Aug. 7, 1928. 1,679,730

A. S. MACDONALD ET AL

ELECTRICAL HEATING APPARATUS AND METHOD

Filed July 17, 1923 3 Sheets-Sheet 1

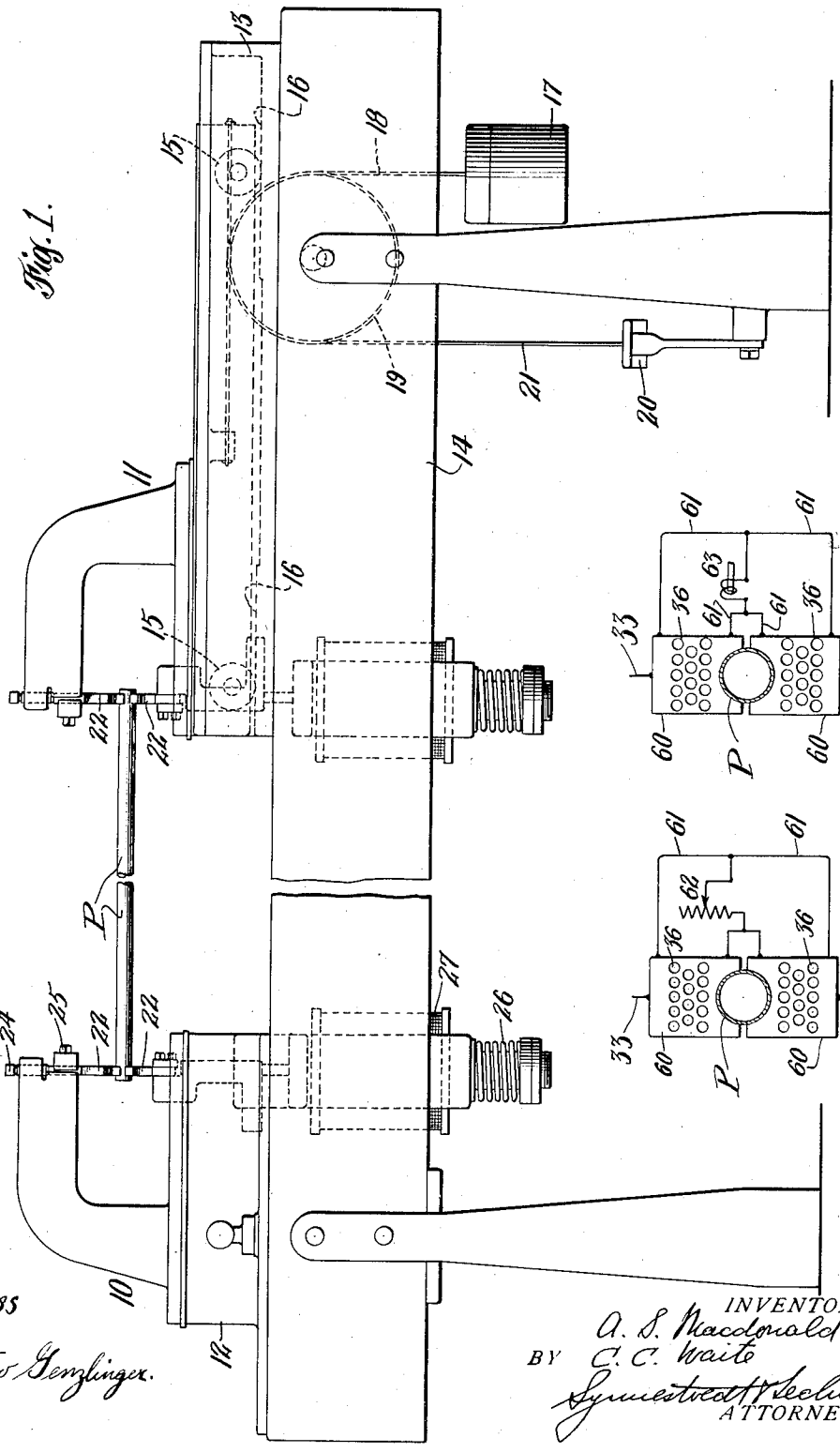


Fig. 1.

