Aug. 30, 1927. 1,640,799

E. F. NORTHRUP

AIR COOLED INDUCTOR COIL

Filed Aug. 1. 1925 4 Sheets-Sheet 1

Fig. 1.

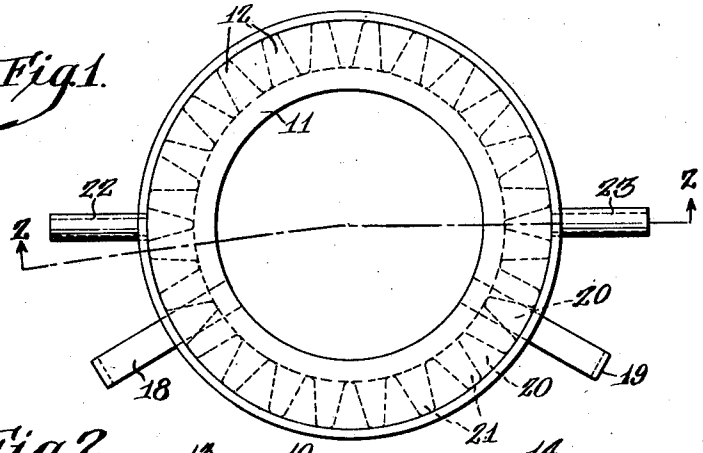
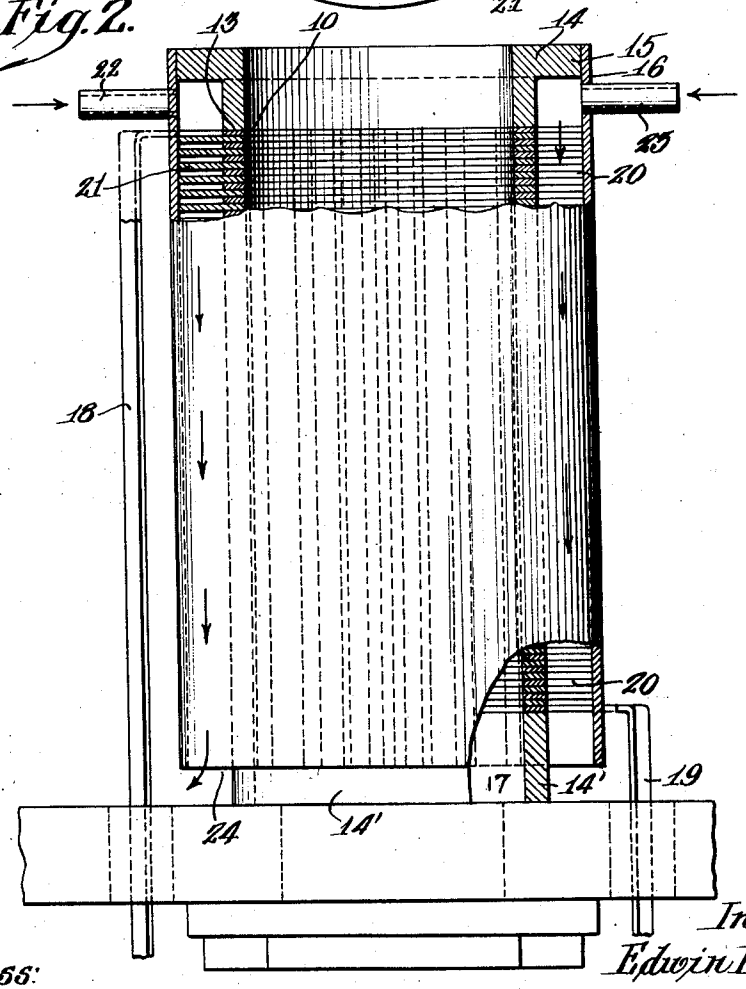



Fig. 2.




Witness:
Walter Chum

Inventor:
Edwin F. Northrup

by W. Steele Jr.
Attorney

Aug. 30, 1927. 1,640,799

E. F. NORTHRUP

AIR COOLED INDUCTOR COIL

Filed Aug. 1. 1925 4 Sheets-Sheet 2

Fig. 3.

