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[54] IMMERSION HEATER ELEMENT

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[51] **Int. Cl.** **H05b 3/06**

[58] **Field of Search** 219/523, 335–336, 219/381, 536, 541–542, 548, 550, 552–553; 338/274, 231, 296

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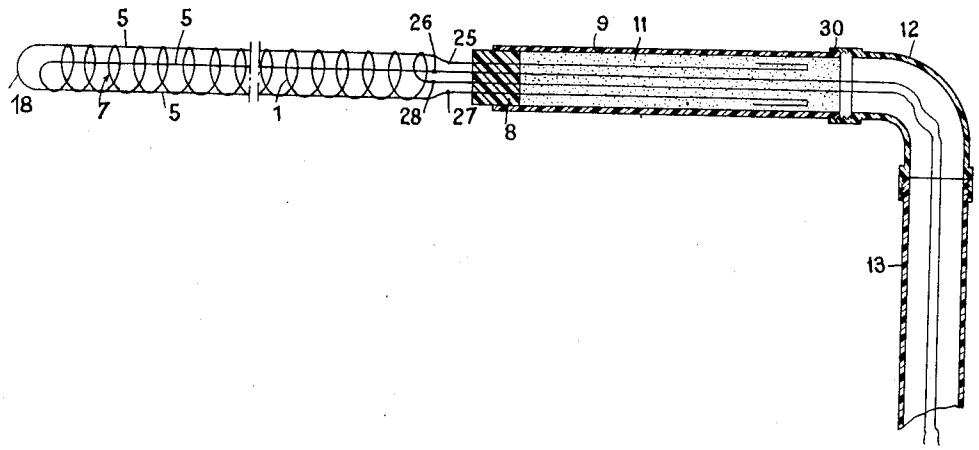
[57] **ABSTRACT**

An immersion heater comprising essentially a coil obtained by winding coilwise cable sections adapted to heat in their central portions and remain cold at their ends, and a tube containing the cold outlets of said coil and of a connector for securing the immersion heater to the edge of the vessel containing the fluid to be heated is characterized in that the turns of the coil are supported by flexible and resistant longitudinal rodlike elements assembled on the same side of the coil as the cold ends thereof, and sealed in the outlet tube. This immersion heater further comprises an electrical relay following the fastening connector. The coil and tube assembly is housed in an insulating sheath formed with slots.

