Dec. 30, 1958 L. C. MILLER 2,866,880

CLAMP FIXTURE FOR WATER-COOLED INDUCTION COIL

Filed March 21, 1957 3 Sheets-Sheet 1

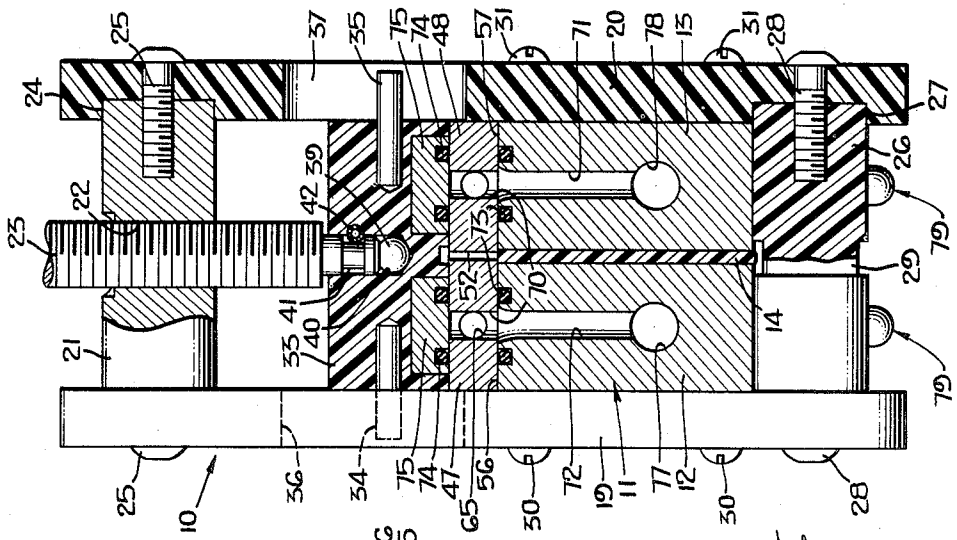


FIG. 3.