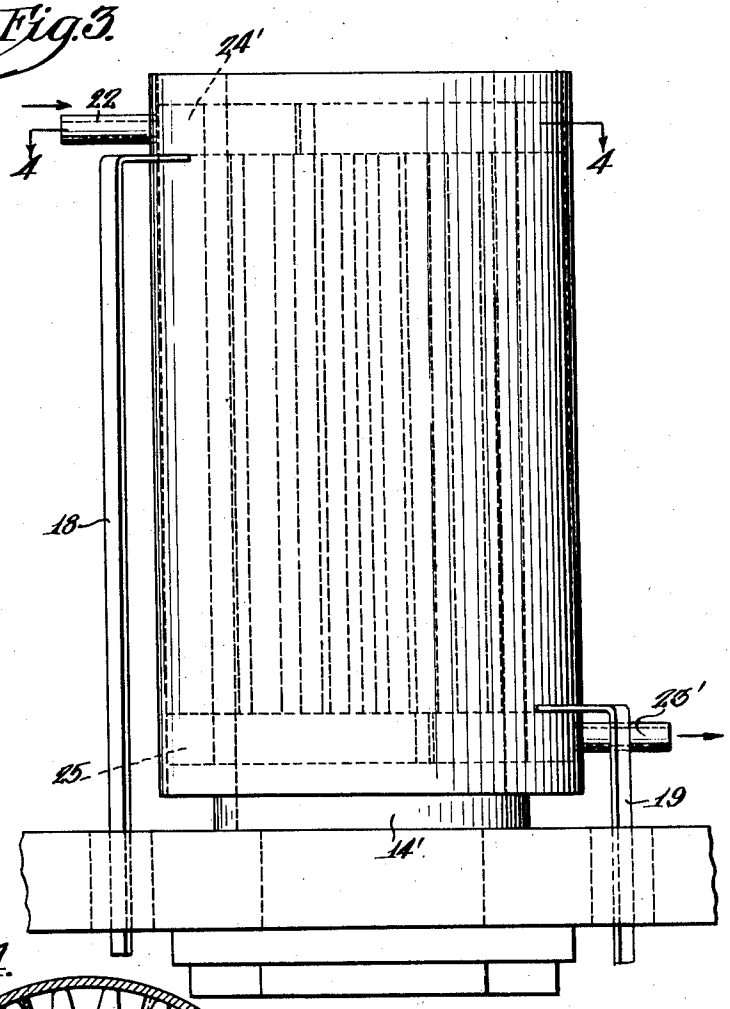
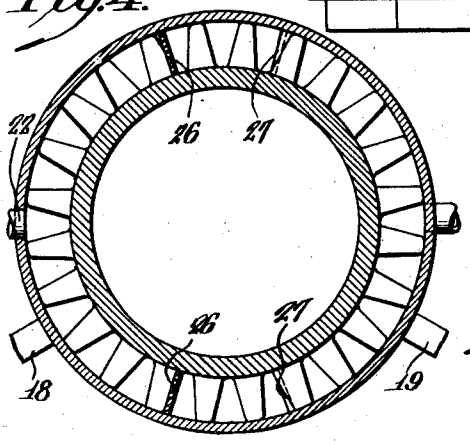



Fig. 4.




Inventor
Edwin F. Northrup.

by

Attorney.

Aug. 30, 1927. 1,640,799

E. F. NORTHRUP

AIR COOLED INDUCTOR COIL

Filed Aug. 1. 1925 4 Sheets-Sheet 3

Fig. 5.