Fig. 10.

Fig. 9.

WITNESS

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ELECTRICAL HEATING APPARATUS AND METHOD

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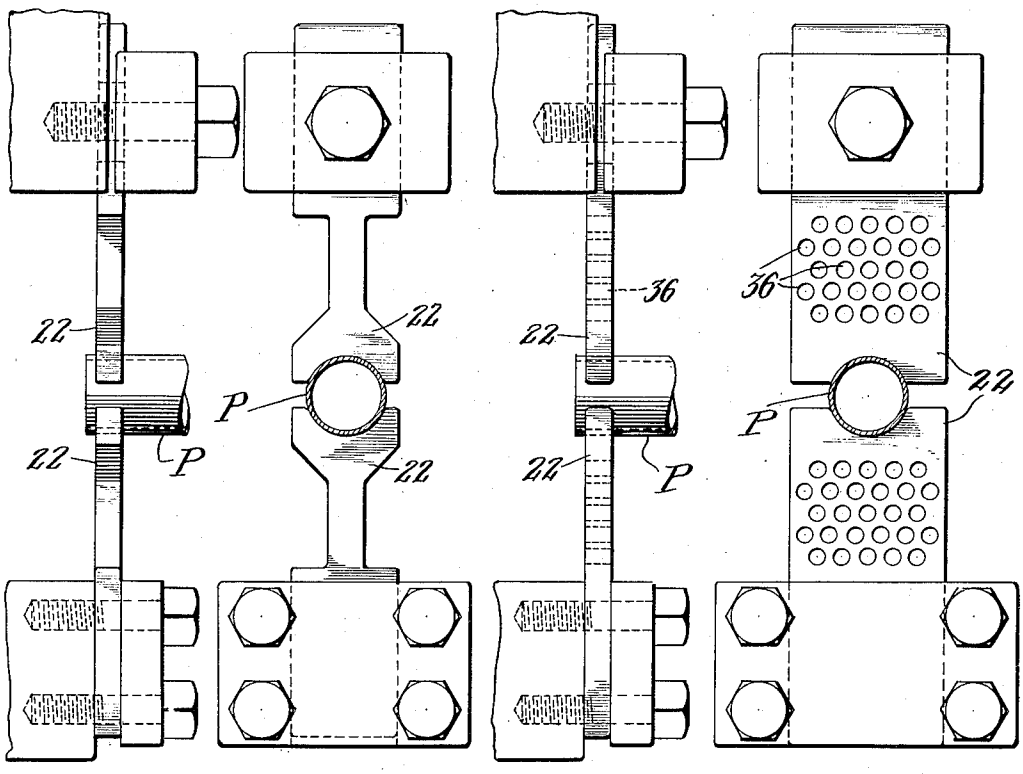


Fig. 3. Fig. 4. Fig. 5. Fig. 6.

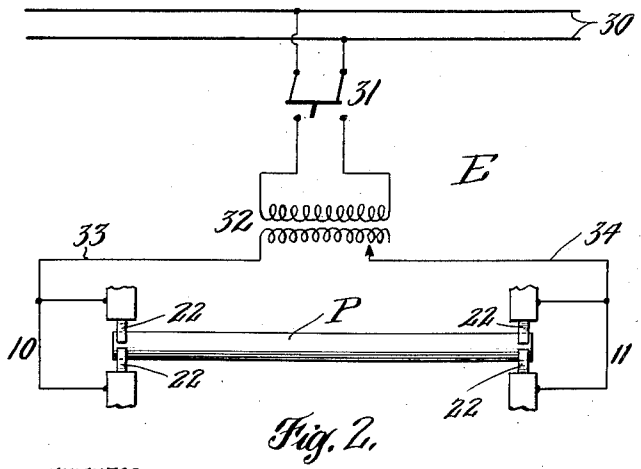


Fig. 2.

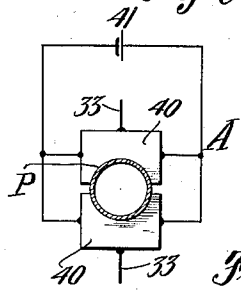


Fig. 7.