4 Claims, 5 Drawing Figures



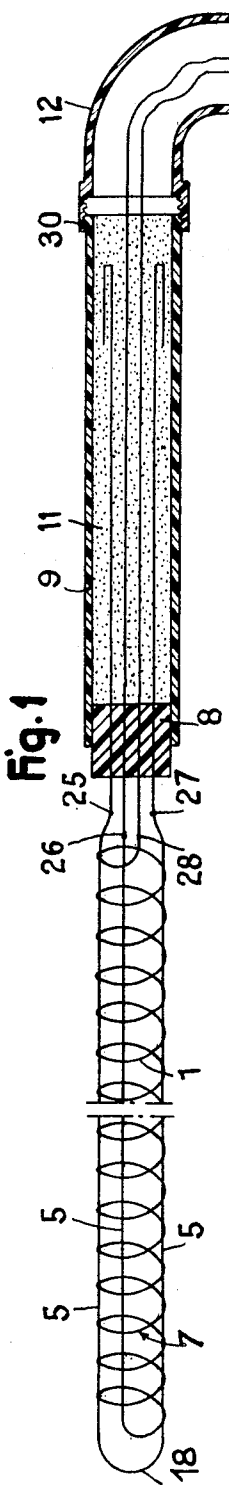


Fig.1

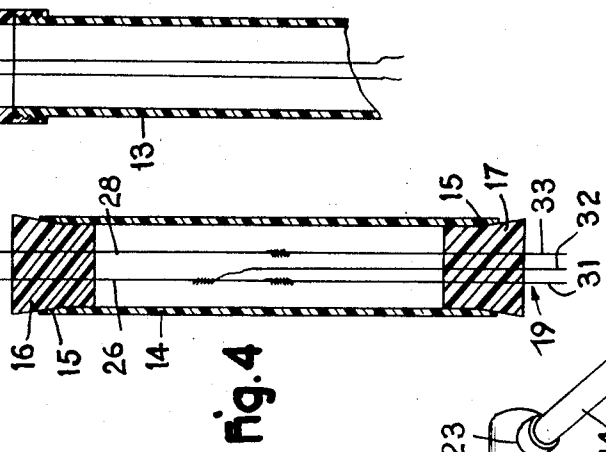


Fig.4

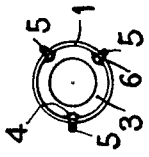


Fig.3

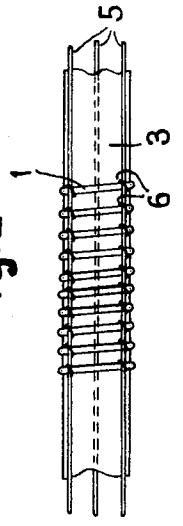


Fig.2

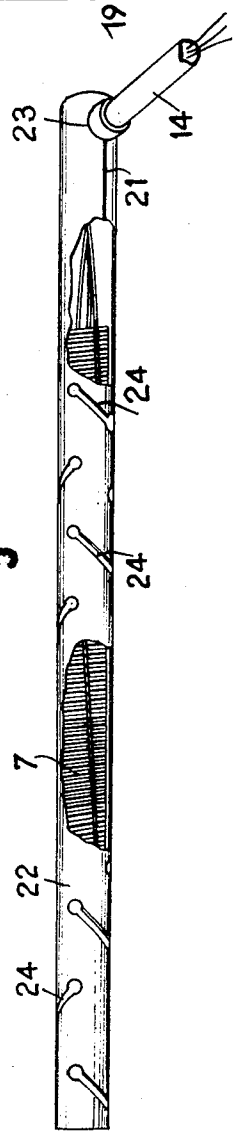


Fig.5

IMMERSION HEATER ELEMENT

SUMMARY OF THE INVENTION

The present invention relates to immersion heaters or heating plungers of the type utilizing insulated heating cables or conductors adapted to emit heat by Joule effect under well-defined conditions of operation, so as to avoid any damage to the insulating material, these devices comprising cold conductors, i.e. outlets of which only the central section is heated appreciably, the ends being scarcely heated or remaining cold along a more or less extended portion.

An immersion heater according to this invention comprises essentially a cold-outlet heating cable wound coilwise to constitute a coil of which the turns are interconnected by longitudinal rods, by using an adequate fastening or tying wire. Said rods may consist of the side branches of hairpin-like members of which at least one acts as a non-heating return end element of the heating cable. These rods and cable returns are connected to the same or common end of the coil.

A device for mechanically assembling these non-heating ends of the cable and the rods associated therewith comprises a tube provided at its inlet end with a plug of elastomeric material, through which said ends are caused to extend, said tube being filled for sealing purposes with a suitable holding compound or material.

A hollow elbow connects this tube to a device for securing the immersion heater or plunger to the edge of the vessel containing the liquid to be heated and also for protecting the cold outlets of the heating cable.

This elbow is connected in turn to an insulating tube receiving the cable outlets or a fluid-tight electrical relay device which permits connecting in a tight manner a multiple-conductor cable having a plastic or rubber insulation of any suitable commercial type. The sealing effect involving the electrical insulation under any weather conditions is obtained by using suitable perforated elastomer plugs at the end of this tube.

A plastic tube protection sheath device formed with suitable perforations is centered with respect to the coil by said rods so as to preclude any direct contact between said protection sheath device and said coil.

