

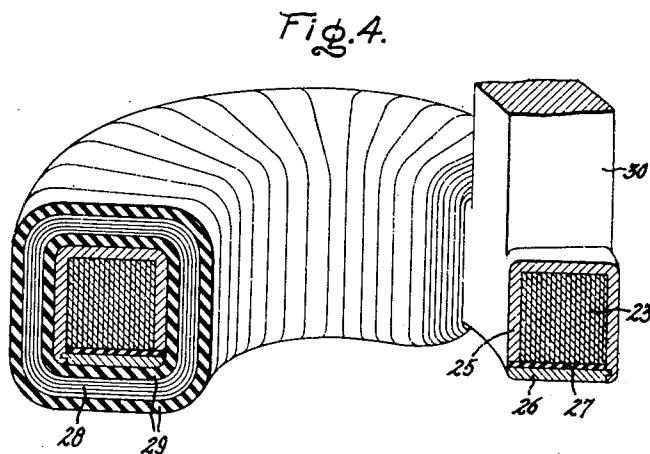
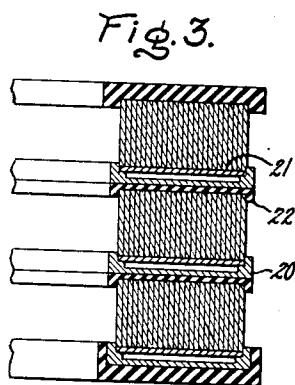
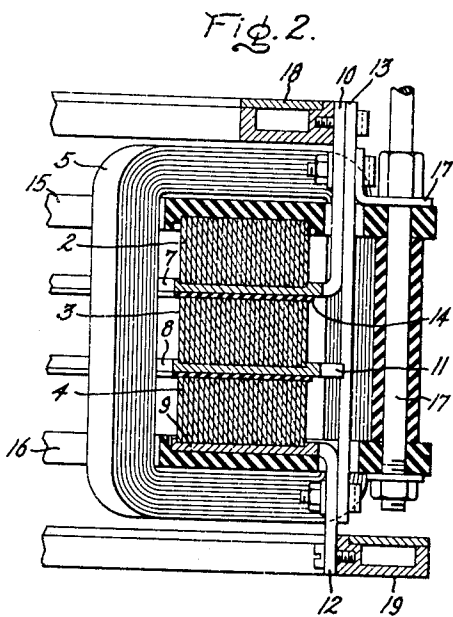
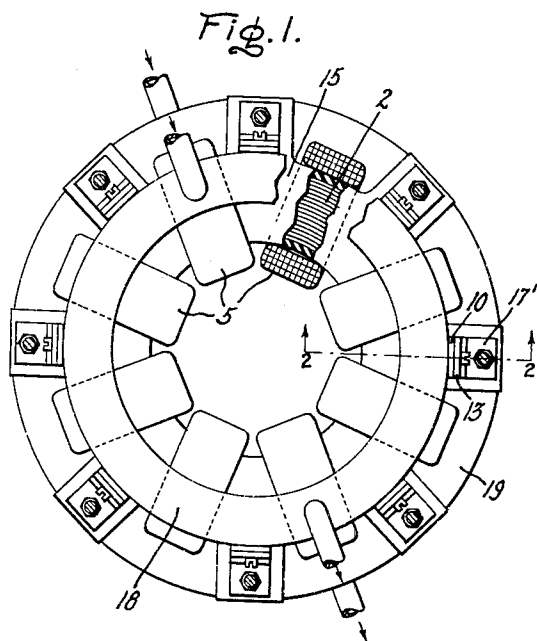
Nov. 6, 1956

W. S. MELVILLE

2,769,962

COOLING MEANS FOR LAMINATED MAGNETIC CORES

Filed July 1, 1953



Inventor:  
William S. Melville,  
by *Gilbert P. Tarleton*  
His Attorney.

1

2,769,962

## COOLING MEANS FOR LAMINATED MAGNETIC CORES

William S. Melville, Rugby, England, assignor to The British Thomson-Houston Company Limited, a British company

Application July 1, 1953, Serial No. 365,508

Claims priority, application Great Britain August 22, 1952

1 Claim. (Cl. 336—61)

This invention relates to laminated magnetic cores, and more particularly, to cooling means for laminated magnetic cores.