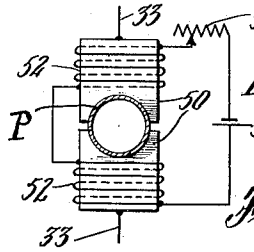


Fig. 8.

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ELECTRICAL HEATING APPARATUS AND METHOD

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Fig. 11.

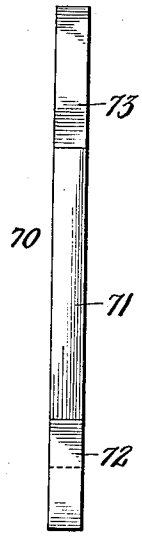


Fig. 12.

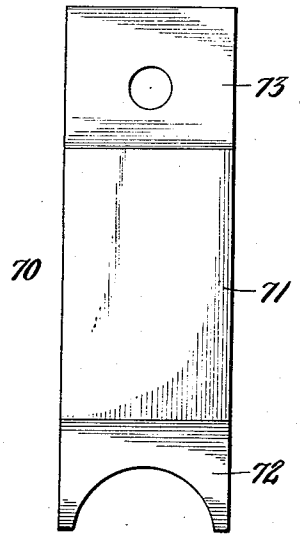


Fig. 13

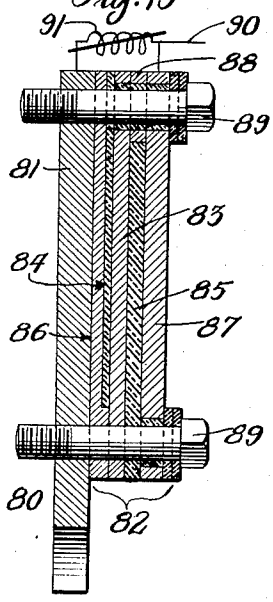
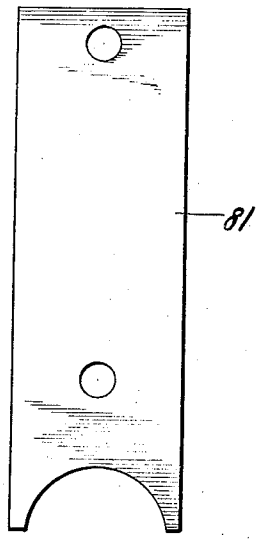


Fig. 14.



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Patented Aug. 7, 1928. 1,679,730

UNITED STATES PATENT OFFICE.

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ELECTRICAL HEATING APPARATUS AND METHOD.

Application filed July 17, 1923. Serial No. 652,047.

Our invention relates to electrical heating apparatus and methods, and is more especially concerned with the heating of articles by passage of current through them. This mode of heating is very advantageous in the case of metal bars or rods,—including hollow rods or tubes,—for the purpose of annealing, tempering, or otherwise heat treating them.

In heating an article in this manner, electrical connection is generally made to it by means of terminals or "clamps" (as they are called), by which the ends of the article are engaged. Naturally, such clamps tend to conduct heat away from the article, so that the portions at and adjacent the clamps do not attain so high a temperature as the intermediate main body of the article. As the range of temperatures within which the best effect on the article can be produced is often a rather narrow one,—too high a temperature being as bad as one too low,—the portions affected by the cooling action of the clamps are often of such poor quality that they have to be cut off and scrapped.

For example, in annealing brass condenser tubing by passage of current, it is sometimes found necessary to discard as much as six inches or more off each end of each tube.

We aim to obviate this drawback of such electrical heating by preventing or minimizing loss of heat at the clamps. Practically, we have found, this can be accomplished to advantage by heating the clamps and by reducing their thermal conduction,—preferably both. The heating of the clamps for this purpose can most conveniently be effected by passage of current. How various objects and advantages can be realized through our invention in a novel manner will appear from our description hereinafter of the best methods and apparatus for the purpose known to us.

In the drawings, Fig. 1 is a somewhat diagrammatic side elevation of an apparatus for electrically heating rods or tubes by passage of current through them, conveniently embodying our invention,—a middle portion being broken out and omitted.

Fig. 2 is a wiring diagram illustrating electrical connections for heating both tube and clamps in the machine of Fig. 1.