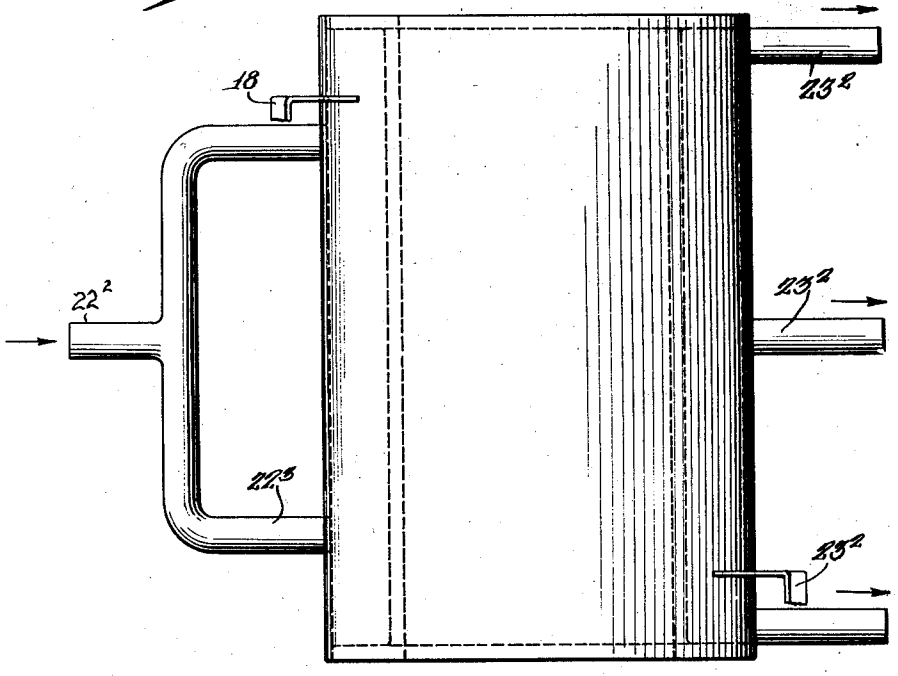
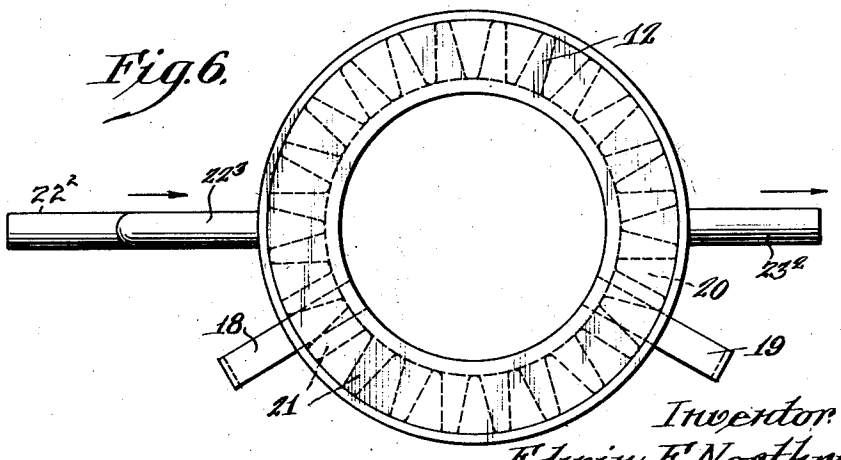



Fig. 6.




Witness:
Walter Thorn

Inventor:
Edwin F. Northrup

by
C. F. Steele Jr.
Attorney.

Aug. 30, 1927. 1,640,799

E. F. NORTHRUP

AIR COOLED INDUCTOR COIL

Filed Aug. 1. 1925 4 Sheets-Sheet 4

Fig. 7.

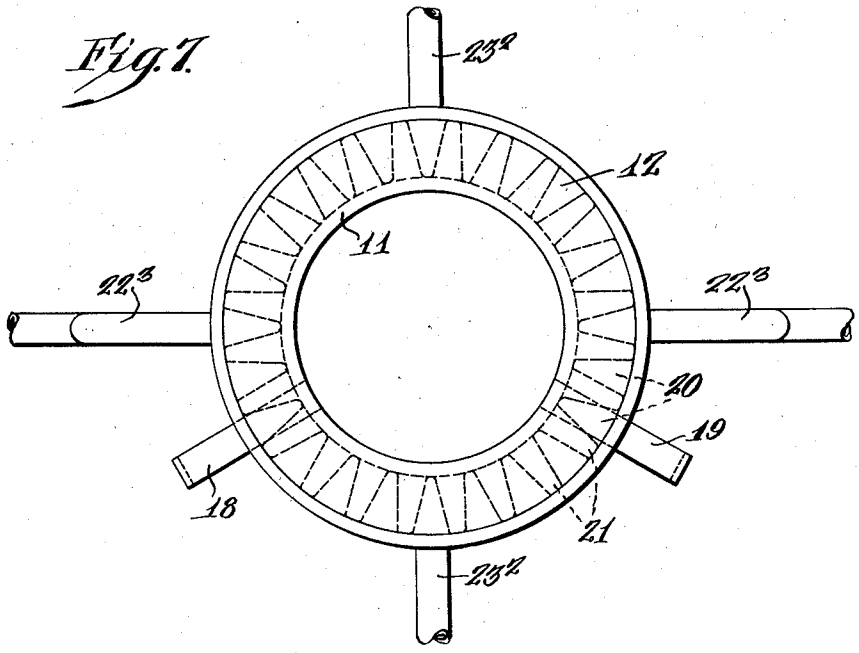
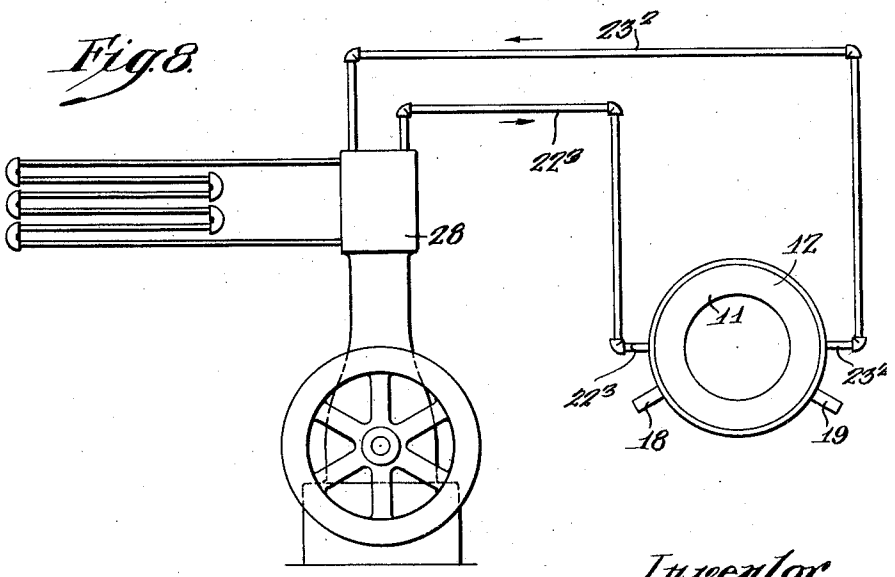



