No. 713,901. Patented Nov. 18, 1902.

W. S. MOODY.

TRANSFORMER.

(Application filed May 28, 1900.)

(No Model.)

Fig. 1.

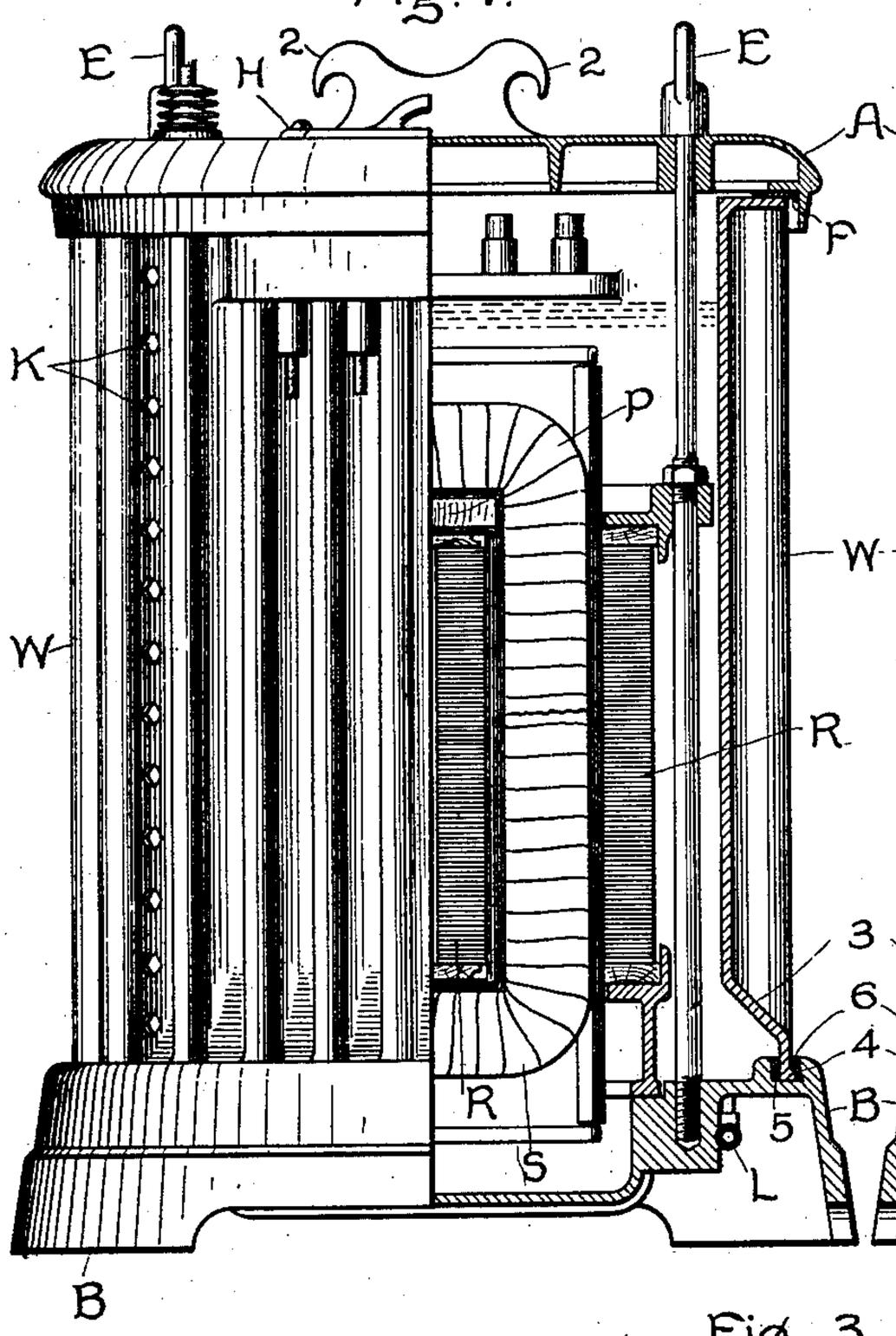


Fig. 2.

