May 27, 1958 W. A. EMERSON 2,836,694

INDUCTION HEATING UNIT

Filed May 25, 1954

Fig.1.

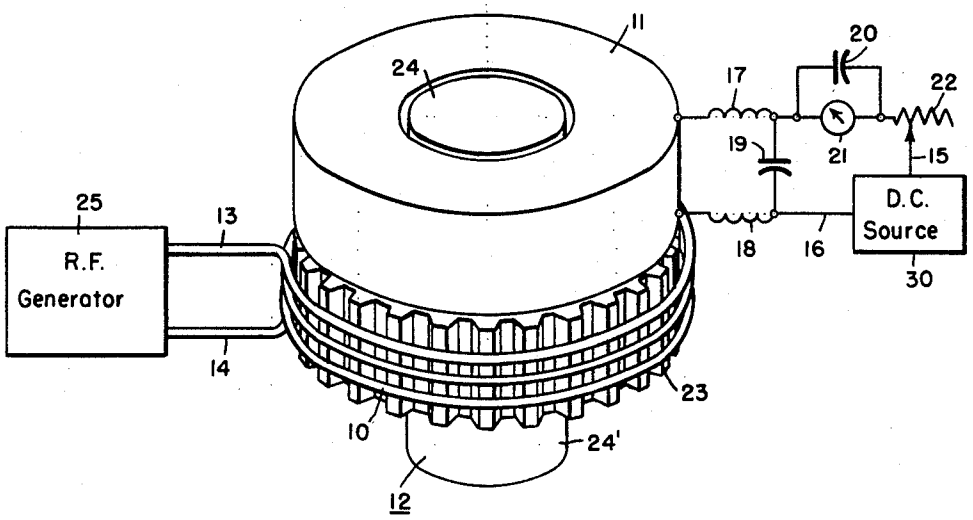
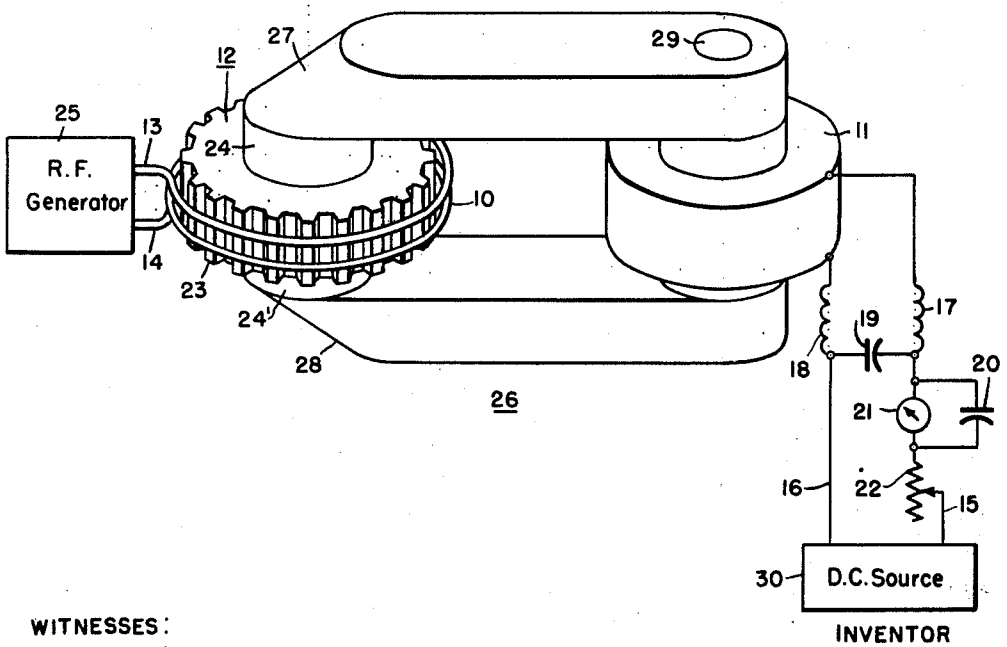


Fig.2.



