United States Patent [19]
Cuvelier

[11] **3,805,010**
[45] **Apr. 16, 1974**

[54] **INSTALLATION OF HEATING BY INDUCTION**

[75] Inventor: **Michel Charles Cuvelier**, Liege, Belgium

[73] Assignee: **Elphiac**, Brussels, Belgium

[22] Filed: **Jan. 15, 1973**

[21] Appl. No.: **323,922**

[30] **Foreign Application Priority Data**

Jan. 14, 1972 Belgium 112830

[52] **U.S. Cl.** **219/10.77**, 219/10.79
[51] **Int. Cl.** **H05b 5/06**
[58] **Field of Search**........... 219/10.49, 10.41, 10.43, 219/10.69, 10.67, 10.79, 10.77, 10.73

[56] **References Cited**

UNITED STATES PATENTS

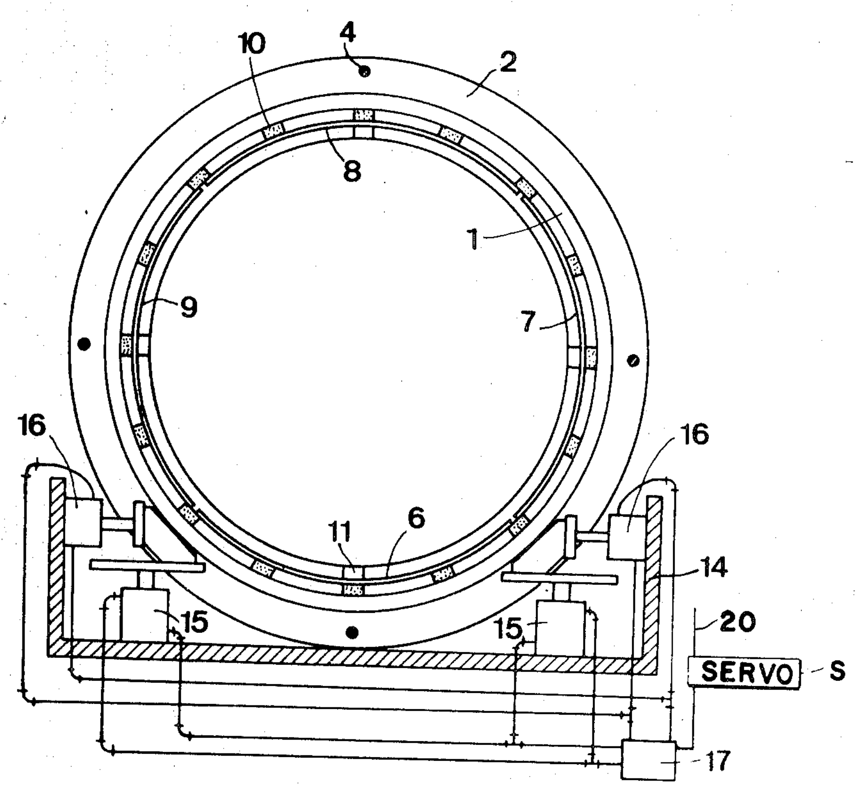
3,647,195	3/1972	Drewry	263/33
2,848,566	8/1958	Limpel	219/10.69 X
891,657	6/1908	Berry	219/10.49
3,317,203	5/1967	Litz et al.	219/10.57
3,489,875	1/1970	Ross	219/10.79
2,813,959	11/1957	Mitchell et al.	219/10.69
2,969,411	1/1961	Gibbs	219/10.79 X
2,781,437	2/1957	McArthur	219/10.79 X

Primary Examiner—Bruce A. Reynolds
Attorney, Agent, or Firm—Raymond A. Robic; J. Ernest Kenney; Arthur Schwartz

[57] **ABSTRACT**

This invention relates to an induction heating apparatus for the heating of continuously moving tubes of large diameter and great length. The apparatus is made up of a cylindrical inductor having a series of induction spiral turns through which the tubes move. A shield held stationary with respect to the inductor and disposed between the induction turns and the tubes to be heated is provided therefor. This shield is formed of a plurality of sheet-metal plates which are electrically and thermally insulated from one another along the juxtaposed edges thereof. The position of the inductor is made adjustable with respect to the tubes and in relation to the local heat losses therefrom by means of hydraulic jacks. Feeling prongs and temperature sensitive probes are held close to either one of the inductor end supports to detect any variation in the heat distribution across the tubes whereby to obtain a uniform heat distribution there across by varying the inductor position accordingly.