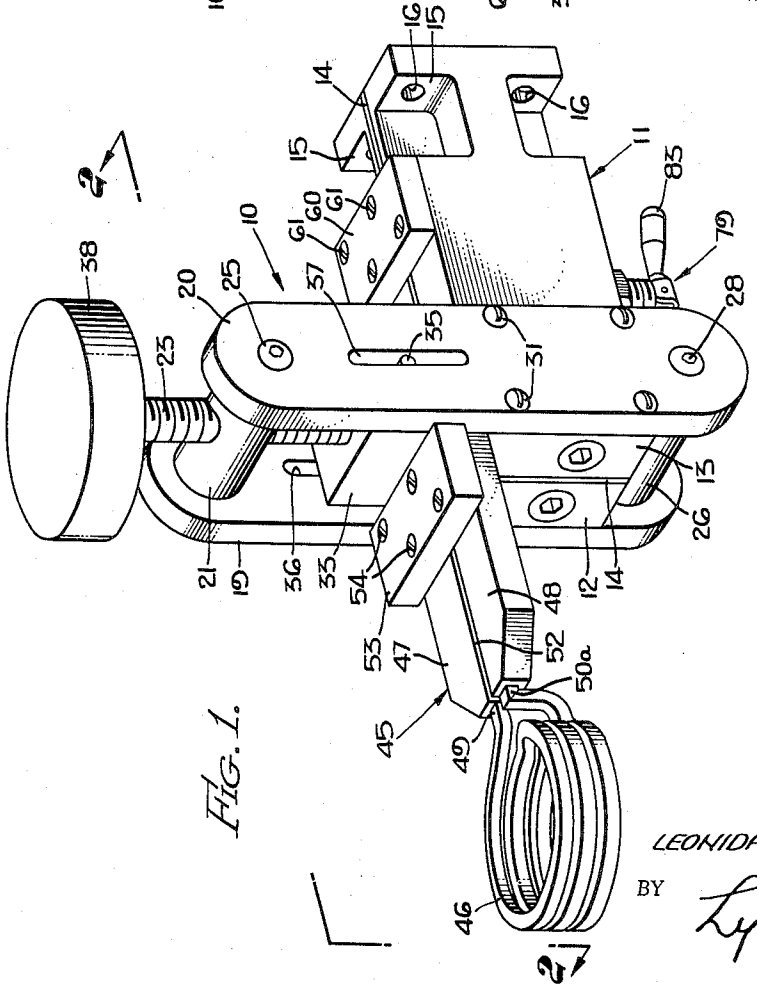


FIG. 1.

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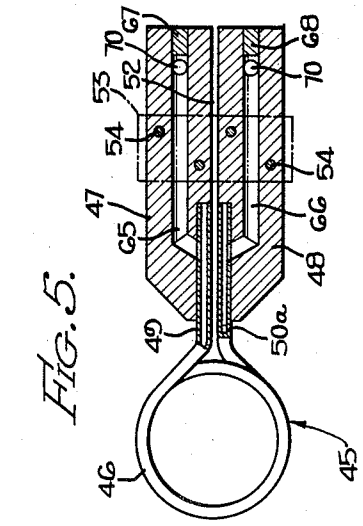


FIG. 5.

FIG. 2.

FIG. 4.

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CLAMP FIXTURE FOR WATER-COOLED INDUCTION COIL

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FIG. 9.

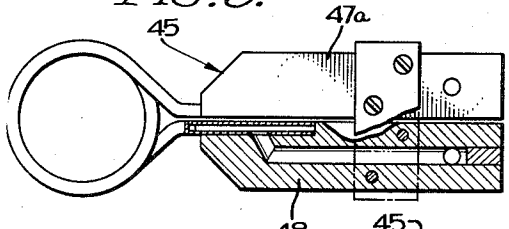


FIG. 6.

FIG. 7.

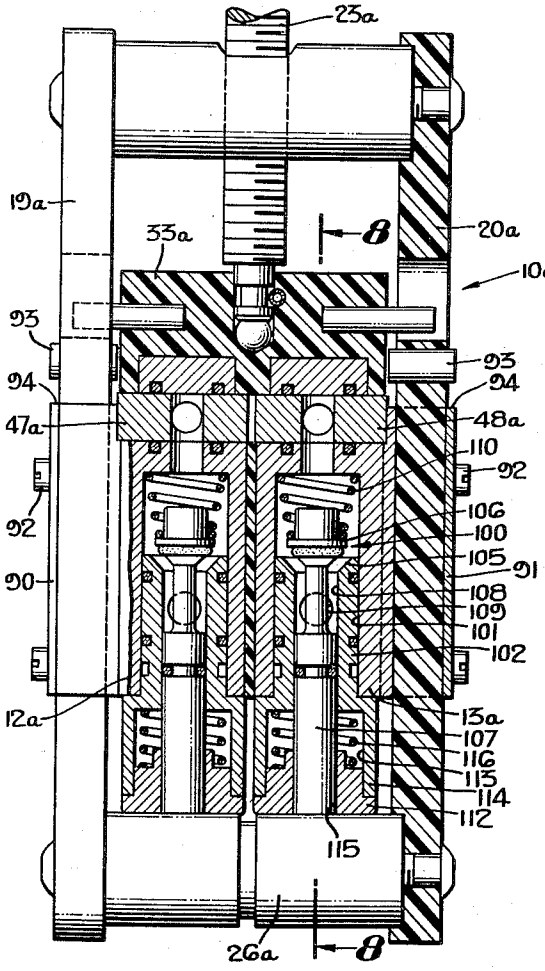
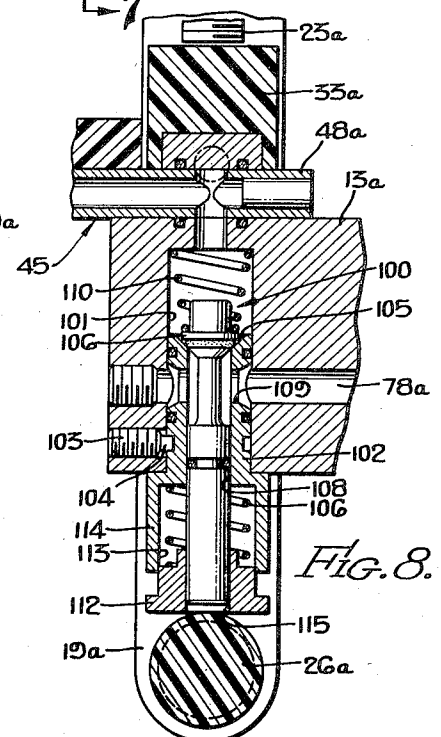


