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RIVET HEATING DEVICE

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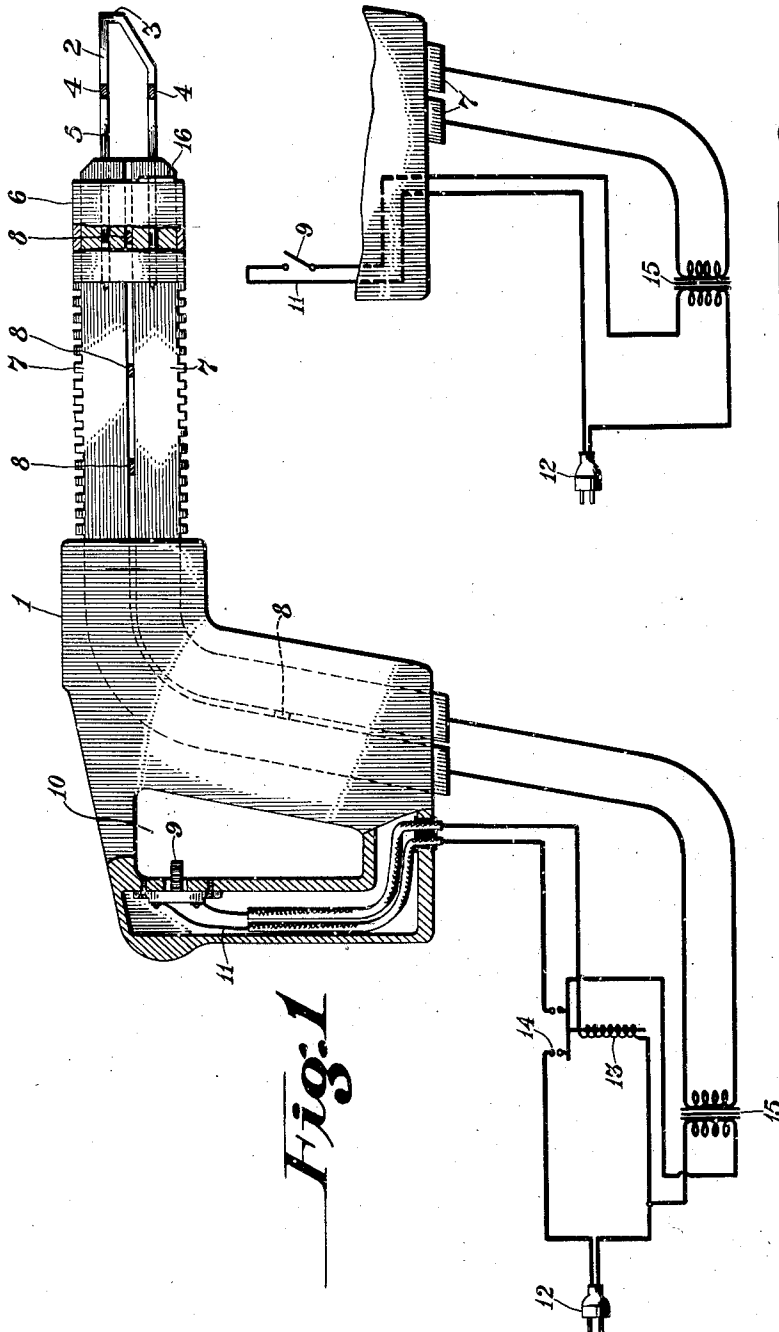


Fig. 1

Fig. 2

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RIVET HEATING DEVICE

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This invention relates to an improved apparatus for the application of heat to localized areas and more particularly to apparatus for the firing of explosive rivets.

The use of explosive rivets has become very extensive in recent years because of their adaptability to situations where ordinary solid rivets could not be used, for example, where two plates were to be joined together but only one side was accessible. An explosive rivet comprises a headed metal pin having a cavity within the shank, opening from either the unheaded or the headed end. An explosive charge is introduced into this cavity, preferably in such position that it extends slightly beyond the far surface of the metal plate most removed from the head of the rivet. When the rivet is fired, the force of the explosion bulges out the walls of the rivet adjacent to the charge, with the result that the metal plates are held tightly together thereby.

The usual method for firing such rivets consists in applying a heated surface to the head of the rivet, whereby the rivet conducts the heat to the explosive charge, which then becomes ignited. The explosives commonly used in rivets have an ignition temperature of around 100° to 150° C. While various methods of heating and different types of apparatus have been employed, all such previously used heating devices have possessed some disadvantages, either from inefficient working, cumbersome apparatus, too rapid deterioration in use, lack of simplicity, slowness in heating, or the like.

An object of the present invention is a new and improved apparatus for the application of intense heat to localized areas. A further object is such an apparatus for the firing of explosive rivets characterized by mechanical strength and the ability to attain the firing temperature quickly. A still further object is a heating device having a durable heating element of relatively high electrical resistance and resistance to corrosion. Additional objects will be disclosed as the invention is described more at length hereinafter.