3 Claims, 2 Drawing Figures



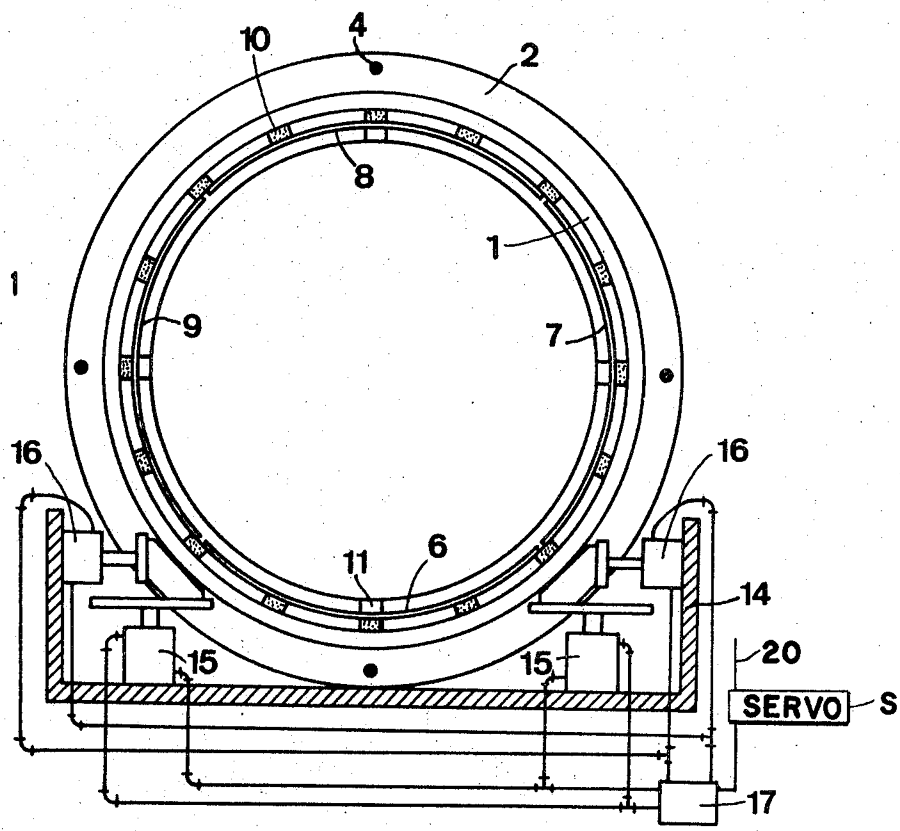

4
10
2
8
1
9
7
16
16
11
6
14
15
15
20
SERVO
S
17

FIG. 1

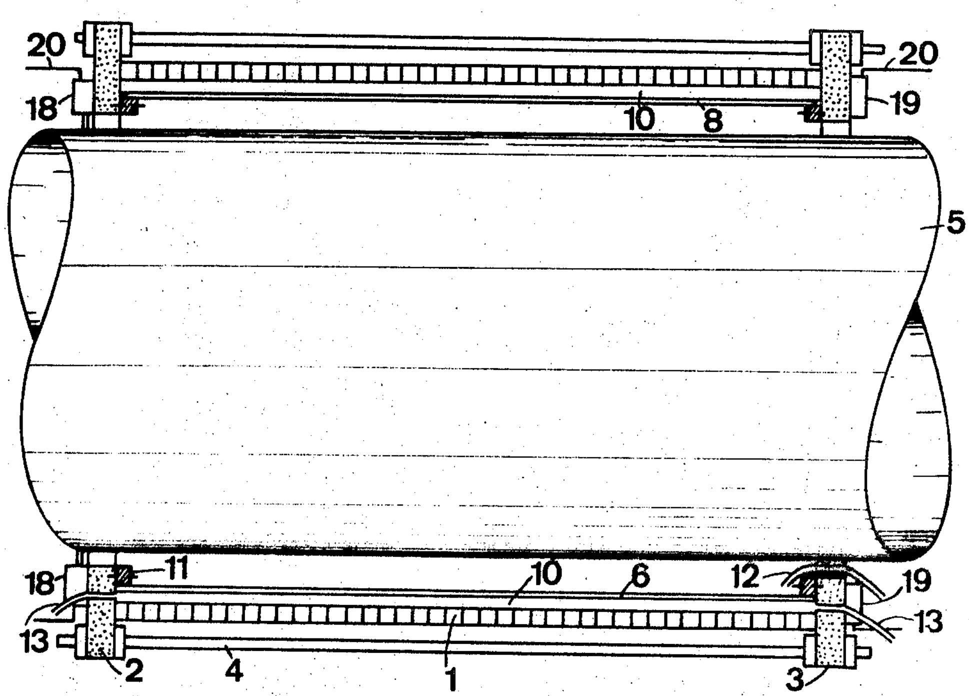

20
20
18
19
10
8
5
18
11
10
6
12
19
13
13
2
4
1
3

FIG. 2

INSTALLATION OF HEATING BY INDUCTION

This invention relates to an induction heating apparatus for heating continuously moving tubes or pipes of large diameters and of great length, the apparatus comprising a cylindrical inductor through which the tubes to be heated move.

The object of the present invention is, on the one hand, to protect the inductor against rapid wear casued, for example, by the heat radiated by the heated tube and, on the other hand, to ensure a uniform temperature throughout the tube section emerging from the inductor.

The apparatus according to the invention is characterized by the provision of a shield held stationary with respect to the inductor, between the inductor turns and the tubes to be heated and by the provision of means for adjusting the position of the inductor in relation to the local temperature of the tube.

The invention will now be described with reference to a preferred embodiment thereof illustrated in the accompanying drawings in which:

FIG. 1 is a transverse cross-sectional view of the apparatus according to this invention, and

FIG. 2 is a longitudinal cross section of an inductor used in the apparatus of the present invention.

A cylindrical inductor is made up of a series of water-cooled spiral turns **1**, held between an upstream annular support **2** and a downstream annular support **3** linked together by means of rods **4**. The terms "upstream" and "downstream" are meant in relation to the displacement of a tube **5** to be heated and which moves through the cylindrical inductor from an upstream to a downstream direction. The supports **2** and **3** are made of insulating material, for example of asbestos plates and