FIG. 8.



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United States Patent Office 2,866,880 Patented Dec. 30, 1958

2,866,880

CLAMP FIXTURE FOR WATER-COOLED INDUCTION COIL

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Application March 21, 1957, Serial No. 647,686

20 Claims. (Cl. 219—10.49)

This invention relates to induction heating apparatus and is particularly directed to improvements in supporting a water-cooled induction coil.

Induction heating machines are commonly provided with electrical terminal blocks for delivery of high frequency electrical energy to an induction heating coil. It is an important object of my invention to provide an improved form of clamp fixture to be mounted on the terminal blocks of such induction heating machine and to provide a novel means for releasably supporting the induction heating coil.

Induction heating coils are generally formed of metal tubing so that they may readily be water-cooled. It is important that the water or other coolant be continuously circulated through the coil whenever the coil is electrically energized, in order to prevent damage to the coil by overheating. Accordingly, it is another feature of my invention to provide a novel clamping apparatus which not only supports the inducting heating coil with proper electrical contact but also provides the necessary connections for circulating a coolant through the turns of the coil.

Another object is to provide a clamp fixture for a water-cooled induction coil having optimum electrical characteristics.

Another object is to provide a device of this type having valve-controlled coolant passageways provided in the support fixture.

Another object is to provide a device of this type in which valves controlling the flow of coolant are actuated by the same member which clamps the induction coil asssembly relative to the fixture.

Another object is to provide a device of this type which permits the induction coil assembly to be mounted on the fixture in either upright or inverted position.

Other and more detailed objects and advantages will appear hereinafter.

In the drawings:

Figure 1 is a perspective view showing a preferred embodiment of this invention.

Figure 2 is a sectional elevation thereof taken substantially along the lines 2—2 as shown in Figure 1.

Figure 3 is a transverse sectional elevation taken substantially on the lines 3—3 as shown in Figure 2.

Figure 4 is a fragmentary view similar to a portion of Figure 2, showing a shut-off valve in open position.

Figure 5 is a sectional plan view of induction heating coil assembly, taken substantially on the lines 5—5 as shown in Figure 2.

Figure 6 is a side elevation partly in section, showing a modified form of this invention.

Figure 7 is a sectional elevation taken substantially on the lines 7—7 as shown in Figure 6.

Figure 8 is a sectional elevation taken substantially on the lines 8—8 as shown in Figure 7.

Figure 9 is a sectional plan view taken substantially on the lines 9—9 as shown in Figure 6.

Referring to the drawings, the clamp fixture generally

designated 10 includes a metallic body 11 which comprises a pair of metallic body sections 12 and 13 mounted in parallel back-to-back relationship and separated by relatively thin insulator 14. Each of the body sections is provided with a mounting flange 15 at one end having apertures 16. As shown in Figure 2, threaded elements 17 extend through these apertures and act to secure the flanges 15 in supporting contact with the terminals 18 of an induction heating machine, not shown.