We have found that the foregoing objects are attained when we employ a heating apparatus comprising a portable, manually-controlled unit having at one extremity a heating element comprised of a material of relatively high electrical resistance and high resistance to corrosion, and terminating in a section of the same material of reduced cross-section. Two metallic leads,

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insulated from one another, are connected to the heating elements, these leads being of a metal of a relatively high degree of conductivity and being adapted to conduct current of high amperage. near the extremity of the heating unit opposite to the heating element is a readily operable switch, preferably with trigger- or push button-type control. This switch controls an electric circuit adapted to carry high voltage current of low amperage through the heating unit. External to the portable heating unit is the source of high voltage alternating current, a transformer, and desirably a relay which is thrown into the circuit by the closing of the finger-operable switch in the portable unit and which then controls the passage of the current to the transformer. The entire apparatus assembly is so connected electrically that the high voltage alternating current passes through one circuit in the portable unit when this circuit is closed by the micro-switch. This causes the closing of the circuit through the magnetically-operated relay and the current then passes to the transformer, where it is stepped down to the desired low voltage, for example, from 120 to 4 volts. This low voltage current of increased amperage, say 500 amperes, then flows through conductors of larger diameter and increased conductance to the heating element, where the tip is heated to incandescence very rapidly. Such a heat, when applied under slight pressure to the head of an explosive-charged rivet, is sufficient to cause the rivet to fire in a very short time interval.

The details and application of the invention will be shown more clearly in the accompanying drawing where a specific and preferred embodiment is illustrated. Figure 1 is a side elevation of the portable heating unit, with disclosure of the method of connecting this unit with the external parts of the assembly for its proper functioning. 1 designates the portable heating unit which resembles an oversized revolver in general appearance and which will be designated as a rivet gun hereinafter. At the forward extremity of the rivet gun is the heating element 2 of Nichrome or other nickel-chromium alloy of high nickel content, terminating in the tip 3 of much reduced area. This heating element 2 is brazed at 4 to copper holding bars 5, which extend into supporting relation with the leads, being held securely in place by the auxiliary metal piece 6, which is insulated at 16 from at least one of the leads and which in turn is secured by set screws (not shown). The aluminum leads 7, comprising bars of this metal $\frac{3}{4}$ " x $\frac{5}{8}$ " in dimensions, are

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adapted to carry the high amperage current to the copper holding bars, the two leads being insulated from one another at intervals by interposed mica layers 8. Otherwise these aluminum leads are free from insulation, and they are designed for rapid air cooling by reason of their great surface areas, as illustrated by the corrugations shown in the drawing. At the end of the rivet gun opposite to the heating element, a trigger or push button arrangement 9, extending into the free space 10, is in such position that by exertion of a slight pressure on said button by the finger, an electric circuit is closed and the current from a source of high voltage alternating current passes through the circuit 11, the plug 12 being inserted in a standard outlet. In the preferred embodiment shown, when the circuit is closed at 9, the current through the holding coil 13 closes the magnetically-controlled switch at 14 and the high voltage current is stepped down by means of the transformer 15, so that a low voltage, high amperage current goes to the leads 7 and thence to the heating element 2. The ordinary commercial electric current of 110-120 volts is stepped down to around 4 volts, and amperages as high as 500 amperes may be obtained, which are well adapted to rapid heating of the resistant metal element 2 and the tip 3. The wires constituting the circuit closed by the trigger 9 carry only high voltage primary current, hence may be of small diameter. The leads beyond the transformer carry secondary current of high amperage, and are of larger diameter and higher conductivity, for example, heavy welding cable. In the drawing, the parts of the apparatus external to the gun have been shown symbolically only. Various types of magnetically-operated relays are suitable for use at 14, and the inclusion of the relay makes it possible to close the electrical circuit and start the heating of the tip with a minimum of mechanical effort or wear on the contact points.

In the arrangement shown, the tips, comprising preferably a nickel-chromium alloy high in nickel content, are brazed to copper holding bars, and the entire tip assembly may be readily removed and replaced. Hence different forms of tips may be used for either flat or brazier head rivets, and of different shapes for reaching into unusual places of any sort. A preferred type of tip is formed from a rod of Nichrome of $\frac{3}{8}$ " diameter, this rod being split to within $\frac{1}{8}$ " of the end and the two halves bent to any desired shape. Nickel-chromium alloys containing more than 50% nickel are desirable, and a preferred composition is 80% nickel — 20% chromium. The tip of the heating element should be of thinner cross section than any of the rest of said element in order to assure the greatest concentration of heat at the tip. If increased length of the heating unit is desired, this should be in the copper holding bars or other parts of the gun and not in the high resistance metal portion.