reinforced by cement. On the inside of the spiral turns **1** of the inductor, there are four juxtaposed sheet-metal plates **6**, **7**, **8** and **9**, which are pressed against strips **10**, made of insulating material, by means of clamps **11** and fixed to the supports **2** and **3**. The sheet-metal plates are relatively thin so as not to substantially perturb the inductive field. They form a protective heat shield for all the spiral turns **1** of the inductor. The sheet metal plates **6** to **9** are also electrically and thermically insulated from the turns **1** by strips **10**. They are likewise insulated from each other owing to an insulating spacing provided between them, along their juxtaposed edges. To avoid buckling of the plates, strips **10** are inserted along such spaces which also serve to protect the inductor turns from the heat radiated by the heated tube.

Means for avoiding buckling of the sheet-metal plates **6** to **9** may be provided. For example, the plates may be crimped or corrugated, or they may be cooled by a refrigerating fluid such as air, nitrogen, water and the like. The refigerating fluid may be scavanged or sprinkled on the plates on the side thereof facing the tube to be heated. In this case, appropriate nozzles such as **12** are provided which pass around the downstream support **3** to direct the refrigerating fluid on the surfaces of the plates **6** to **9** or at least on one of the surfaces of the said plates.

Cooling of the plates **6** to **9** may also be performed by forcing the refrigerating fluid through the areas defined by the strips **10**, the turns **1** and the plates **6** to **9**, or at least some of such areas. For this purpose, appropriate refrigerating fluid conduits, such as **13**, are provided in the supports **2** and **3** for connecting these areas with a feeding and, eventually, an outlet refrigerating fluid device, not shown.