Insulator straps 19 and 20 are fixed to the ends of the body sections 12 and 13 remote from the apertured flanges 15. A crossbar 21, also hereinafter referred to as a "first member," extends horizontally between the upper ends of the insulator straps 19 and 20. This crossbar is made of metal and is provided with a central threaded opening 22 for reception of the axial screw 23. The ends of the crossbar 21 are recessed into the insulator straps 19 and 20, as shown at 24. Threaded fastenings 25 hold the parts in position. A second crossbar 26 stands horizontally between the lower ends of the insulator straps 19 and 20 and is held in position by means of the recesses 27 and threaded fastenings 28. This crossbar 26, hereinafter referred to as a "second member," is formed of electrically insulating material and is provided with a central groove 29 in the vicinity of the insulating separator 14. Machine screws 30 secure the strap 19 to the body section 12 and, similarly, machine screws 31 secure the strap 20 to the body section 13. The lower crossbar 26 is thus maintained in contact with the lower surfaces of the body sections 12 and 13.

A slide block 33 formed of an insulating material is guided for longitudinal sliding movement between the straps 19 and 20 and moves in a direction toward and away from body sections 12 and 13. Oppositely extending horizontal pins 34 and 35 are fixed on the block 33 and travel in vertical guide slots 36 and 37, respectively, provided in the straps 19 and 20. The lower end of the screw 23 is connected to the block 33 and the upper end is provided with a handwheel 38. The connection between the screw 23 and the block 33 includes a ball bearing 39 mounted in the lower end of the central bore 40 in the block 33. The extreme lower end of the screw 23 is recessed to rest on the ball bearing 39. A groove 41 in the screw 23 receives a retaining pin 42 fixed on the block 33. From this description, it will be understood that the turning of the screw 23 by means of the handwheel 38 serves to raise and lower the clamping block 33 with respect to the body 11.

An induction coil assembly, generally designated 45, includes a coil 46, having several turns and preferably formed of copper tubing which is square in cross-section. Laterally spaced parallel metallic bars 47 and 48 are connected to end portions 49 and 50*a*, respectively, of the coil 46. The bars 47 and 48 comprise terminal pads and the upper and lower contact surfaces thereof, 50 and 51, lie in parallel planes. The bars and the terminal pads 47 and 48 are separated by an air gap 52 and are maintained in their laterally spaced relationship by means of a spacer 53 formed of insulation material and connected to the bars by means of fastenings 54.

The ends of the parallel bars 47 and 48 remote from the coil 46, are adapted to be received within a clamping space 55 defined between the upright straps 19 and 20 and between the block 33 and the upper surfaces 56 and 57 of the body sections 12 and 13. The spacer 53 extends laterally beyond the edges of the bars 47 and 48 to form an abutment engaging the straps 19 and 20 to limit movement of the terminal pads into the clamping space 55. The lower surface of the terminal pad 47 is held in surface contact with the upper surface 56 of the body section 12. Similarly, the lower surface of the

terminal pad 48 is held in surface contact with the upper surface 57 of the body section 13. Accordingly, an electrical path for high frequency electrical energy is provided from one of the apertured flanges 15 through the body section 12, terminal pad 47, coil 46, terminal pad 48, body section 13 and back to the other apertured flange 15. An insulated spacer block 60 may be secured to the body sections 12 and 13 by means of threaded fastening 61 and the spacer block assists in maintaining the insulator 14 in clamped position between the body sections 12 and 13.

The induction coil assembly 45 may be removed from the clamp fixture 10 by turning the handwheel 38 in the direction to raise the block 33 away from the body 11. Induction coil assembly 45 may then be withdrawn forwardly out of the clamping space 55. If desired, it may be inverted and then reinserted into the clamping space 55 so that the coil 46 is placed in a different position with respect to the body 11.