Fig. 8.




Witness:
Walter Chinn.

Inventor.
Edwin F. Northrup.
by W. Steell Jackson
Attorney.

Patented Aug. 30, 1927. 1,640,799

# UNITED STATES PATENT OFFICE.

EDWIN F. NORTHRUP, OF NEAR PRINCETON, NEW JERSEY, ASSIGNOR TO AJAX ELECTROTHERMIC CORPORATION, OF TRENTON, NEW JERSEY, A CORPORATION OF NEW JERSEY.

## AIR-COOLED INDUCTOR COIL.

Application filed August 1, 1925. Serial No. 47,595.

My invention relates to inductor coils intended for use in heating by induction where the coil surrounds the charge.

The main purpose of my invention is to provide the coil with rigid and preferably integral radiating surfaces through which the heat may be distributed to the best advantage.

A further purpose is to provide the radiating portions of the coil with circulation spaces longitudinally of the coil, so as to facilitate distribution of the cooling medium.

A further purpose, where air cooling is effected, is to provide the fins or webs with spacing circumferentially about the coil as well as generally lengthwise of the coil.

A further purpose is to enclose a coil provided with radiating fins or webs with an enclosed coil so that special cooling liquids may be used within it and about the fins.

A further purpose is to provide a gas- or vapor-cooled inductor coil with cooling gas or vapor under pressure, taking advantage of the cooling effect of the expansion taking place in the gas or vapor.

A further purpose is to apply the cooling medium through multiple paths of flow in order to reduce the fluid resistance and to use an enclosed casing to guide the paths of flow.

Further purposes will appear in the specification and in the claims.

I have preferred to illustrate my invention by several variations only of but one main form, selecting a form which is practical, efficient and inexpensive and which at the same time well illustrates the principles involved.

Figure 1 is a top plan view of one form of my invention.

Figure 2 is a broken side elevation of Figure 1 taken upon line 2—2.

Figure 3 is a side elevation of the structure seen in Figure 1 except for slight variation in the location of the fluid inlet and outlet openings.

Figure 4 is a section of Figure 3 taken upon line 4—4.

Figure 5 is a side elevation and Figure 6 a top plan view of another modified form of Figure 1.

Figure 7 is a top plan view of another form.

Figure 8 is a diagrammatic view of one of my furnaces connected to a refrigerating machine.

In the drawings similar numerals indicate like parts.

