No. 646,500. Patented Apr. 3, 1900.

W. S. MOODY.

ELECTRIC TRANSFORMER.

(Application filed Aug. 27, 1897.)

(No Model.)

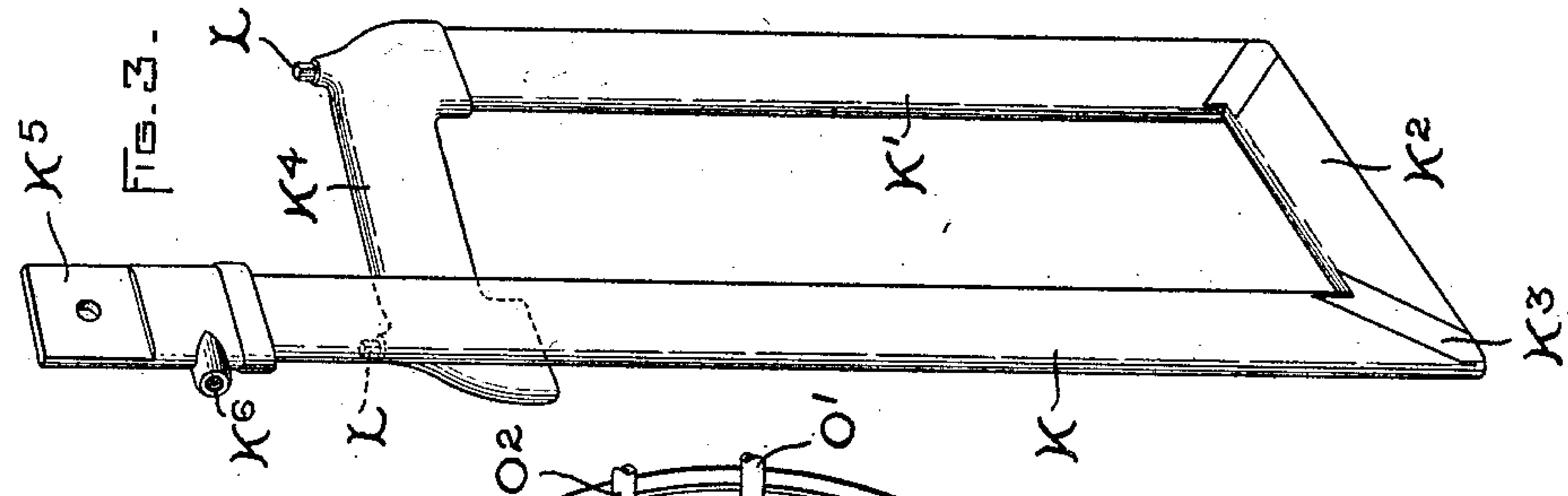

FIG. 3.