In order to prevent damage to the coil 46 by overheating, it is essential to circulate a coolant through the interior of the tube forming the coil. This is accomplished by providing passages 65 and 66 which extend within the bars 47 and 48, respectively, and by providing ports which establish communication between the passage 65 and the end 49 of the coil tube and between the passage 66 and the end 50 of the tube. The ends of the passages 65 and 66 are closed by plugs 67 and 68. Ports 69 extend through the upper and lower contact surfaces of the bar or terminal pad 47 and communicate with the passage 65. Similarly, ports 70 extend through the upper and lower contact surfaces of the bar or terminal pad 48 and communicate with the passage 66.

The port 70 is adapted to be aligned with opening 71 provided in the body section 13 and extend to its upper surface 57. Port 70 is adapted for alignment with opening 72 formed in the body section 12. Seal rings 73 are provided on the body sections adjacent the surfaces 56 and 57 and encircling the openings 71 and 72. Similar seal rings 74 are mounted in insert pieces 75 provided on the block 33. The seal rings 73 and 74 engage the contact surfaces 50 and 51 of the terminal pad 47 and 48 to prevent leakage.

A passageway is provided in each of the body sections 12 and 13. The passageway 77 communicates with the opening 72 in the body section 12. Similarly, the passageway 78 communicates with the opening 71 in the body section 13. The passageways 77 and 78 are substantially identical and each is provided with a shut-off valve assembly 79 interposed between the ends thereof. A stationary downwardly facing seat 80 is provided on each body section and a movable valve 81 is adapted to close against the seat. A spring 82 urges the valve element 81 toward closed position against the seat 80 and a toggle lever 83 having a cam surface 84 acts on the valve stem to move the element 81 away from the seat 80. When the toggle lever 83 is in the position shown in Figure 2, the valve is closed, and when the lever is in the position shown in Figure 4, the valve is open. The passageways 77 and 78 extend through the apertured flanges 15 and are aligned with coolant openings 86 provided in the terminals 18 of the induction heating machine. Seal rings 87 are provided to prevent leakage. When the valves 79 are opened, a coolant such as water is circulated through the passageways in the body sections and through the terminal pads and coil on the induction heating coil assembly 45.

When it is desired to remove the assembly 45 from the fixture 10, the toggle levers 83 are manually actuated to close the valves 79 and the handwheel 38 is then turned to raise the block 33. The induction coil assembly 45 may then be withdrawn forwardly from the clamping space beneath the block 33. Some small leakage of coolant from the passages in the terminal blocks 47 and 48 and from the interior of the coil 46 may occur, but otherwise the coolant pressure system is shut off by the valves 79 so that no major amount of leakage occurs from the fixture 10. It will be observed that the seal rings 74 in the block 33 and the seal ring 73 in the body sections 12 and 13 prevent leakage of coolant when the terminal bars 47 and 48 are clamped in position, and this is true whether the coil assembly 45 is clamped in upright or inverted position.

In the modified form of my invention, shown in Figures 6–9, inclusive, the induction coil assembly 45 is identical to that previously described. The clamp fixture 10*a* is mounted on the terminals 18 of the induction heating machine in the same manner as described above, but the shut-off valves are actuated by the screw 23*a* and handwheel 38*a* instead of being manually actuated. The insulator straps 19*a* and 20*a* are slidably mounted on the body sections 12*a* and 13*a* by means of guide caps 90 and 91 fixed in place by threaded fastenings 92. Limit stops in the form of pins 93 engage shoulders 94 to limit downward movement of the straps 19*a* and 20*a* with respect to the body sections.

In this form of my invention, a valve assembly 100 is provided at the forward end of each of the body sections 12*a* and 13*a*. Since the valve assemblies are duplicates and function in the same manner, only one need be described. A vertical bore 101 in the body section 13*a* receives a stationary sleeve 102 which is fixed into position by means of a plug 103 having a projection 104. The upper end of this stationary sleeve 102 is provided with a valve seat 105. A movable valve element 106 closes against this seat and is carried on a valve stem 107 slidably mounted within the bore 108 of the sleeve 102. A lateral port 109 in the sleeve 102 communicates with the passageway 78*a* provided in the body section 13*a*. The valve element 106 is closed against the seat 105 by means of the spring 110.