The furnace inductor coil 10 is formed of edgewise wound flat copper strips, progressively wound and here in the form of a helix providing an interior inductor portion 11 and outer cooling web 12. Between each two turns of the inductor coil spacing and insulating strip material 13 is wound. It is preferably spiralled into the space between the turns of the helix. In order to provide a suitable restrained space for the cooling medium, it is convenient to apply a cap 14 at one end of the coil using its flange 15 as a radial spacer to close that end of a casing 16 surrounding the webs and discharging at some convenient point, in Figures 1 and 2, at the open bottom 17 of the casing past the bottom ring 14'. Obviously other means are available and are shown.

Alternating electric current is supplied to the coil by conductors 18 and 19 connecting with opposite ends of the coil.

The radial width of the edgewise wound copper strip is considerably in excess of the inductor (conducting) portion of the strip, so that the web provided offers a considerable cooling surface in intimate (here integral) heat-transferring engagement with the inductor.

In order greatly to increase the circulation of cooling air or other gas or vapor, I remove the metal of the web at intervals as 20, so as to leave intervening fins or leaves 21 and to permit fluid circulation between these fins, not only circumferentially as provided by the spacing of their spiral windings, but also generally lengthwise of the inductor.

I find it more desirable to stagger the openings 20 of one turn of the web with respect to the corresponding openings of the other turns of the web, rather than to have an axially straight path for air passage at each opening. In cutting the spaces between the fins I therefore first compress the inductor and its web tightly in an axial direction, prior to the insertion of the in-

sulation between its turns, and cut or groove it longitudinally to produce the openings 20 by slotting, planing, or otherwise, while in this compressed condition. As a result, that when the turns spring or are sprung to their normal spacing, as shown in the illustration, the openings cut, and correspondingly the fins left, are somewhat spiralled about the inductor, giving in addition to the circumferential air passage between the fins, longitudinally spiralled air spacing from one end of the inductor to the other—or for such portion thereof as may be desired—between the fins.

In Figures 1 and 2 the air enters in several places at one end of the casing, preferably at the top, so as to provide as even a flow of air as possible through the longitudinal passages. It passes down through the openings 20 and out at the bottom of the casing.

In Figures 3 and 4, by introducing air at 22 at one end of the inductor and one side thereof and withdrawing it at 23′ at the opposite end and side thereof, excellent circulation of the air through the spaces and between the fins is secured even without the necessity of using baffles or other guides or separators to direct the air through or to any particular part or path within the casing or of the inductor, leaving such additional means of securing circulation available for further cooling effect where needed.

However, I have shown such baffles in the upper and lower spaces 24, 25 at 26 and 27 for the purpose of cutting off shortcutting of air across the top and down through the length of the inductor. As a result the air, except as it may pass circumferentially between the pins, goes down the passage at the left of baffles 26, up the passages between the position of baffles 26 and 27 on each side of Figure 4 and down the passages at the right of the baffles 27.

It will be seen from this illustration that even without the baffles entering the spaces between the fins, it is possible to get a very thorough circulation of air through the longitudinal and annular spaces provided, if direct longitudinal air flow be not desired.

In Figures 5 and 6, much more reliance is placed upon passage of the air circumferentially between the fins of adjoining turns. In order to avoid short-circuiting of the air at the top or bottom as well as the necessity for the use of baffles to stop this short-circuiting, the spaces 24 and 25 are omitted and the top of the furnace is substantially at the top of the inductor. The air inlet $22^2$ is divided and the air is introduced at a plurality of points $22^3$ along the length of the inductor. Air outlet is provided on the opposite side of the casing at a plurality of points $23^2$ staggered with respect to the inlet points $22^3$.

It will be noted that but one line of inlet and one line of outlet openings is provided and that the two lines are directly opposite each other. One line will ordinarily be sufficient. However, additional lines of inlet and outlet may be provided as needed and as illustrated in Figure 7, where opposite lines of inlet $22^3$ are shown with intermediate lines of outlet $23^2$, providing as many inlets and outlets as may be required in each of as many angular positions, as may be selected.

Though air is the simplest, most easily accessible and cheapest cooling medium for such a purpose available and ordinarily is therefore the most desirable, it will be obvious that any other gas or vapor may be used for the cooling function and that whatever gas or vapor is applied, it may be used under pressure and with or without artificial refrigeration. Where artificial refrigeration is desired, any refrigerant may be used, so far as my purposes require, which is not inflammable or otherwise objectionable about a furnace.

In Figure 8, my furnace is shown as connected by piping $23^2$ with a diagrammatic refrigerating plant 28 adapted to supply any fluid refrigerant under pressure to the casing, with return therefrom through piping $22^3$. In this case, the furnace casing must be closed to prevent escape of the refrigerating medium.