WITNESSES:

E. A. McCloskey.

J. J. Callahan

INVENTOR

William A. Emerson.

BY

F. E. Browder

ATTORNEY

United States Patent Office 2,836,694 Patented May 27, 1958

2,836,694

INDUCTION HEATING UNIT

William A. Emerson, Baltimore, Md., assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Application May 25, 1954, Serial No. 432,235

5 Claims. (Cl. 219—10.41)

This invention relates to induction heating apparatus and method for the heat treatment of magnetic materials.

In the induction heating of magnetic workpieces the change in the workpiece being heated as it passes through the Curie point is accompanied by a substantial increase in the penetration of induced current into the workpiece. This causes a reduction in the rate of heating and in the power taken from a generator. In this respect, the Curie point corresponds to the temperature of the workpiece at which the above phenomena occur.

It is a nobject of this invention to provide an improved induction heating apparatus for the heat treatment of magnetic workpieces.

It is another object to provide an induction heating apparatus for the heat treatment of magnetic workpieces in which the generator is operated under optimum conditions.

It is another object to provide an induction heating apparatus for the heat treatment of magnetic workpieces in which the loading on the generator remains substantially constant as the workpiece being heated passes through the Curie point.

It is another object to provide an induction heating apparatus for the heat treatment of magnetic workpieces in which the flux density of the workpiece is maximum during the heat treatment operation.

It is another object to provide an induction heating apparatus for the heat treatment of magnetic workpieces in which the generator is set at maximum loading above the Curie point of the workpiece during the heat treatment operation.

These and other objects of the invention are effected as will be apparent from the following description and claims, taken in accordance with the accompanying drawing which forms a part of this application and in which like numerals are employed to designate like parts throughout the same.

Figure 1 is a diagrammatic view of an induction heating apparatus embodying this invention.

Fig. 2 is a modification of the induction heating apparatus illustrated in Fig. 1.

Referring to Fig. 1, in detail, I illustrate apparatus employing my invention for the heat treatment of magnetic workpieces.

The apparatus illustrated in the drawing comprises an inductor or induction heating means 10, a first generator 25 for supplying power to the inductor or induction heating means 10, a saturation means or coil 11, a second generator 30 for supplying power to the saturation means or coil 11, and a magnetic workpiece 12 adapted to be positioned adjacent to the inductor or the induction heating means 10 and the saturation means or coil 11.

The inductor or induction heating means 10 comprises a plurality of turns which are adapted to surround one portion of the magnetic workpiece 12.

Radio frequency power is supplied to the inductor 10 from a generator 25 through coil leads 13 and 14.

The saturation means or coil 11 comprises a plurality of turns which are adapted to surround another portion of the magnetic workpiece 12. The saturation means or coil 11 is positioned as close to the coil 10 as possible without causing arcing over or burning of the coil 10.

Direct current power is supplied to the coil 11 from a direct current generator 30 or other suitable source through conductors 15 and 16. A filter network comprising inductances 17 and 18 and a capacitor 19 are connected between the coil 11 and the generator 30 to keep the radio frequency energy out of the direct current supply 30. An ammeter 21 shunted by a capacitor 20 serves to measure the direct current flowing through the coil 11. A variable resistance 22 is adapted to control the flow of direct current through the coil 11.

The magnetic workpiece 12 is illustrated as a gear 23 with parts 24 and 24' extending from each side of said gear. The gear 23 is surrounded by the inductor 10. The part 24 of the gear is surrounded by the coil 11.

Referring to Fig. 2, in detail, I show a modification of the induction heating apparatus in accordance with this invention. A core 26 of a material which has a high value of magnetic permeability but a relatively low value of electrical conductivity, such as soft iron or like material, is provided. The core 26 is substantially C-shaped and the end portions of said core are adapted to engage the parts 24 and 24' respectively of the magnetic workpiece 12. The core 26 provides a low reluctance flux path and reduces the number of ampere turns needed for the coil 11. A portion of the core 26 is surrounded by the coil 11. The core 26 is hinged at 29 so that the magnetic workpiece 12 may be positioned within the inductor 10 and removed therefrom when the heat treatment process is terminated.