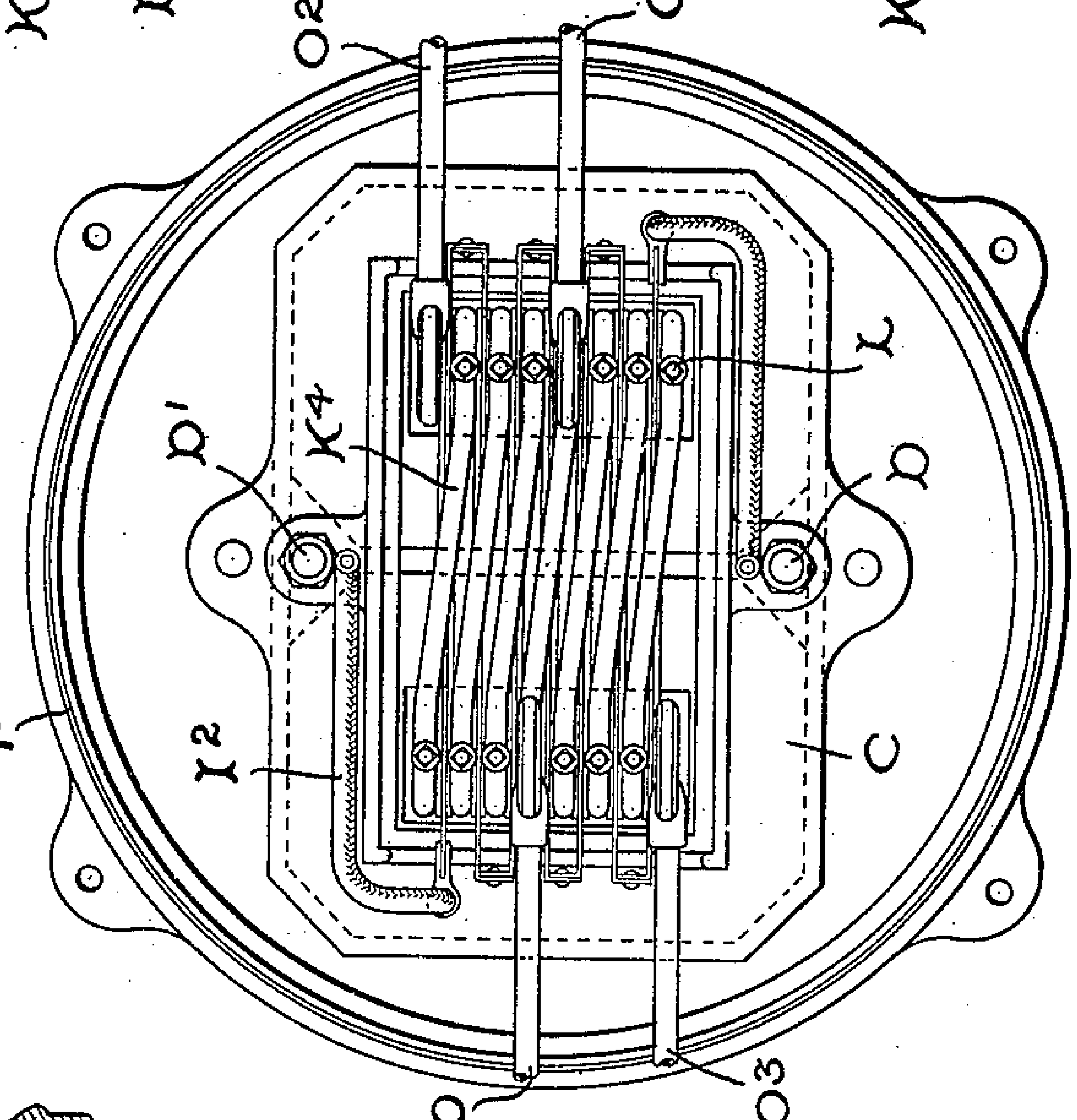

FIG. 2.

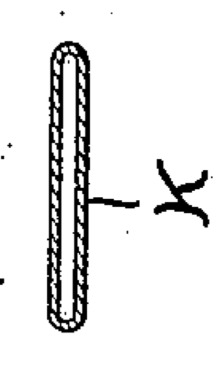

FIG. 4.