In the heating assembly shown in Figure 1, the heating takes place with use of a relay outside the rivet gun. This is the preferred assembly but the inclusion of a relay is not essential. Figure 2 is a diagrammatic representation of the arrangement of the assembly parts when no relay is used.

In Figure 2, 9 again represents the element that is operated by the finger to close the circuit in the rivet gun at the time when the current is to be passed through the heating element. When

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the circuit through 11 is closed at 9, the high voltage alternating current is stepped down at the transformer 15 and the low voltage, high amperage current then goes through cables to the leads 7, thence to the tip of the heating element.

It will be understood that in actual use, while the portable, manually-controlled rivet gun 1 can be readily moved from place to place for the firing of a large number of rivets, the external portions of the heating assembly, namely the transformer, the relay, and the heavy cables, are less readily moved about and will desirably be mounted in the most convenient manner for use and movement, when necessary. A control box may contain the relay and the fuses necessary for protecting the operator and the apparatus. Desirably, arrangement will be made for varying the voltage and current delivered by suitable connections for tapping the primary transformer coil.

With a rivet gun such as described and with an alternating primary current source of 100-120 volts, a secondary current of around 4 volts at as high as 500 amperes may be supplied. This will be sufficient to bring the tip of the heating element to red heat from a cold start in about ten seconds.

The tip of the heating element, which becomes incandescent and causes the firing of the rivet, has been stated to be of high electrical resistance. While a variety of materials may be used for this heating tip, it should be of a metal having an electrical resistivity higher than 100 ohms per circular mil foot. It will be understood that such metals as copper, silver and aluminum are not applicable for this purpose as they possess resistivities of approximately 10.4, 9.8 and 17, respectively. Preferably we employ a metal or alloy having a resistivity of over 300 ohms per circular mil foot and possessing a considerable degree of corrosion resistance at high temperatures. As illustrative, the metals below are cited as applicable:

Metal	Resistivity (Ohms/circ. mil foot)
Nickel-Chromium (80-20).....	650
Nickel-Chromium-Iron (62-15).....	675
Manganin.....	115-600
Monel Metal.....	280
Stainless Steels:	
(18-8 Cr-Ni).....	548
(25-12).....	482

Our invention has been described at length in the foregoing. It will be understood, however, that many variations in details and procedures may be introduced without departing from the scope of the invention. While the use of the apparatus has been emphasized for the firing of explosive rivets, it is applicable to all cases where quick application of intense heat to localized areas is desired. We intend to be limited, therefore, only by the following patent claims:

We claim:

1. In an apparatus for the firing of explosive rivets, the combination of a portable heating unit and arrangements external to the heating unit for controlling the current input to said unit, said heating unit comprising at one extremity a heating element terminating in a portion of relatively high electrical resistance, said portion being adapted for good heat-exchange contact with an explosive rivet, two metallic leads

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insulated from one another and connected to said heating element and characterized by a considerably greater degree of electrical conductivity than the heating element, and a finger-operable switch near the extremity opposite to the heating element, said means external to the heating unit comprising a means for connection to a source of high-voltage alternating current, a transformer, a magnetically-operated relay for controlling the circuit to said transformer, and electrical connections between said external means and said portable heating unit, the entire apparatus combination being so connected electrically that the closing of the switch in the portable heating unit causes the primary, high-voltage current to flow and close the circuit through the magnetically-operated relay, thence to the primary coil of the transformer, the resulting low-voltage current of relatively high amperage then flowing through the heating element of the heating unit, whereby an intense localized heating effect results in the tip of said element.

2. The apparatus of claim 1, in which the heating element comprises a metallic material having an electrical resistivity of over 300 ohms per circular mil foot.

3. The apparatus of claim 1, in which the heating element comprises a nickel-chromium alloy containing more than 50% nickel.

4. The apparatus of claim 1, in which the heating unit has an elongated extremity at the end comprising the heating element, said element having a reduced cross section at the tip.

5. The apparatus of claim 1, in which the metallic leads connected to the heating element are uninsulated except from one another and possess irregular surfaces, whereby the surface areas are increased.

6. In an apparatus for the firing of explosive rivets, the combination of a portable heating unit and means external to the heating unit for con-

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trolling the current input to said unit, said heating unit comprising at one extremity a heating element terminating in a portion of relatively high electrical resistance, said portion being adapted for good heat-exchange contact with an explosive rivet, two metallic leads insulated from one another and connected to said heating element and characterized by a considerably greater degree of electrical conductivity than the heating element, and a finger-operable switch near the extremity opposite to the heating element, said means external to the heating unit comprising means for connection to a source of high-voltage alternating current and a transformer, the entire apparatus being so connected electrically that the closing of the switch in the portable heating unit causes the primary, high-voltage current to flow to the primary coil of the transformer and the resulting secondary low-voltage current of relatively high amperage to pass through the heating element of the heating unit, whereby an intense localized heating effect results in the tip of said element.

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