Fig. 3 is a fragmentary side view of the clamps at one end of the tube as shown in Fig. 1, on a larger scale.

Fig. 4 is a view of the clamps from the right of Fig. 3, the tube appearing in section.

Figs. 5 and 6 are views similar to Figs. 3 and 4, illustrating a different form of clamp.

Fig. 7 is a diagram illustrating a mode of heating the clamp somewhat different from that of Fig. 2.

Fig. 8 is a diagram illustrating still another mode of heating the clamps.

Figs. 9 and 10 are diagrams illustrating provisions for varying and regulating the heating of the clamps.

Figs. 11 and 12 are edge and side views of a different form or type of clamp device.

Fig. 13 shows a longitudinal section through still another type of clamp device.

Fig. 14 is a side view of one of the parts shown in Fig. 13.

The apparatus illustrated in Fig. 1 is substantially that described and claimed in the pending application of Macdonald, Waite & Huggins, Serial No. 639,231, filed May 16, 1923, and assigned to the assignee of this application. For the purposes of this application, it may be sufficiently described as comprising clamping heads 10 and 11 carried by carriages 12 and 13 mounted on timber ways 14. Either or both of the carriages 12 and 13 may be shifted along the ways 14 to take care of differences in length of pieces to be treated. In addition, the clamping head 11 is shiftable to take care of variation in length of the piece P undergoing treatment with change of temperature, by virtue of being mounted on rollers 15 rolling on ways 16 carried by the main body of the carriage 13, that rests directly on the ways 14. In order that such resistance to movement along the ways 16 as the head 11 may offer shall not tend to buckle the piece P as it expands with heating, a weight 17 is connected with the head 11 by a cord 18 passing over a pulley sheave 19. If heavy enough, this weight 17 will not only take up the expansion of the piece P, but will also exert tension on it, so as to straighten out any kinks in the piece while the latter is hot and soft. A treadle 20 connected to the head 11 by a cord 21 also pass-

ing over the sheave 19 affords a convenient means of returning the head 11 each time to the desired initial position for the next heat. As shown, each of the heads 10 and 11 has a pair of opposed clamping jaws 22, 22, one conveniently adjustable by means of set screws 24, 25, and the other operable by a spring and opposing solenoid arrangement 26, 27. At the end of each "heat", the current through the piece P is shut off and the movable clamping jaws 22 are opened.

As shown in Fig. 2, current to heat the piece P is supplied from an A. C. power line 30 (at 220 volts, say), through a switch 31 and a transformer 32 with adjustable secondary. As shown, the secondary leads 33 and 34 from the transformer 32 divide at each of the clamping leads 10 and 11, so that the heating current for the piece traverses each pair of clamps 22, 22 in parallel. In the apparatus illustrated in Fig. 2, the current thus supplied the piece P through the clamps 22, 22 is also relied on to heat the clamps. For this purpose, the clamps 22, 22 may preferably be made of metal of suitably high electrical resistance and refractory character, such as nichrome, so that they can afford ample area of contact with the piece P, and thus minimize heating effects at the portions which engage it, and still be of sufficient total resistance to heat adequately. With this arrangement, it will be seen, the adjustment at the transformer 32 that varies and regulates the current in reference to the heating of the piece P can also be made to serve for varying and regulating it in reference to the heating of the clamps.

While the heat developed as a result of the contact resistance between the piece P and the clamps 22, 22 tends, of course, to counterbalance their conduction of heat away from the piece, it is usually desirable not to have the contact resistance high enough to compensate entirely for thermal conduction, in order to avoid risk of excessive local heating at the contacts, but rather to proportion the clamps to reduce their thermal conduction and increase their electrical resistance sufficiently to bring about a balance. As shown in Figs. 1, 3 and 4, each of the clamps 22, 22 is reduced in effective cross section and thus specially heated, for this purpose, at a point behind the piece-engaging portion. In this particular instance, each clamp 22 is formed of a metal plate or strip with its end round-notched in conformity to the tubular piece shown, and with its longitudinal edges also reduced or notched for a considerable length to reduce its effective cross section and electrical conductivity. The shank or butt is of full width, so as to afford ample conductivity and contact surface for securing it to the head.