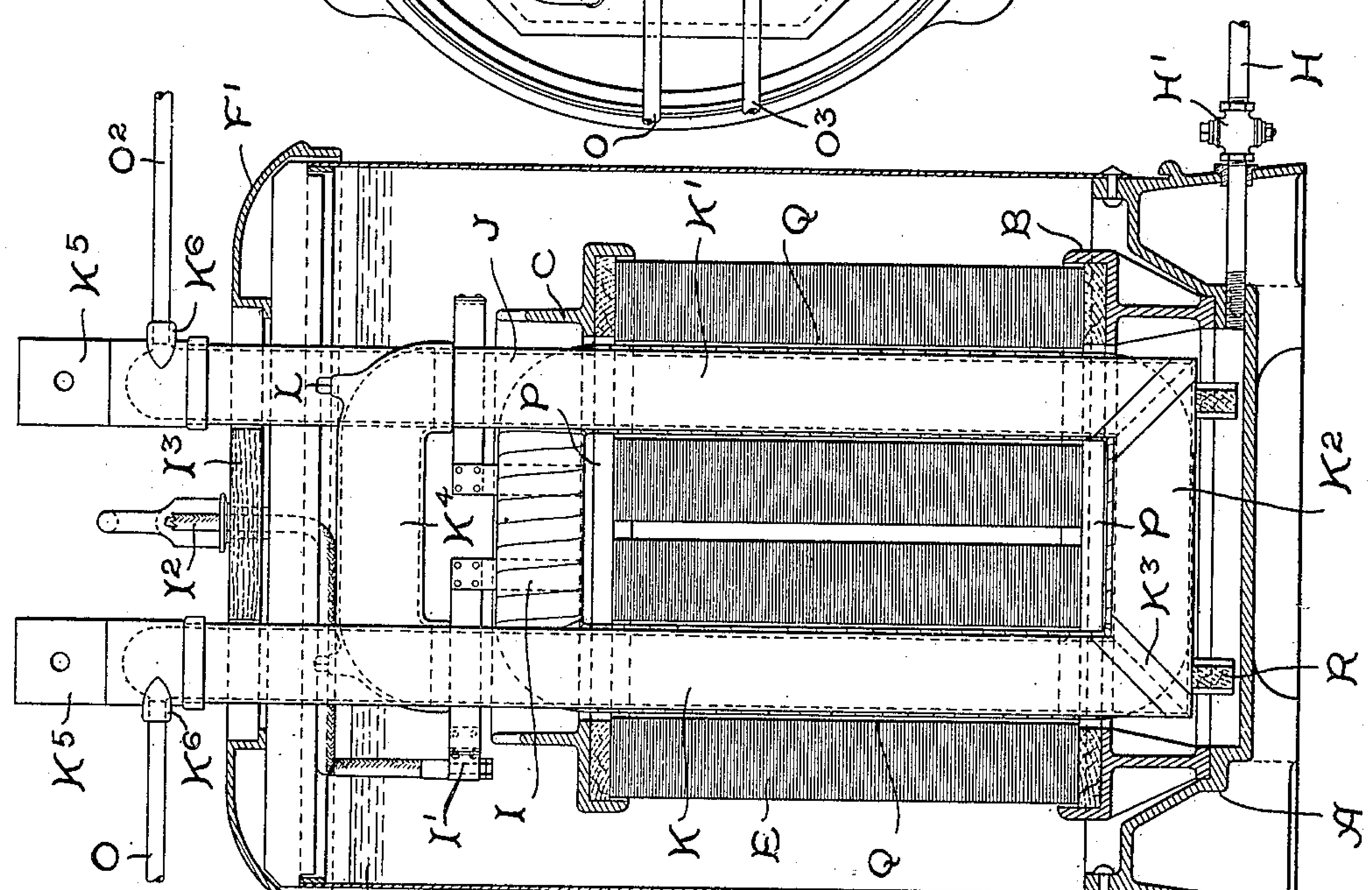

FIG. 1.

WITNESSES.
A. H. Abell.
A. F. Macdonald.

INVENTOR.
Walter S. Moody, by
Geo. R. Blodgett,
Atty.

UNITED STATES PATENT OFFICE.

WALTER S. MOODY, OF SCHENECTADY, NEW YORK, ASSIGNOR TO THE GENERAL ELECTRIC COMPANY, OF NEW YORK.

ELECTRIC TRANSFORMER.

SPECIFICATION forming part of Letters Patent No. 646,500, dated April 3, 1900.

Application filed August 27, 1897. Serial No. 649,692. (No model.)

To all whom it may concern:

Be it known that I, WALTER S. MOODY, a citizen of the United States, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Transformers, (Case No. 571,) of which the following is a specification.