BRIEF DESCRIPTION OF THE DRAWING

A preferred form of embodiment of the immersion heater according to this invention will now be described with reference to the accompanying drawing, in which:

FIG. **1** is a diagrammatic elevational view with parts broken away showing the heating section and the non-heating section of the device, with the connecting means thereof;

FIG. **2** is an elevational fragmentary view showing one portion of the heating section of the device during the assembling operation;

FIG. **3** is a corresponding end view;

FIG. **4** is a fragmentary axial section showing a relay for connecting the device to the supply cable;

FIG. **5** is a fragmentary elevational view, with parts broken away, showing the immersion heater of this invention without the relay of FIG. **4**.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The immersion heater according to this invention comprises essentially a cable **1** wound to form helical turns on a cylindrical mandrel **3** comprising a number of longitudinal grooves **4** disposed at spaced intervals on its outer surface, the exemplary form of embodiment illustrated comprising three grooves **4** spaced 120° from one another. Preferably, the cable is of the heating type with cold outlets, all the heating section and a small non-heating section of this cable being wound to constitute a heating coil **7**. Then, a longitudinal rod **5** of different material but capable of resisting chemical agents, such as a steel wire coated with a plastic film by extrusion or threading, is so disposed as to register with each groove **4** and secured in position by temporary means. Then, by operating according to

the methods of commercial basketwork technique, facilitated by the presence of said grooves **4**, the rods **5** may be secured to the cable **1** at each intersection obtained therebetween, for example by using a wire **6** consisting either of a monofilament of suitable plastic material, i.e. heat-resistant and insensitive to chemical agents, or a wire sheathed with suitable plastic material, or any other material such as glass fiber yarn, with or without protection coating or the like.

According to an application of current commercial type the following dimensions have been used: diameter of mandrel 3 = 28 mm; diameter of cable 1 = 3.8 mm; diameter of rods 5 = 3 mm; diameter of wire 6 = 1 mm, and length of cold outlet = 10 cm.

The order of magnitude of the cable diameter, for example within the range of 2.5 to 5 mm, is essential for the purpose of the present invention, for:

- if a smaller diameter were used, the step of bending the cable **1** on rods **5** would lead to prohibitive cost and complication;
- if a larger diameter were used, the cable **1** would not accommodate radii of curvature permitting the production of immersion heaters having suitable over-all dimensions;
- if different diameters were used, the temperature gradient from the core to the outer periphery would be changed and become remote from the ideal proportion existing between the primary insulation of the cable: 260° C, and the secondary insulation : 205° C.

If the rod **5** consists of a plastic-coated wire, it is preferable to keep the ends of this wire outside the fluid to be heated in order to avoid the attack of the branches by chemicals. The rods **5** may advantageously consist of an even number of rectilinear sections interconnected at their ends by continuous curves, i.e. hairpins **18**, without any discontinuity in their protection.

At a same end of the coil thus obtained the two ends **26**, **28** of the heating cable and the ends **25**, **27** of rods are assembled, the third rod **5** consisting of a non-heating return of the heating cable. Thus, the two ends **26**, **28** of cable **1** and the two ends **25**, **27** of the hairpin are assembled at one end of said coil.

The advantages deriving from this arrangement may be summarized as follows: firstly, it ensures a strict control of the relative spacing of the various cable sections, without allowing these sections to contact one another, while maintaining them sufficiently close to each other to spare space. It also avoids unduly large contact areas with the cable supports that are not heat conductive, as would be the case if the cable were wound directly for example on a tube of plastic material; in fact, in this case abnormal heating would take place and prove detrimental to the useful life of the cable insulation at these points of contact, and thus interfere with the circulation or renewal of the liquid around the cable. In all cases, these points of contact must be reduced to a minimum.

Another advantage deriving from this device is that all the cable surface is perfectly and easily accessible, this feature being particularly valuable for cleaning purposes; in fact, this characteristic although quite obvious as far as the outer surface of the coil is concerned, is also useful for the inside, which, after the mounting mandrel **3** has been removed by slipping, appears as a hollow cylindrical body of circular cross-section which, owing to its particular dimensions, is easily accessible for cleaning purpose by using a circular brush of suitable dimensions.

