element would be sufficient to melt the aluminum head. However, absolutely no damage results from such superheating while the gun is operating to spray metal. As soon as the operator stops supplying air, as by releasing the trigger 75, the diaphragm 81 then springs away from the contacts 82 and 83, the fine wire coil portion 44 is replaced in the circuit, and the added resistance immediately decreases the amount of heat supplied by the heating element. It is then safe to hang up the gun or lay it aside. The diaphragm 81, when it snaps forwardly to break the circuit 86-88, may operate as an audible signal to inform the operator that normal or low heating has been reestablished, or some other suitable signal may be provided, such as described below.

It may be mentioned that the coil portions 43 and 44 may be transposed if desired, by repositioning the coil wire and altering the connections. Also, the different portions of the coil may be of the same wire and more or less of it used selectively to obtain the desired normal and superheating. Moreover, the two portions of the coil may be in parallel, and, in that event, the diaphragm operated switch would cut one of the coil portions entirely out of the circuit to reduce heating of the head. In other words the dia-

phragm operated switch would be arranged to establish a circuit through one portion of the coil to enable it to act as a booster for the other portion and thus increase the effective temperature of the head when, and only when, the gun is used for spraying metal.

As a suitable signal or tell-tale, a light bulb may be mounted inside the frame 1 and so connected into the electrical circuit that it informs the operator when a predetermined heat condition obtains in the gun. For instance, a suitable low-wattage bulb 94 may occupy a socket 95 mounted on the closure member 3 and having its effective terminals electrically connected with the binding posts of the contact members 82 and 83, thus causing the light to operate in parallel circuit arrangement with respect to the heating element portion 44. Thus, the light is by-passed in the circuit when the switch 81, 82, 83 is closed and the gun operates at "superheat." In other words, the light goes out during normal operating periods of the gun, and whenever the switch becomes effective to reestablish low heat, then the light shines through the window openings provided by the side slits 1a in the frame, to remind the operator that the gun is still plugged in on the service line and also to inform him that it is then safe to hang it up as by the loop 1b awaiting arrangement of work, etc. No time is lost (waiting for heat) when the operator is ready to resume spraying.

It may be noted that any appropriate audible signal could be used instead of the visible one described, it being contemplated that, for instance, the switch may be of the type which snaps or clicks to "on" and "off" positions as a suitable tell-tale of the heat setting of the gun.

The electrical connections above described are shown more simply in the diagram, Fig. 7, which will be self-explanatory, in view of the above, and reference characters on the diagram.

The signal might be connected in parallel with either heating element portion when the elements operate in parallel as above mentioned (one portion cut out of circuit to reduce heating, so that, for instance, the light goes on when the gun is operating to superheat, and goes out, during storage-heating periods).

Fig. 8 shows a modification of electrical hook-up, which may be used, and in this, one main line, say 85 is connected at an intermediate point with the heating coil, having portions 43x and 44x. One end of this coil, e. g. extremity of 43x, is permanently connected as by the branch 88' of the main line 88, to such main line. Thus, when the plug of cord 5 is connected with a service circuit and switch member 81x is in the position in which shown on the diagram, only the portion 43x of the coil becomes heated; the remainder of the coil 44x being unsupplied with current. In such event, the signal 94 informs the operator that the gun is operating at low heat, being placed in the circuit by contact established as at 94' through branch 94''. Now, when, for instance, back pressure in the air tube 15 operates the switch 81x to connect it with the contact shown opposite 94' and leading to the coil 44x, then the two portions of the coil operate in parallel, and 44x becomes a booster for 43x to maintain effective superheating of the desired degree. Obviously, other arrangements of electrical circuits and switches can be arranged to effect the essential purposes above described, as well known to electrical engineers.

Referring to the arrangement shown in Fig. 3, only so much of this will be specifically described as differs from the showing of Fig. 2. In this arrangement, means are provided for controlling the heating element either in connection with the air supply valve 71 or independently thereof, as by a separate trigger or switch, but in any event so that superheat control is independent of air pressure. Another difference resides in the manner in which the main barrel parts, 1, 2 and 3, are assembled and held together as by two or more attaching stud assemblies (three preferred), one only of which is shown in detail and described below.