The present invention relates to the means employed for cooling electric apparatus; and it consists in the parts and combinations of parts more fully described hereinafter.

In the accompanying drawings, attached to and made a part of this specification, Figure 1 is a vertical section of my improved transformer. Fig. 2 is a plan view with the cover removed. Fig. 3 is a perspective view of one of the secondary turns, and Fig. 4 is a view showing a secondary conductor in cross-section.

Mounted upon the base A is an auxiliary base B, and between the auxiliary base and the cap C is clamped the core E of the transformer. Bolts D D′, Fig. 2, are employed to secure the cap to the base. Surrounding the transformer-core and secured by rivets to base A is a sheet-metal case F. This case is filled with oil or other fluid insulating material G, which prevents condensation of moisture in the conductors, which would injure the insulation, and the coils and core of the transformer are immersed therein. Fitting down over the casing is a removable cover F′. Located in the bottom of the base is a pipe H, having a valve H′, which is employed in drawing the oil or other insulating material from the case or tank F.

The primary winding I may be wound and insulated in any well-known manner. In the present instance it comprises a number of oblong coils, each covered with insulation and having an outside layer of tape. The inner edges of the coils are separated from the core by blocks of insulation P, and between the sides of the coils and the core are vertically-extending passages Q, through which the oil G passes. From the coils extend terminals I′, which may be connected in any desired manner. In the present instance they are shown as connected to a cable I^2, which extends upward to the top of the transformer and is supported by a block of wood I^3, mounted in the cover F′. The primary is preferably divided into sections, and between these sections are located the turns of the secondary winding J. The secondary conductors are made hollow to permit the circulation of a cooling medium therein and preferably are of the oblong cross-section shown in Fig. 4, for with such a construction there is very little waste room and a large cooling-surface is presented to the insulating medium circulating in the casing F. A circulation of fluid is maintained through the secondary such that not only is the heat absorbed therefrom and carried off by the fluid, but the secondary is thus kept at such a low temperature that the latter in turn absorbs heat from the oil or other insulating fluid which has already conveyed the heat from the other heated parts of the transformer. The presence of the cool and heated parts in contact with the oil causes a circulation of the latter, so that fresh heated portions of the oil are constantly presented to the large cooling-surface of the secondary, whereby the extra heat which in large transformers cannot all be carried by the oil to the heat-conducting metal casing has the above-described auxiliary path. This method of cooling by providing an extra path for the heat in the oil is a very important feature of the transformers I am now building for high-power transmission, for without it the oil and the conducting-casing only would not be sufficient to carry off the heat as rapidly as is necessary and explosions and the destruction of the apparatus would be the inevitable result. A cooling medium might be circulated through separate coils of pipe submerged in the oil; but I regard that method as extremely undesirable, as its efficiency is much lower than that of the structure described, for the pipe would serve no other function than as a cooling means and would take up a large amount of very valuable space, thus requiring extra material for the apparatus. Furthermore, the pipe construction would require a larger quantity of oil, whereas with my construction, while no greater cross-section of copper is used than is essential for the flow of current, yet a large surface of the secondary is exposed directly to the cooling fluid within it and little more space is occupied by the hollow secondaries than would be the case if they were not hollow. Also this slight extra space, since it is arranged parallel with the secondary conductor itself, is so evenly distributed with respect to the core and primary that the difference in total space from a transformer with solid secondaries is not serious. Another advantage which results from this distribution is that the cooling-surfaces are brought throughout the apparatus in proximity to the heated conductors, so that the heat is conveyed by the oil but a short distance before it is absorbed by the cool secondary. A still further advantage is that the shape of the secondary, which provides a large cooling-surface, also adapts the conductor readily to the structure of the apparatus.

In the present instance a water circulation is employed in the secondary conductor; but any other cooling medium may be employed, as ammonia, for example.