A collar 112 is slidably received within the bore 113 of a skirt 114 provided on the stationary sleeve 102. The collar 112 has a bore 115 which slidably receives the valve stem 107. A compression spring 116 acts on the collar 112 to maintain it in contact with the crossbar 26*a* which is formed of insulation material and which connects the lower ends of the straps 19*a* and 20*a*. When the terminal pads 47*a* and 48*a* of the induction coil assembly 45 are clamped in position between the block 33*a* and the upper surfaces of the body sections 12*a* and 13*a*, the parts are in the positions shown in Figures 6 and 7 of the drawings. The lower ends of the valve stems 107 engage the crossbar 26*a*, thereby lifting the valve elements 106 away from the seats 105, permitting flow of coolant. When it is desired to remove the induction coil assembly 45 from the clamp fixture 10*a*, the handwheel 38*a* is manually actuated to turn the screw 23*a*. The force of the springs 116 acting through collars 112 against the crossbar 26*a* causes the straps 19*a* and 20*a* to move downward with respect to the body sections 12*a* and 13*a* as the screw 23*a* is turned. Continued turning movement of the screw 23*a* brings the parts to the position shown in Figure 8, with the valve elements 106 closed against the seats 105. Further turning movement of the screw 23*a* brings the limit stops 93 into engagement with the shoulder 94 and thereafter raises the block 33*a* away from the body sections 12*a* and 13*a* to permit withdrawal of the induction coil assembly 45. Conversely, turning of the handwheel 38 in a direction to clamp the induction coil 45 in position serves first to clamp the terminal pads 47*a* and 48*a* and then subsequently opens the valves to permit coolant to flow. This is a safety feature since it avoids overheating of the induction coil assembly 45 by inadvertent failure to open the coolant valves prior to energizing the coil electrically.

Having fully described my invention, it is to be understood that I do not wish to be limited to the details

set forth, but my invention is of the full scope of the appended claims.

I claim:

1. In a device of the class described, the combination of: a metallic body comprising a pair of spaced parallel body sections, means on the body whereby it may be connected to a support, a member fixed relative to the body and provided with an opening, an axial screw extending through the opening, a block guided for movement relative to the body and engaged by the screw, an induction coil assembly provided with laterally spaced parallel terminal pads having co-planar contact surfaces, each terminal pad being adapted to have surface contact with one of said body sections, respectively, whereby the terminal pads may both be removably clamped between the body sections and said block by means of said screw.

2. Apparatus set forth in claim 1 in which the terminal pads each have parallel surfaces to permit the induction coil assembly to be inverted with respect to the metallic body.

3. Apparatus set forth in claim 1 wherein coolant passages are provided in the body sections and connected with coolant passageways provided in the terminal pads.

4. In a device of the class described, the combination of: a metallic body comprising a pair of spaced parallel body sections; means at one end of each body section whereby it may be releasably connected to a support, parallel straps at the other end of the body, one secured to each body section, a member extending between projecting ends of the straps and provided with an opening, an axial screw extending through the opening, a block guided for movement between the straps and engaged by the screw, an induction coil assembly provided with laterally spaced parallel terminal pads having coplanar contact surfaces, the terminal pads being insertable into a space defined between the straps with a contact surface of each terminal pad in surface contact with one of said body sections, respectively, whereby the terminal pads may both be removably clamped between the body sections and said block by means of said screw.

5. Apparatus set forth in claim 4 in which the terminal pads each have parallel surfaces to permit the induction coil assembly to be inverted with respect to the metallic body.

6. Apparatus set forth in claim 4 wherein coolant passages are provided in the body sections and connected with coolant passageways provided in the terminal pads.