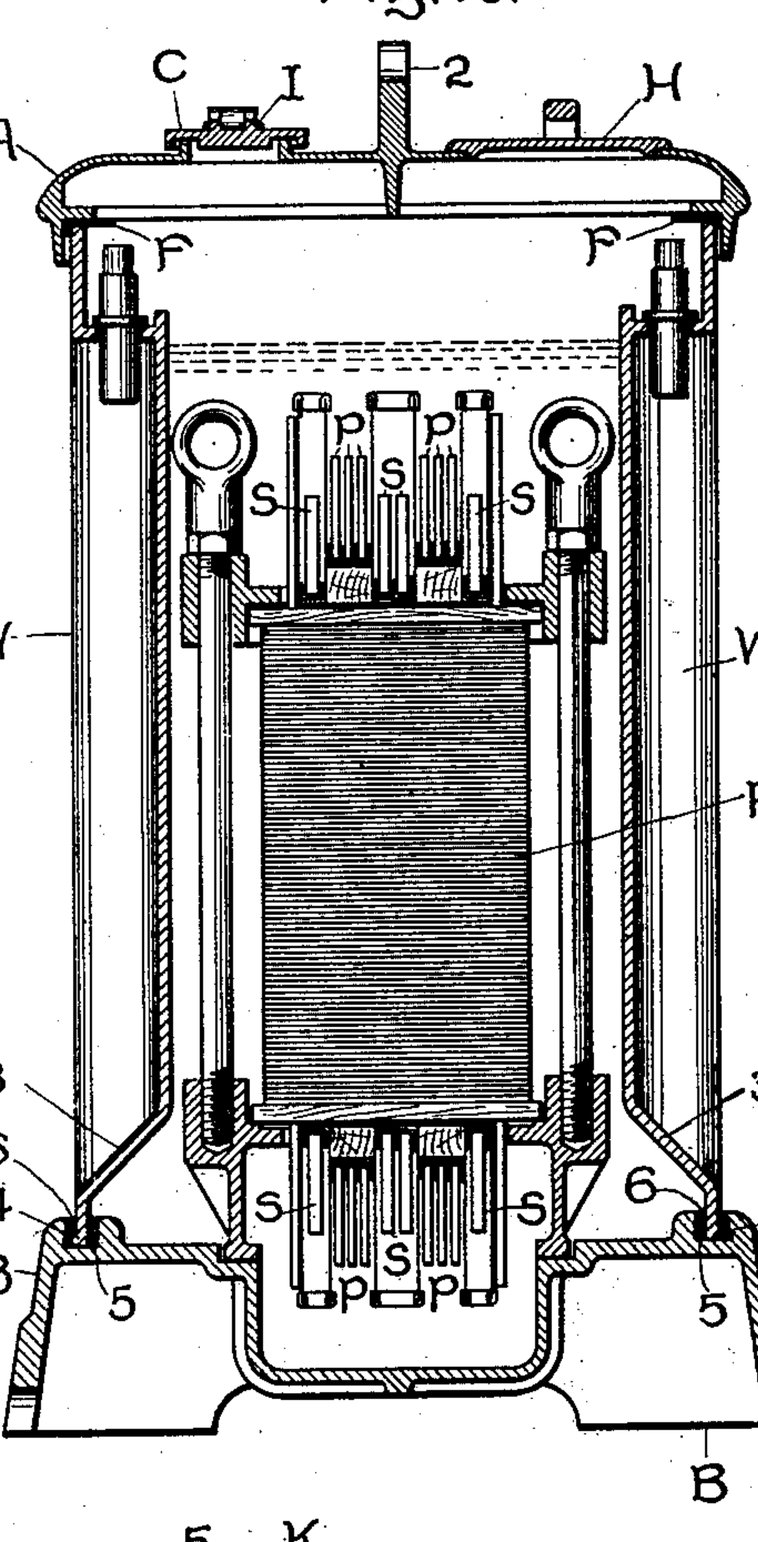
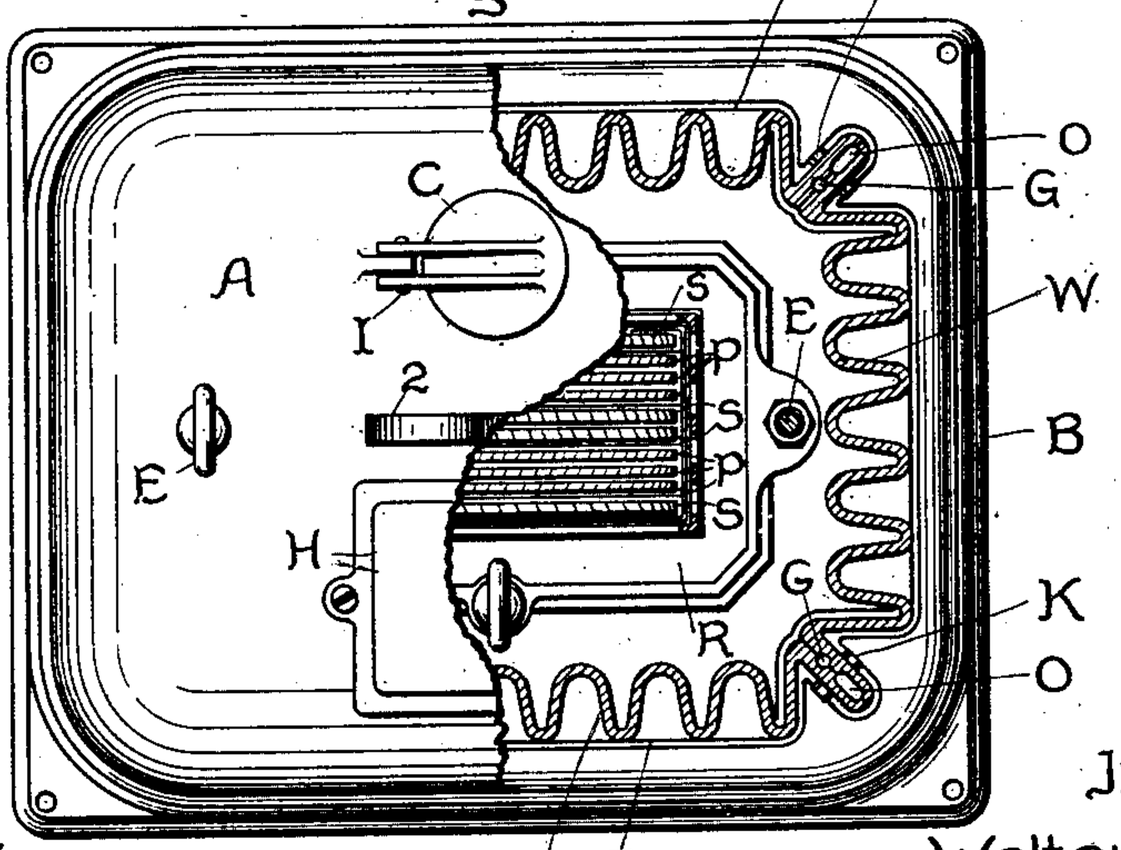