The contour of each turn of the secondary winding is substantially the same as that of the primary coils, with the exception that the vertical portions are slightly longer. This is partly for the purpose of exposing a still larger cooling-surface to the oil. The turns of the secondary are supported from their bottom ends by means of transverse pieces of wood R, which are mounted in base A. The space between the primary coils being limited, particularly so at the points where the terminals are secured to the coils, the secondary conductors are extended to a point above the primary where there is plenty of room and are connected in any desired manner. In the present instance the end conductors extend across the primary winding from one secondary conductor to another. This arrangement permits the primary and secondary to be well insulated from each other, at the same time rendering the parts easy of access and inspection. Each turn of the secondary comprises two vertically-extending hollow pieces K and K', made of flattened tubing. These are connected at the bottom by a piece K^2, which is similarly shaped.

The conductivity of drawn copper being considerably greater than that of cast-copper, it is preferable to make the conductors out of the former material. It not being practical to draw the conductors of the desired shape, the copper is first made into a tube in the usual manner and afterward flattened by any suitable means. The piece K^2 is secured in place by any suitable means, as by brazing or soldering, for example, and is reinforced at the joints by pieces K^3. The construction of the top connector K^4 differs somewhat in that it is provided with downwardly-extending portions which fit over the upper ends of the vertical portions K and K'. In addition to the above each is provided with a slight offset to permit it to cross from a conductor on one side of the transformer to the next one in advance on the other side and over the primary winding, as clearly shown in Fig. 2.

It sometimes happens that the transformer is allowed to remain idle in a place where the temperature is low enough to freeze the water which circulates in the secondary conductor, and to provide for the removal of the water openings having screw-threaded plugs L are provided, through which a piece of pipe may be lowered.

On the ends of certain of the secondary conductors are provided terminals K^5, by means of which the turns of the secondary can be connected in any desired relation. Each terminal is provided with a boss K^6, and mounted therein is a pipe connected with the water-supply.

In the present instance the secondary is shown as divided into two parts, and it is intended that the two parts shall be connected in multiple to a common load-circuit. With the secondary connected as above described the water system may or may not be common to both. In certain instances I have connected pipes O and O' with a piece of rubber hose. Then the water enters pipe O^3 and circulates through the secondary and leaves by pipe O^2. When the load on the transformer is a heavy one and it is desired to keep the temperature down to the lowest possible degree, water may enter at pipes O^3 and O' and leave at O and O^2, the two systems being entirely separate.

The use of water alone in a transformer for cooling is objectionable on account of the condensation of moisture from the atmosphere on the conductors, which soon causes damage to the transformer by destroying the insulation between primary and secondary windings. By submerging the conductors of both primary and secondary in oil and employing a water, ammonia, or other cooling medium circulation in either the primary or secondary, or both, the temperature of the transformer is reduced to a minimum and the oil which surrounds the conductors prevents condensation and consequent damage. In addition to this the water circulating through the winding, and particularly the upper part above the core, as in connector K^4, for example, tends to cool and further reduce the temperature.

The invention while described in connection with a transformer is by no means limited to this, for it may be used in connection with other kinds of electrical apparatus, and in the claims I aim to embrace such use.

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

1. An electrical apparatus, a hollow conductor thereof, a non-volatile fluid which absorbs heat from one member and is in contact with the other, and a fluid flowing in contact with said other member, which fluid absorbs heat from the latter such that the latter in turn absorbs heat from said non-volatile fluid.

2. An electrical apparatus, a fluid which absorbs heat therefrom, and a hollow conduct-

ing member which is cooled by a fluid flowing therethrough, which member absorbs heat from the fluid which has cooled said apparatus.

3. An electrical apparatus, a heat-conducting casing therefor, a fluid which absorbs the heat from the apparatus and conveys it to the casing, and a hollow conducting member which is cooled by a fluid flowing therethrough, which member absorbs heat from the fluid which has cooled said apparatus.