Figs. 5 and 6 illustrate another way of reducing the cross section without so greatly diminishing the strength and rigidity of the clamp in a transverse direction in its own plane. Here the clamp plates 22, 22 are each perforated with a multitude of holes 36 (arranged in rows and staggered) for a suitable length behind their piece-engaging extremities.

In Fig. 7, main reliance for specially heating the clamps 40, 40 shown is placed on current supplied for this purpose from a separate (A. C. or D. C.) source 41. As shown the cooperating jaws 40, 40 are connected in the jaw-heating circuit in parallel, and are traversed by such current in a general direction at right angles to the general flow of clamp-heating current. As here indicated, the reduction in effective cross section of the high-resistance metal clamp pieces 40, 40 due to their piece-engaging notches may be availed of to assure adequate heating. In this case, the extent transversely of a jaw 40 of the highly conductive lead 33 for the piece-heating current is insignificant, so that such lead will not act as a shunt to reduce the heating effect of the transverse current flow.

In Fig. 8, the clamps 50, 50 are specially heated by current from a separate source 51, but not in parallel; and instead of traversing the clamps themselves, the current flows through separate heating elements 52, 52,—here shown as in the form of external coils (of nichrome or other suitable metal) wound around the terminals. An adjustable resistance or rheostat 53 is included in the heating circuit, as a convenient means for varying and regulating the heating current.

In Figs. 9 and 10, the clamps 60, 60 are specially heated in parallel by the heating current for the piece P itself, as in Figs. 1 to 6; and the heating devices for this purpose consist of reduced portions of the clamps themselves behind their piece-engaging portions (note the rows of holes 36 as in Figs. 5 and 6), rather than of separate resistance coils 52 as in Fig. 8. In these figures, however, there are separate provisions for regulating and controlling the heating of the clamps 60, 60 by variably shunting portions of the clamps. As shown in Fig. 9, the shunt circuits 61, 61 for this purpose extend from the more conductive piece-engaging portions of the pair of clamps 60, 60 around their reduced heater portions to their portions just behind the holes 36, and include a common connection with a rheostat or variable resistance 62 therein. In Fig. 10, these shunts 61, 61 are similarly arranged, but include a variable inductance 63 instead of the rheostat 62.

In this way, it will be seen, the heating of the clamps 60, 60 can be adjusted to a nicety notwithstanding considerable variations in the total heating current for the piece P, since the shunts 61, 61 can be ad-

justed to carry a heavy current around the clamp heaters if need be. In this case, of course, the clamps 60, 60 are preferably made of high resistance material.

In Figs. 11 and 12 is shown a clamp or contact jaw 70 specially heated effectively without reduction in cross section such as illustrated in Figs. 3 to 6, 9 and 10. The heating device of this jaw 70 consists of an intermediate portion 71 of high resistance material (such as nichrome) interposed (and welded or otherwise secured) between contact and butt ends 72, 73 of copper or other highly conductive material. The high conductivity of the copper ends 72, 73 allows them to be made of such limited cross section that a portion 71 of like section will heat amply on current insufficient to heat the ends themselves much, and will also have sufficiently low thermal conduction. This type of clamp is adapted to a variety of circuit arrangements, including those shown in Figs. 2, 6, 9 and 10.

Figs. 13 and 14 illustrate a clamp or jaw device 80 also specially self-heating without cross sectional reduction. Here the jaw member 81 proper may be of copper or other highly conductive material throughout, and may be made readily detachable from the heating device 82 to permit of easy replacement. As shown, the heating device 82 comprises a strip of high resistance material 83 (such as nichrome) interposed or sandwiched between strips of electrical insulation 84, 85 and inner and outer protective facing plates 86, 87, of copper or the like. The heating strip 83 is in connection with the inner facing 86 adjacent the piece-engaging end of the jaw member 81, by direct contact with its thickened end, and is in connection with the outer facing 87 at the other end, by contact of both with an interposed copper collar or block 88. The bolts 89 that secure the parts together may be insulated from the facing 87 and collar 88, as shown.