Materials for constructing laminated magnetic cores are now available which possess rectangular magnetization characteristics, the area under the hysteresis loop being relatively small. One such material comprises an alloy of equal parts of nickel and iron, the crystals of which have been oriented into a common direction by heat treatment and rolling during manufacture. Such material may be referred to as "grain-oriented nickel iron."

In order economically to utilize the improved magnetic characteristics of a core of such material, it is necessary to apply the windings and their insulation to the core so as to enclose the core. This materially reduces the ventilation of the core, so that the dissipation of heat from the core arising from the losses therein, is restricted. The removal of the heat generated when the core is substantially enclosed within its windings becomes of some difficulty which it is the object of the present invention to overcome.

The invention comprises a laminated magnetic core having non-magnetic heat-absorbing metallic material of good thermal conductivity in heat exchanging relation with the core laminations whereby heat generated in said core is absorbed by the heat-absorbing material, and means connected to said material for removing said heat.

The invention is of particular utility in connection with laminated cores formed from the grain-oriented steels above referred to. Cores formed from such materials are most conveniently constructed by winding the core material in strip form into a coil with the faces of adjacent turns in contact with one another, as opposed to the hitherto more usual construction of employing stacks formed from assembled separate laminations. In carrying out the invention in connection with such a core we may enclose the core in a casing of heat-absorbing material shaped to conform with the configuration of the core and particularly to engage one edge of each of the laminations. The casing may be formed of copper or other non-magnetic material having good thermal conductivity. The casing must be gapped to ensure that it does not constitute a short-circuited turn around the core, and must not engage both edges of the laminations as this would cause the laminations themselves to form short-circuited turns. Thus, where the core is of annular shape, the casing may consist of a copper ring of channel shape in cross-section surrounding three edges of the core and completed by a ring placed on top of the channel to form a lid.

Alternatively, the core may be made in sections, each of wound strip, assembled side-by-side with the edges of the laminations adjacent to one another but separated by heat-absorbing material in the form of rings of non-magnetic material of high thermal conductivity shaped to conform with the configuration of the sections.

2

The core assembly with its heat-absorbing material is insulated from the windings associated therewith in any suitable manner, the windings may be spaced from the core assembly and the whole supported in an oil filled casing. Alternatively, the core assembly may be encased in insulating material, the windings being placed on the insulation and further insulation being provided over the windings to complete the construction of the induction apparatus. In order to remove from the heat-absorbing material the heat removed by it from the core laminations, the heat-absorbing material may itself be in the form of a hollow casing through which coolant is circulated for removing the heat therefrom, the inlet or outlet conduits for the coolant extending through the insulation. Alternatively, the heat-absorbing material may be provided with lugs extending therefrom which are in turn in thermal conducting relation with means for dissipating the heat conducted from the core. The lugs may, therefore, in turn contact with hollow tubes through which coolant is circulated or be formed with radiating fins adapted to provide extended surface contact with the ambient air.

The invention will be better understood by considering the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claim.

In the drawing,

Fig. 1 is a plan view of an induction apparatus having a magnetic core which is cooled by means forming part of the invention;

Fig. 2 is a cross-section of one-half of the core and assembled parts of the arrangement shown in Fig. 1, the section being taken along the line 2—2 of Fig. 1;

Fig. 3 is a cross-section similar to that of Fig. 2 but showing a modified arrangement; and

Fig. 4 is a perspective view in cross-section of a further modification.

Referring firstly to Figs. 1 and 2, the induction apparatus comprises an annular magnetic core of rolled strip providing laminations which are parallel with the axis of the core. The core may be made of a material having a rectangular magnetization characteristic, such as that above referred to, and is made of a plurality of co-axial sections assembled side-by-side, three sections 2, 3, 4, being shown in the arrangement illustrated. On the core are provided winding sections 5 which are made to embrace the three sections of the core and, as indicated in Fig. 1, occupy a major portion of the periphery of the core, thus materially preventing the removal of the heat generated in the laminations when the induction apparatus is in operation.

In order to remove the heat generated, there is placed between the sections of the core, so as to engage one edge of the laminations in each section, heat absorbing material in the form of rings 7, 8, and 9, of good heat conducting material such as copper, the copper rings being provided with extensions or lugs 10, 11, and 12, respectively, in intimate contact with heat-conducting members 13, also suitably of copper. The ring 7 is in contact with the lower edges of the laminations in section 2 of the core, but is insulated from the upper edges of the laminations of the adjacent section 3 by insulating material 14, thus preventing the rings from forming, with the laminations, short-circuited turns around the sections of the core. Ring 8 is similarly insulated from core section 4. The sections of the core are supported by being clamped between insulating rings 15, 16 the upper ring 15 engaging the upper edges of the laminations in section 2 while the ring 16 engages ring 9 of core section 4. The rings 15, 16 are clamped together by supporting studs 17, which are also clamped to the thermally conducting members 13 by brackets 17'.