4. An electrical apparatus, a heat and electricity conducting casing therefor, a fluid which absorbs the heat from the apparatus and conveys it to the casing, and insulates the parts of said apparatus from each other and from the casing, and a hollow conducting member cooled by the fluid flowing therethrough, which member absorbs heat from the fluid which has cooled said apparatus.

5. In a transformer, the combination with the members thereof, one of which is hollow, of a non-volatile fluid which absorbs heat from some of said members, and is in contact with the hollow member, and a fluid flowing through said hollow member which absorbs heat from the latter whereby said hollow member absorbs heat from said non-volatile fluid.

6. In a transformer, the combination with a heat-conducting casing, a fluid which absorbs heat from the transformer parts and conveys it to the casing, and a hollow conducting member cooled by a fluid flowing therethrough, which member absorbs heat from the fluid which has cooled said parts.

7. In a transformer, the combination with a heat and electricity conducting casing and a fluid which absorbs heat from the transformer parts and conveys it to the casing, and also insulates said parts from each other and from the casing, and a hollow conducting member cooled by a fluid flowing therethrough, which member absorbs heat from the fluid which has cooled said parts.

8. A transformer provided with a hollow conducting member cooled by a fluid passing therethrough, and with means which prevent deterioration of insulation by condensation of moisture on said member due to the cooling fluid therein.

9. A transformer provided with a hollow member cooled by the passage of a fluid therethrough, said member being adapted to absorb heat from the other parts of the transformer.

10. A transformer provided with a hollow secondary cooled by the passage of a fluid therethrough, said secondary being adapted to absorb heat from the core and primary.

11. A transformer provided with a flattened hollow secondary cooled by a fluid passing therethrough, the flat surfaces of said secondary being arranged in proximity to the surfaces of the core and primary.

12. A transformer inclosed by a casing containing oil, and provided with a hollow secondary cooled by a fluid passing therethrough, said conductor having large surfaces which are arranged in proximity to corresponding surfaces of the core and primary, said secondaries extending beyond said members whereby a large cooling-surface is exposed to the oil.

13. In a transformer, the combination with a base supporting a casing containing oil, of a core mounted on the base and separated therefrom by insulating material, and a primary winding mounted on said core and separated therefrom by insulating material and oil-filled spaces.

14. In a transformer, the combination of an iron core, a primary winding mounted on the core and insulated therefrom, and a secondary winding situated beside and extending beyond the primary winding and so arranged that a portion of each turn crosses the primary winding.

15. In a transformer, the combination of a core, a subdivided primary mounted on the core, and a subdivided secondary mounted between and extending beyond the coils of the primary, having end portions which cross the primary coils.

16. In a transformer, the combination of primary and secondary windings, a core, pieces of insulation between the primary winding and the core for supporting the primary, and pieces of insulating material mounted on the base for supporting the secondary winding.

17. In a transformer, the combination of a core, a primary winding mounted on the core, and a secondary winding also mounted on the core, comprising a hollow conductor made in the form of a flattened tube, through which is maintained a fluid circulation.

18. In a transformer, the combination of a core, a subdivided primary winding, a subdivided secondary winding consisting of a conductor oblong in cross-section, side portions of the secondary located between the sections of the primary, portions forming the ends of the secondary turns also located between the sections of the primary, other portions of the secondary turns situated beyond and crossing over the primary, and a cooling medium circulating in the secondary.

19. In a transformer, the combination of a secondary winding, each turn consisting of parallel hollow conductors oblong in cross-section and connected at one end by a piece similar in construction, and at the other end by a piece having sockets which fit over the ends of the conductors, thereby completing a turn.

20. A conductor for a transformer or other electric apparatus, comprising a flattened tube of drawn copper.

In witness whereof I have hereunto set my hand this 26th day of August, 1897.

WALTER S. MOODY.

Witnesses:
B. B. HULL,
A. H. ABELL.