I have not considered it necessary to describe in detail the insulating base and support upon which my furnace rests, as this has no part in the invention and may be of any character suitable for an inductor coil furnace having the characteristics of my invention.

For the same reason, I have not illustrated nor described the character of crucible suitable with my inductor coil furnace as it is not even necessary to use a crucible, as shown in various patents issued to me and the crucible, if used, may be of any character suitable for direct heating or heating within the body of the crucible.

Though in accordance with the statute, I have shown the best mode known to me of applying my invention, the description and discussion of this form will obviously suggest to those skilled in the art other ways in which projecting fins or interrupted cooling surfaces with intermediate spaces for cooling fluid and means for effecting the cooling may be provided which will secure all or a part of the benefit of my invention. It is therefore my purpose to include herein all such as come within reasonable spirit and scope of my invention.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In an inductor furnace, an inductor of

spiral form having projections in heat conductive relation therewith and spaces between the projections, in combination with a casing about the inductor and fluid supply for passing fluid through the spaces between the projections.

2. In an inductor furnace, an inductor of spiral form having projections in heat conductive relation therewith and spaces between the projections, both circumferentially and longitudinally of the coil, in combination with a casing about the inductor and fluid supply for passing fluid through the spaces between the projections.

3. In an inductor furnace, a progressively wound inductor having its turns spaced longitudinally, and insulated one from the other, and having integral fins extending beyond the outside radius of the inductor and openings between the fins, in combination with means for passing cooling fluid through the spaces.

4. In an inductor furnace, a progressively wound inductor having its turns spaced longitudinally and insulated one from the other and having integral fins extending beyond the outside radius of the inductor and openings between the fins, staggered one turn with respect to another turn, in combination with means for passing cooling fluid through the spaces.

5. In an inductor furnace, a progressively wound inductor having its turns spaced axially and having integral fins extending beyond the outside radius of the inductor with grooves between, the fins and grooves spiralling along the circumference of the inductor, in combination with a casing about the inductor and means for passing cooling fluid through the casing.

6. In an inductor furnace, a progressively wound inductor having its turns spaced axially and having integral fins extending beyond the outside radius of the inductor with grooves between, the fins and grooves spiralling along the circumference of the inductor, in combination with a casing about the inductor and means for passing cooling fluid through the casing, entering at the top, coursing through the grooves toward the bottom and passing out at the bottom.

7. In an inductor furnace, a progressively wound inductor having its turns spaced axially and having integral fins extending beyond the outside radius of the inductor with grooves between, the fins and grooves spiralling along the circumference of the inductor, in combination with a casing about the inductor and means for passing cooling fluid through the casing, entering at the top, passing to the bottom, reversely turned to course back toward the top and subsequently out of the casing.

8. In an inductor furnace, a progressively wound inductor having its turns spaced axially, having integral fins extending beyond the outside radius of the inductor with grooves between, the fins and grooves spiralling along the circumference of the inductor and baffles adapted to assist in the circulation in combination with a casing about the inductor and means for passing cooling fluid through the casing, entering at the top and directed by the baffles downwardly, upwardly and downwardly to the outlet.

9. In an inductor furnace, a progressively wound inductor having its turns spaced axially and having integral fins extending beyond the outside radius of the inductor with grooves between, the fins and grooves spiralling along the circumference of the inductor, in combination with a casing about the inductor and means for passing cooling fluid through the casing, entering at one side and leaving at another side at a plurality of points after coursing circumferentially through the spaces between the inductor fins.

10. In an inductor furnace, a progressively wound inductor having its turns spaced axially and having integral fins extending beyond the outside radius of the inductor with grooves between, the fins and grooves spiralling along the circumference of the inductor, in combination with a casing about the inductor and means for passing cooling fluid through the casing, the casing having distribution space at the ends and outlets spaced from the inlet to require that the cooling medium course through the spaces between the fins.

11. In an inductor furnace, a progressively wound inductor having its turns spaced longitudinally and having fins extending beyond the outside radius of the inductor and spaces between the fins and a casing therefor, in combination with means for passing a refrigerant medium under pressure between the fins from an inlet to an outlet.

12. A spirally wound inductor of section having greater dimension in section radially than parallel with the axis, having a radially inner portion of the winding continuous and the radially outer portion of the winding interrupted.

EDWIN F. NORTHRUP.