7. In a device of the class described, the combination of: a metallic body comprising a pair of parallel body sections having an insulator element clamped therebetween, mounting means at one end of each body section whereby it may be releasably connected to a terminal of an induction heating machine, parallel insulator straps at the other end of the body, one secured to each body section, a member extending between projecting ends of the straps and provided with a threaded opening, an axial screw engaging within the threaded opening, a block guided for movement between the straps and engaged by the screw, an induction coil assembly provided with laterally spaced parallel terminal pads, a spacer element extending between the terminal pads, the terminal pads being insertable into a space defined between the straps with each terminal pad in surface contact with one of said body sections, respectively, whereby the terminal pads may be removably clamped between the body sections and said block by means of said screw, the spacer element forming an abutment to limit movement of the terminal pads into said space.

8. Apparatus set forth in claim 7 in which the terminal pads each have parallel surfaces to permit the induction coil assembly to be inverted with respect to the metallic body.

9. Apparatus set forth in claim 1 wherein coolant passages are provided in the body sections and connected with coolant passageways provided in the terminal pads.

10. In a device of the class described, the combination of: a metallic body comprising a pair of spaced parallel body sections, support means at one end of each body section whereby it may be connected to one of the terminals of an induction heating machine, a block guided for longitudinal movement toward and away from the body sections, an induction coil assembly including a pair of laterally spaced parallel metallic bars comprising terminal pads, the terminal pads being adapted to be removably clamped between the body sections of said block in either of two positions 180° apart, each metallic bar having a coolant passageway therein and communicating ports extending to opposed surfaces of the terminal pads, each body section having a coolant passageway therein and a communicating opening extending to a surface thereof, and seal means on the block and on the body sections adapted to prevent leakage adjacent the ports in either position of the terminal pads.

11. In a device of the class described, the combination of: a metallic body comprising a pair of spaced parallel body sections, support means at one end of each body section whereby it may be connected to one of the terminals of an induction heating machine, a block guided for longitudinal movement toward and away from the body sections, an induction coil assembly including a pair of laterally spaced parallel metallic bars comprising terminal pads, the terminal pads having parallel contact surfaces lying in parallel planes, so that the induction coil assembly is adapted to be removably clamped between the upper surfaces of the body sections and said block in either upright or inverted positions, each metallic bar having a coolant passageway therein and communicating ports extending to said opposed contact surfaces of the terminal pads, each body section having a coolant passageway therein and a communicating opening extending to the upper surface thereof, and seal means on the block and on the body sections adapted to prevent leakage adjacent the ports in either position of the induction coil assembly.

12. In a clamp device adapted to be secured to the terminals of an induction heating machine and adapted to support an induction coil assembly, the combination of: a metallic body comprising a pair of laterally spaced parallel body sections, support means at one end of each body section whereby it may be connected to one of the terminals of the induction heating machine, parallel insulator straps at the other end of each body section, one secured to each body section, a first member extending between projecting ends of the straps above the body sections and provided with a threaded opening, an axial screw engaging within the threaded opening, a block guided for longitudinal movement between the straps and engaged by the screw, a second member extending between the straps below the body sections, the straps, block and upper surfaces of the body sections defining a clamping space for reception of one end of an induction coil assembly.

13. In a clamp device adapted to be secured to the terminals of an induction heating machine and adapted to support an induction coil assembly, the combination of: a metallic body comprising a pair of laterally spaced parallel body sections, support means at one end of each body section whereby it may be connected to one of the terminals of the induction heating machine, parallel insulator straps at the other end of each body section, one secured to each body section, a first member extending between projecting ends of the straps above the body sections and provided with a threaded opening, an axial screw engaging within the threaded opening, a block guided for longitudinal movement between the straps and engaged by the screw, a second member extending between the straps below the body sections,

the straps, block and upper surfaces of the body sections defining a clamping space for reception of one end of an induction coil assembly, and coolant passage means on each body section communicating with said clamping space.