The main heating current lead 90 is connected to the outer facing 87, so that the current traverses the length of the heating strip 83 on its way to the jaw piece 81, which it reaches close to its piece-engaging end. The jaw piece 81 lies snug against the inner facing 86, and is heated by conduction through the latter and the thin layer of electrical insulation 84. Thus the current for heating the piece (not shown in Figs. 13 and 14) also heats the clamp device. A shunt connection with current regulating means 91 (shown as a variable inductance) may be provided to the upper end of the jaw member 81, as a means of controlling the proportion and amount of current flow through the strip 83, and so regulating the heating.

What we claim is:

1. A method of preventing deleterious cooling, by terminal clamps, of a piece electrically heated by passage of current through it, without risk of excessive local heating effects at the contacts between clamps and piece; which method comprises specially heating, by passage of electric current, portions of the clamps behind those which engage the piece, while minimizing heating effects at the latter portions.

2. A method of preventing deleterious cooling, by terminal clamps, of a piece electrically heated by passage of current through it, without risk of excessive local heating effects at the contacts between clamps and piece; which method comprises minimizing heating effects at the portions of the clamps that engage the piece, and specially heating portions of the clamps behind those which engage the piece sufficiently to compensate for the difference between the conduction of heat by the clamps and the heating effect of their contact resistance.

3. A method of preventing deleterious cooling, by terminal clamps, of a piece electrically heated by passage of current through it, without risk of excessive local heating effects at the contacts between clamps and piece; which method comprises minimizing heating effects at the portions of the clamps that engage the piece, and specially heating portions of the clamps behind those which engage the piece, variably shunting such specially heated portions to regulate their heat.

4. Apparatus for heating by passage of current comprising terminal clamps for a piece to be treated, with means for passing current through the piece to heat it and means for specially heating portions of the clamps behind those which engage the piece.

5. Apparatus for heating by passage of current comprising terminal clamps for a piece to be treated, with means for passing current through the piece to heat it, means for specially heating portions of the clamps behind those which engage the piece while minimizing heating effects at said engaging portions, and means for varying and regulating the current for the specially heated portions of the clamps.

6. Apparatus for heating by passage of current comprising a terminal clamp with a resistance heater device behind its conductive piece-engaging portion, and a variable shunt for said heater device for regulating the heating of the clamp.

7. Apparatus for heating by passage of current comprising terminal clamps for pieces to be treated heated by passage therethrough of the current for heating the piece, and means for variably shunting portions of the clamps behind those engaging the piece to regulate the heating of the clamps.

8. Apparatus for heating by passage of current comprising a terminal clamp having

a piece-engaging portion affording adequate area for transmission of heating current to the piece, and locally reduced in cross section behind such portion to cause heating thereof by the heating current, and a variable shunt from such piece-engaging portion around such reduced portion for regulating the heating effect of the latter.

9. A terminal clamp for pieces to be heated by passage of current locally reduced in cross section behind its piece-engaging portion to cause heating of the clamp by the heating current for the piece.

10. A terminal clamp for pieces to be heated by passage of current having a piece-engaging portion affording adequate area of contact for transmission of current to the piece, and locally reduced in cross section behind its piece-engaging portion to bring the thermal conduction and the electrical heating effect substantially to a balance.

11. A terminal clamp for pieces to be heated by passage of current having a highly conductive piece-engaging portion, and a heater portion of high resistance behind such piece-engaging portion.

12. A terminal clamp for pieces to be heated by passage of current through the pieces, comprising a heater device and a jaw member detachably secured thereto.

13. A terminal clamp for pieces to be heated by passage of current through the pieces, comprising a jaw member and a heater device therefor.

14. A terminal clamp for pieces to be heated by passage of current comprising a jaw member, and a heater device therefor including a heating strip connected to said member at one end and to a current lead at the other, with a layer of electrical insulation between said heating strip and said jaw member.

15. A terminal clamp for pieces to be heated by passage of current comprising a jaw member, and a heater device against one side thereof comprising a heating strip sandwiched between insulative layers and conductive facing plates.

In testimony whereof, we have hereunto signed our names.

ANGUS S. MACDONALD.
CHARLES C. WAITE.