In acccordance with this invention as illustrated in Fig. 2, the magnetic workpiece 12, which is to be heat treated, is positioned so that the gear 23 is surrounded by the inductor 10. The core 26 is positioned so that one of its end portions 27 engages the part 24 of the gear 23. The other end portion 28 of the core 26 engages the part 24' of the gear 23.

The gear 23 is subjected to the alternating field of the inductor 10. A low direct current is caused to flow through the coil 11 and a strong unidirection magnetic field is built up. The core 26 offers a low reluctance path for the flux set up. The unidirectional magnetic field causes the workpiece 12 to become saturated with maximum flux density.

The generator 25 is tuned for maximum loading above the Curie point of the magnetic workpiece 12. The magnetic workpiece 12 having maximum flux density appears to the loading of the generator 25 to be above said Curie point. Hence, the loading of the generator 25 may be maintained substantially constant throughout the heat treatment operation.

If the unidirectional magnetic field were not used to saturate the magnetic workpiece 12, the generator 25 would overload below the Curie point of the workpiece 12.

When the workpiece 12 reaches the Curie point, current is no longer supplied to the coil 11. The workpiece 12 is then heated by the inductor 10 until a predetermined temperature above the Curie point is reached.

This induction heating apparatus and method for the heat treatment of magnetic workpieces eliminates the need for expensive and cumbersome means for returning the tank circuit of a generator when a magnetic workpiece reaches the Currie point.

While I have shown my invention in particularly one embodiment with several modifications, it will be obvious to those skilled in the art that it is not so limited, but

is susceptible of various changes and modifications without depatring from the spirit thereof.

I calim as my invention:

1. In induction heating apparatus for the heat treatment of a magnetic workpiece to a temperature above the Curie point, inductor means encompassing a first portion of said workpiece and subjecting said workpiece to the action of an alternating magnetic field to establish a first magnetic flux therein, and a saturation coil positioned adjacent a second portion of said workpiece for subjecting said workpiece to the action of a unidirectional magnetic field to cause the workpiece to be substantially saturated with a second magnetic flux, the position of said saturation coil being such that said second flux is oriented within said workpiece to increase the reluctance of said workpiece to said first magnetic flux.

2. In induction heating apparatus for the heat treatment of a magnetic material including a first supply generator and a second supply generator, the combination of an inductor adapted to be positioned adjacent to said material, means connecting said first generator to said inductor, a core having end portions, said end portions being positioned adjacent to said material, a saturation coil surrounding a portion of said core, and means connecting said second generator to said saturation coil.

3. In induction heating apparatus for the heat treatment of a magnetic material including a first supply generator and a second supply generator, the combination of an inductor adapted to be positioned around one

portion of said magnetic material, said first generator being connected to said inductor, a core having ends portions, said end portions engaging other portions of said magnetic material, a saturation coil adapted to be positioned around a portion of said core, said second generator being connected to said saturation coil.

4. The method of heating a magnetic material which comprises heating said material to approximately the Curie point of said material by subjecting said material to the action of a unidirectional magnetic field and an alternating magnetic field, the alternating magnetic field being used to heat the material to a predetermined temperature above the Curie point of said material after said material reaches said Curie point.

5. The method of heating a magnetic material to a predetermined temperature above the Curie point of said material which comprises subjecting said material to the action of both a unidirectional magnetic field and a radio frequency alternating field until said material is heated to approximately the Curie Point, and thereafter subjecting said material to the action of said radio frequency field to heat the material to said predetermined temperature.

References Cited in the file of this patent

UNITED STATES PATENTS

1,335,453	Nilson	Mar. 30, 1920
1,779,604	Kneer	Oct. 28, 1930
2,521,955	Vang	Sept. 12, 1950