When the inductor is disposed horizontally, water splashes on the lower plates are to be feared and to avoid any thermal shock, the plate **6** must be cooled. This partial cooling of the shield, made up of the plates **6** to **9**, may produce an uneven distribution of temperature in the portion of the tube running out of the downstream support **3** of the inductor. To avoid this drawback and in order to obtain an even temperature distribution across the tube, the inductor is mounted on a cradle **14** the position of which is adjustable by means of hydraulic jacks **15**, for vertical motion, and **16** for horizontal motion. These jacks **15** and **16** are parts of a servo-control system that include an hydraulic liquid distributor **17** controlled by a temperature probe measuring system, in relation to the local heat losses in the tube **5** to be heated. If the heat losses can be determined once and for all, owing to a strong cooling of the plate **6**, the measuring system may be constituted by feeler prongs **18** fixed to one of the supports **2** or **3**. In FIG. 2, these prongs **18** are mounted on the upstream support **2**. On the other hand, if the heat losses are liable to vary during heating, the measuring system may be constituted by probes **19** sensitive to the local temperature of the surface of tube **5**. These probes are secured on the downstream support **3** of the inductor. These probes then give a direct measure of the local temperature along the cross-section of tube **5** emerging from the downstream support **3**.

The probes **19** or the prongs **18** send out signals useful in the servo-control S(FIG. **1**), toward the liquid distributors **17**. These signals are transmitted through leads **20**. If the probes **19** or the prongs **18** are four in number they are preferably arranged along two perpendicular diameters, one vertical, the other horizontal. Thus, the probes **19** or the prongs **18** disposed along the vertical diameter have a direct influence on the positioning of jacks **15** for vertical displacement, and the probes **19** or prongs **18** along the horizontal diameter directly influence the positioning of the jacks **16** for horizontal displacement. The servo-control system is so designed as to allow the jacks to shift the inductor position until the prongs along the same diameter measure the very same variation from a reference position or until the probes **19** along the same diameter measure the very same temperatures. Owing to this servo-control system, the parts of the tube surface **5** which endure a more severe loss of heat are submitted to a stronger induction coupling and, hence, to a more intense heating. Thus, a perfectly even temperature distribution is obtained over the full cross-section of the tube **5** emerging from the downstream support **3**.

The servo control system per se does not constitute claimed subject matter in this case, and may be constructed, for example, in accordance with the servo control systems shown in U.S. Pat. Nos. 2,998,966 and 3,647,195. Any conventional temperature responsive servo control systems which would provide the desired output function could be used in this invention.

I claim:

1. An induction heating apparatus for the heating of continuously moving tubes of large diameter and great length, said apparatus including a cylindrical inductor having upstream and downstream support means, and further including a series of induction spiral turns shielded with a shield formed of a plurality of sheet metal plates, said tubes moving through said inductor, comprising:

a cradle as a part of the support of the induction heating apparatus,

a moving mechanism on said cradle on which said inductor is secured and capable to move said inductor in directions perpendicular to its axis,

a servo-control means for said moving mechanism,

a plurality of heat measuring probes sensitive to the local temperature of the surface of the tube to be heated, secured near the downstream support of the inductor, said measuring probes being connected to said servo-control means to operate said moving mechanism and displace said inductor in directions perpendicular to its axis and consequently to the axis of the tube to be heated, whereby said inductor is moved closer to the tube being heated in the area of said tube cross section where said probes sense a decreased local tube temperature and is moved away from the tube being heated in the area of said tube cross section where said probes sense an increased local tube temperature to thereby achieve a uniform heat distribution across the tube.

2. The induction heating apparatus recited in claim **1**, wherein said mechanism comprises hydraulic jacks and wherein said servo-control means comprise hydraulic fluid feeding and controlling means for feeding and controlling said jacks.

3. The induction heating apparatus as recited in claim **1**, wherein said heat measuring probes are located at diametrically opposed positions wth respect to the tube being heated, and wherein said servo-control means operates said moving mechanisms to shift the position of said inductor until said probes sense equal local temperatures at diametrical opposite portions of said tube surface.

* * * * *