At the upper portion of the barrel in Fig. 3, 100 designates a relatively short stud section having its forward shouldered end screwed into the head 2 as at 101. The shoulder, provided by an enlargement 102, seats in one of the edge recesses 46 of the disc 45. These stud sections 100 may be of stainless steel and as shown there are heat radiating fin effects on the shank portions. The frame 1 has inwardly extending ears at 104, which are countersunk on their forward sides to receive fixed enlargements 106 on the stud sections 100. The threaded rearward extensions 107 of the stud sections 100 extend through the ears 104 for engagement by internally threaded studs 109, the shanks of which may be of the same diameter throughout their length; or which may be made as shown, with enlarged threaded outer ends 108 secured to the relatively reduced shanks as by threads and/or solder, or by welding. Head effects 110 on the studs 109 (heads may be separate nuts) clamp the end closure 3 to the frame, or against space maintaining washers 32, when the studs are tightened onto the rearwardly projecting ends 107 of the stud sections 100. The fixed shoulders 106 maintain the proper space at 30 between the head 2 and the frame 1, and the studs 109 cooperate to clamp all of the main parts of the barrel together. In the event separate nuts replace the heads 110, then, the outer ends (e. g. sleeves 108) are seated against the forward faces of the ears 104 (or against spacers or lockwashers for same effect), before the end closure 3 is applied, thus making a rigid sub-assembly of the head 2 and frame 1 which is independent of the end closure member.

Referring to the control switch, a pair of spring contact members 115 and 116 may be mounted on a suitable insulation block assembly 117, supported, as by a bracket 118, held in place by one or more of the nuts 63, previously described. The ends of the spring contact members extend loosely into a cavity 120, formed in the top of the handle. As shown, the forward contact 115, is arranged to be pressed against its cooperating contact by the air-control trigger 75, through the agency of a pin 123 the head of which is normally maintained against the trigger, as by a light compression spring 124, bearing against the handle. The switch could, of course, have an actuator which is independent of the air-control trigger.

The upper ends of the contacts 115 and 116 are suitably connected with the binding posts 48a, 48b or 48c (the latter two, as shown) in such manner that when the contacts are brought together the heating element is conditioned for superheating as by any of the electrical arrangements already described. It will be noted that superheating occurs only after the air valve has been opened, and the cooling operation tending

to maintain a safe temperature, notwithstanding

ing the higher application of heat, has become effective.

No signal is shown in connection with Fig. 3, but it will be understood that a visible or audible signal may be arranged in this form, in any of the ways already referred to. The necessary modification of switches to enable simultaneous use of two coil portions for superheating i. e. boosting effect according to Fig. 8, will be obvious to anyone skilled in electrical construction.

I claim:

1. In a gun for spraying metal having an electric heating head and heating element therein for melting the metal to be sprayed, a hollow body section through which conductors pass to the heating element, inwardly extending ears on said section, rods attached to the head and extending past the ears, supported thereby, an electric cord support positioned to close the end of the hollow section opposite the head and attaching members passing from said support into the hollow section and detachably associated with the extended portions of the rods.

2. In a gun arranged for spraying metal, a body which supports heating means to melt the metal and a nozzle operable to spray the metal by fluid under pressure, a tube for conveying such fluid to the nozzle, a continuously open passage in the body for receiving the tube, said passage opening at both ends, one end being open adjacent the nozzle, and means comprising

a disc capable of being slid into and out of the passage with the tube, said disc being apertured to receive the tube and having edges which contact with the walls of the passage to support the tube in a definite position, other portions of the disc being notched to provide openings spaced circumferentially of the disc to permit flow of air through the passage externally of the tube for cooling.

3. In a gun for spraying metal, an electric heating element disposed in a hollow head member having threaded positioning rods projecting therefrom adapted to attach the head to a supporting body, a disc arranged to hold the element in the hollow head, said disc having passages therein for electrical conductors adapted to extend from the support to the element, and a spring retainer adapted to engage the threads of the rods to hold the disc in place.

4. In a gun for spraying metal, having an electric heating element arranged to melt the metal, a hollow head for the element, a hollow body section aligned with the head, a plurality of attaching rods extending from the head and through the hollow section, means in the hollow section which engage and locate the rods as to said section at axially spaced regions inside the hollow section, and an attaching means for an electric cord adapted to be coupled with the heating element, said attaching means being detachably secured to the ends of the rods.

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