3

Thermally conducting members 13 are arranged in the spaces between adjacent winding sections as are the lugs 10, 11, 12 which convey the heat absorbed by the rings 7, 8, 9 to the members 13. In order to remove the heat transferred by the members 13 from between the sections of the core I provide hollow ducts 18, 19 also of annular form, through which water or other coolant is circulated during the operation of the apparatus. By this construction, heat generated in the core and otherwise prevented from being readily radiated by the presence of the embracing windings is removed to the coolant fluid, and undue rise in temperature of the core prevented.

In the modified arrangement shown in Fig. 3, the heat-absorbing rings located to engage one edge of the laminations of each section of the core are themselves in the form of ducts 20 in which a coolant fluid is circulated for the purpose of removing the heat generated in the core. These ducts are, in the illustrated embodiment, in the form of channel-shaped rings having lids 21 in contact with the lower edges of the laminations in each section and insulated, by insulating material 22, from the upper edges of the laminations in the adjacent section.

In the modified arrangement shown schematically in Fig. 4, the annular core 23 is substantially wholly embraced by an electrical winding and removal of the heat generated therein is effected by a somewhat different means. In this case, the core is encased in a heat-absorbing material 25 which may be in the form of a channel-shaped ring contacting the upper edges of the laminations, and having its lower face spaced from the lower edges of the laminations sufficiently to avoid contact therewith. To prevent the channel-shaped ring with its lid 26 from forming a short-circuited turn around the core, insulation 27 is provided to form a gap in the ring. The encased core is now provided with its winding 28, insulated from the core, and externally, by an insulating material 29. Heat absorbed by the ring 25 from the core is removed by means of lugs 30, one or more of which may be brought out from the ring 25 and put into contact with a cooling channel similar to that provided in the arrangement shown in Figs. 1-2. Each lug, of course, forms a break in the continuity of the electrical winding.

While there have been shown and described particular embodiments of the invention, it will be obvious to those skilled in the art that changes and modifications may be made without departing from the invention, and that it is intended by the appended claim to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

A stationary electrical induction apparatus magnetic core comprising three generally identical spirally strip wound closed annular core sections each comprising a plurality of concentric and superposed annular turn laminations, said sections vertically stacked with respect to each other whereby the axes of said sections are vertically disposed and coincide with each other, an annular body of heat absorbing thermally conductive non-magnetic material positioned between the uppermost and central sections and making contact with all of the bottom side edges of all of the turn laminations of said uppermost section, an annular portion of electrical insulating material disposed between said conductive body and central section making contact with said conductive body and the upper side edges of all of the turn laminations of said central section, another annular conductive body and insulating portion identical to said first mentioned annular conductive body and insulating portion identically disposed with respect to said central section and the lowermost of said sections as said first mentioned annular conductive body and insulating portion are disposed with respect to said uppermost and central sections, a third annular conductive body identical to said first mentioned conductive body identically disposed with respect to said lowermost section as said first mentioned conductive body is disposed with respect to said uppermost section, each of said conductive bodies having an annular cooling duct formed therein, a cooling fluid circulated through said cooling ducts, and annular electrical insulating material plates disposed against the uppermost surface of said uppermost section and said third annular conductive body for clamping all of said sections, conductive bodies, and insulating portions therebetween each of said core sections having a narrow depth measured in a direction parallel to the axis thereof.

#### References Cited in the file of this patent

##### UNITED STATES PATENTS

|           |          |                |
|-----------|----------|----------------|
| 513,420   | Rowland  | Jan. 23, 1894  |
| 1,878,173 | Northrup | Sept. 20, 1932 |
| 2,326,151 | Marbury  | Aug. 10, 1943  |
| 2,326,152 | Marbury  | Aug. 10, 1943  |
| 2,547,045 | Sabol    | Apr. 3, 1951   |
| 2,547,065 | Wadhams  | Apr. 3, 1951   |
| 2,569,468 | Gaugler  | Oct. 2, 1951   |
| 2,601,240 | Blair    | June 24, 1952  |