14. In a coil assembly clamp device adapted to be secured to the terminals of an induction heating machine and adapted to support an induction coil assembly, the combination of: a metallic body comprising a pair of spaced parallel body sections, support means at one end of each body section whereby it may be connected to one of said terminals, a block guided for longitudinal movement toward and away from said body sections, the block and upper surfaces of the body sections defining a clamping space for reception of one end of an induction coil assembly, each body section having an opening communicating with said clamping space, and each body section having a coolant passage extending from the flange to said opening.

15. In a coil assembly clamp device adapted to be secured to the terminals of an induction heating machine and adapted to support an induction coil assembly, the combination of: a metallic body comprising a pair of spaced parallel body sections, support means at one end of each body section whereby it may be connected to one of said terminals, a block guided for longitudinal movement toward and away from said body sections, the block and upper surfaces of the body sections defining a clamping space for reception of one end of an induction coil assembly, each body section having an opening communicating with said clamping space, and each body section having a coolant passage extending from the flange to said opening, and a manually operable shut-off valve on each body section interposed in its respective coolant passage.

16. In an induction coil assembly, the combination of: a pair of laterally spaced parallel metallic bars comprising terminal pads, the terminal pads having contact surfaces lying in the same plane, a coil having at least one turn and formed from a tube, each end of the tube being joined to an end of one of the metallic bars, respectively, each bar having a coolant passage extending longitudinally thereof and communicating with its respective tube end, and each bar having a lateral port communicating with its coolant passage and extending through its respective contact surface.

17. In an induction coil assembly, the combination of: a pair of laterally spaced parallel metallic bars comprising terminal pads, the terminal pad each having parallel contact surfaces, each contact surface on one pad being co-planar with a contact surface on the other pad a coil having at least one turn and formed from a tube, each end of the tube being joined to an end of one of the metallic bars, respectively, each bar having a coolant passage extending longitudinally thereof and communicating with its respective tube end, and each bar having a lateral port communicating with its coolant passage and extending through at least one of said parallel contact surfaces.

18. In an induction coil assembly, the combination of: a pair of laterally spaced parallel metallic bars comprising terminal pads, the terminal pads being rectangular in cross-section and each having parallel contact surfaces, each contact surface on one pad being co-planar with a contact surface on the other pad a coil having at least one turn and formed from a tube each end of the tube being joined to an end of one of the metallic bars, respectively, each bar having a coolant passage extending longitudinally thereof and communicating with its respective tube end, and each terminal pad having oppositely extending lateral ports communicating with its coolant passage and extending through both of its respective contact surfaces.

19. In a device of the class described, the combination of: a metallic body comprising a pair of spaced parallel body sections, a block guided for longitudinal sliding movement relative to the body sections, an induction coil assembly having laterally spaced portions clamped between the block and the body sections, each body section having a coolant passageway communicating with a coolant passage in the induction coil assembly, a shut-off valve assembly on each of the body sections controlling flow through each of said passageways, each valve assembly having a movable valve element, and common means for moving the block and said valve elements in order to clamp the induction coil assembly in place and to open the valve assemblies.

20. In a device of the class described, the combination of: a metallic body comprising a pair of spaced parallel body sections, parallel insulator straps slidably mounted on the body sections, a first member extending between projecting ends of the straps above the body sections and provided with a threaded opening, an axial screw engaging within the threaded opening, a block guided for longitudinal movement between the straps and engaged by the screw, a second member extending between the straps below the body sections, the straps, block and upper surfaces of the body sections defining a clamping space, an induction coil assembly having laterally spaced portions projecting into the clamping space, each body section having a coolant passageway communicating with a coolant passage in the induction coil assembly, a shut-off valve assembly on each of the body sections controlling flow through each of said passageways, each valve assembly having a movable valve element actuated by said second member, whereby turning of the screw serves to clamp the induction coil assembly in place and to open the valve assemblies.

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