These features are of primary importance for it is known in the art that the heating elements immersed in certain fluids, such as those of bright nickel, for instance, become regularly coated with a muddy deposit which must compulsorily be removed at suitable time intervals. On the other hand in this respect it may be pointed out that if the heating cable has been properly made these deposits, given an equal heating power, are reduced considerably in comparison with conventional heating devices of the immersion type, notably in that they do not adhere to the cable. However, the cable must be so ar-

ranged that an inspection and a light cleaning operation by means of soft brushing elements be nevertheless feasible without difficulty.

A third advantage of this device is that it permits a very easy and efficient external protection of the coil assembly by introducing this coil for example into a plastic tube **22** of suitable diameter (see FIG. **5**). This tube may be of commercial type, such as an overchlorinated P.V.C., having well known properties as far as the resistance to thermal and chemical agents and effects are concerned. In fact, for current commercial use this protection is particularly desirable against the mechanical actions to which an immersion heater is compulsorily exposed in a manufacturing workshop. However, as in the above-mentioned case of cable supports, this protection should not involve any interference as far as the renewal of the fluid to be heated by contact with the cable is concerned, otherwise the cable would be damaged. The presence of the above-defined rods **5** or hairpins **26** interposed between the inner wall of the protection plastic tube and the outer surface of the turns of the heating cable coil will preserve the cable against any detrimental contact.

FIG. **1** illustrates a device constituting the outlet of coil **7**. The "cold" outlets **26, 28** of the cable and the ends **25, 27** of the hairpins or their equivalents extend through a sealing plug **8** of plastic elastomer or like material formed with holes of suitable diameter and secured to the inner wall of a plastic tube **9**. The ends of the hairpins may be curved in order to ensure a safer mechanical anchorage thereof. Only the non-heating ends of cable **1** emerge therefrom. By properly selecting the dimensions of these elements it is possible, by using a tapered perforated plug **8** and a tapered lower portion of tube **9**, to safely wedge the plug in the tube to seal the assembly at this level. The plug **8** may consist for instance of moulded plasticized P.V.C. or like elastomer, or special rubber compositions, or halogenated or non-halogenated polyolefines. The tube **9** may consist of over-chlorinated P.V.C., or halogenated or non-halogenated polyolefines.

An adhesive or filling and fastening substance **11** may then be introduced into the tube for mechanically securing, on setting, the above-described assembly and provide an additional sealing effect between the cable ends, the plastic tube **9** and the bent ends **5** of the longitudinal rods or hairpins **25, 27**.

This product **11** may consist of a cement capable of resisting to the attack of chemical substances, such as a resin polymerizing in the cold state by catalysis, with or without the addition of a filler, or a known cable compound (pitch), or any other filling substance capable of providing at the same time the fluid-tightness, protection against chemical agents and exerting a mechanical assembling action.

The end **30** of plastic tube **9** may be screw-threaded and a plastic hollow elbow **12** may be screwed thereto; alternatively, cemented elbows may be used.

To the other end of elbow **12** another plastic tube **13** may be screwed or cemented in turn, as shown in FIG. **1**, for acting both as a support and as a means for fastening the immersion heater to the edge of the vessel containing the fluid to be heated, and also for protecting the cold outlets of the heating cable.

In lieu of this tube **13**, a fluid-tight electrical relay (FIG. **4**) may be secured to the outlet or rear end of tube **9**, between the cold ends **26, 28** of heating cable **1** and the conductors of a multiple-conductor cable **31, 32, 33**. This relay, having a predetermined length, for instance 20 cm (8 inch) consists of a plastic tube **14** machined internally to have a slightly tapered wall at either end **15**. Plugs **16, 17** of suitable elastomeric material, such as moulded plasticized P.V.C. or special rubber compositions, are then forced into the ends of tube **14** so that the desired sealing effect is obtained by wedging. These plugs are formed with a sufficient number of holes of suitable dimensions for the passage, through one plug, for example of the two cold outlets **26, 28** of the heating cable, and through the other plug, for example of the three conductors **31, 32, 33** of the outlet cable. After making the electrical connections, the tube **14** and perforated plugs **16, 17** are moved to their operative position by slipping along it the electrical conductors, and wedged in the tube ends in order to seal the assembly and provide a reliable insulation in workshops where the relay is exposed to all kinds of attacks by the corrosive atmosphere and to splashing with noxious chemicals. It may be noted that with certain coating of the heating cable such as halogenated polyolefines any adherence is safely precluded, so that also any sealing effect is also avoided except by the resilient tightening of an elastomeric body. The chief advantages of this relay are a complete inertia or protection against all the above-mentioned attacks, in contrast to what is currently observed with most existing relays. A fluid-tightness providing an absence of electrical leakages which is usually obtained by using materials considerably more expensive but without the same properties of insensitivity to chemically noxious atmospheres. If desired, the fluid-tightness may be further improved by casting into the tube **14** of FIG. **4** a suitable commercial product such as pitch, cable compound, a special rubber composition, a suitable resin, etc., before closing the tube.

The use of adequately tight relays under frequently severe service conditions in electrochemical workshops permits avoiding the use of heating cables having abnormally long cold outlets which would obviously be very expensive, since the cold outlet, by definition, must have the same insulation as the heating section of the cable. However, it permits transferring as far as desired away from the working place proper of the immersion heater any electrical connection to be made in the workshop where the heater is actually to be used.

The coil **7**, outlet tube and relay **14** (FIG. **5**) are covered with a suitable protection tube **22** slipped thereon.

A slit **21** of sufficient length is formed at one end in the protection tube **22** together with a hole **23** of a diameter corresponding to the outer diameter of the elbow **12**; the protection tube **22** is thus secured very simply in position by slipping the coil **7** into it. The function of slit **21** is to permit the resilient expansion of the protection tube **22** for introducing the elbow **12** or the tube **13** or alternately the tube **14** into the hole **23**. Slots **24** permitting an easy renewal of the fluid within the tube **22** from the fluid circulating externally in the vessel are also formed at spaced intervals along this tube.

An extension of the above-described devices may be used in case it is desired to supply balanced three-phase current to the immersion heater. In this case three identical cables having suitable electrical properties are wound simultaneously and in parallel relationship into a single coil. The three cold outlets thus obtained at the end of the coil may then be bent to emerge from the opposite end as substitutes for the three rods **5**, and under these conditions, if desired, other hairpins of coated wire for the additional rods **5** may be dispensed with. In the dimensional example given hereinabove the perforated plug **8** will then comprise six holes for the cable ends but no holes for other rods **5**. The perforated plug **16** is also provided with six holes. Thus, inside the tube **14**, which may still be merged into the tube **13**, the electrical connection may comprise a balanced three-phase, star-delta circuit leading from the supply network through the multiple-conductor cable.

What I claim is:

1. An immersion heater comprising an insulated heating cable comprising a major heating portion of resistance wire and opposite end portions of non-heating conductive wire, said heating cable being wound into a helical coil with spaced turns, an insulated support rod bent in hairpin shape with opposite legs connected by a bend, said legs extending lengthwise of said coil and said bend extending beyond one end of said coil, means securing the turns of said coil to said legs, end portions of said legs and said non-heating end portions of said cable extending from the end of said coil opposite said bend, a plastic tube receiving said end portions of said legs and said non-heating end portion of said cable, setable insulating material embedding said end portions of said legs, said non-heating end portions of said cable in said plastic tube

and lead wires connected to said non-heating end portions of said cable to supply electric current thereto, and a plastic stopper closing the end of said plastic tube nearest said coil, said stopper having holes therethrough for said and portions of said legs and said non-heating and portions of said cable.

2. An immersion heater according to claim 1, comprising a second plastic tube section and a plastic elbow connecting said second tube section to said first-mentioned plastic tube.

3. An immersion heater according to claim 2, comprising relay means disposed in said second plastic tube section and connected to said heater cable, and means sealing said relay means in said second plastic tube section.

4. An immersion heater according to claim 1, comprising an electrically insulating protection tube fitting over said coil and having spiral slots therein.

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