Fig. 3.



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UNITED STATES PATENT OFFICE.

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

TRANSFORMER.

SPECIFICATION forming part of Letters Patent No. 713,901, dated November 18, 1902.

Application filed May 28, 1900. Serial No. 18,235. (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, county of Schenectady, State of New York, have invented certain new and useful Improvements in Transformers, (Case No. 1,637,) of which the following is a specification.

This invention relates to improvements in electrical apparatus, and especially to transformers. With apparatus of this nature it has been found necessary to provide means for carrying off the heat generated by the internal losses. Oil has been found to be the fluid best adapted for the purpose of absorbing heat from the parts of the apparatus, as it serves as an insulator between the parts and prevents deterioration of the solid insulation. It has been found that unless precautions are taken fire and explosions are likely to be caused in apparatus cooled in this manner, which would not only wreck the apparatus itself, but cause great damage to surrounding property. The invention includes means for preventing the occurrence of accidents of this kind.

Electrical apparatus of various kinds, and especially transformers, should not only be maintained at a low temperature, but the temperature of all parts should be uniform. Uniform temperature cannot be maintained when the exposed ends only of the winding are relied upon to cool the coils. Heat is generated in every part of the winding, and every part should therefore be cooled directly, rather than by conduction through the coils. It has been found that a most effective way of causing uniform temperature throughout is to submerge the entire apparatus in a fluid contained in a heat-conducting casing. The casing of a large apparatus should possess strength to render proper support and protection to the apparatus and to withstand the shocks sustained in shipment and should be made of some material, such as cast-iron, which not only provides a strong structure, but at the same time is highly heat-conducting in its nature, and therefore carries off the heat from the fluid which has cooled the heated parts of the apparatus and radiates it into the surrounding space with great rapidity.

This invention aims to provide a structure which shall accomplish this purpose in a highly-efficient manner.

In the drawings, Figure 1 is a side elevation, partly in section, of a transformer which embodies the features of my invention. Fig. 2 is an end sectional elevation of the same; and Fig. 3 is a plan view, partly in section.

In all the figures, R represents the core of the transformer, and P and S the primary and secondary coils thereof, respectively.

B is the base upon which the transformer is mounted in a suitable manner, as shown, and W is the casing mounted in the base. A is a plate which closes the upper end of the casing. Material F, such as felt, is interposed between the plate A and the casing in order to form a tight joint. Suitable bolts E secure the plate A, the base B, and the transformer parts together in engagement with suitable supports for said parts, as shown.

H represents a cover which is secured to the plate A to close a hand-hole or opening, through which the transformer parts can be reached without removing the plate. Hooks 2 are formed on the plate A, by which hooks the entire apparatus when assembled can be lifted for transportation.

A cover C is pivoted or otherwise movably secured to the plate A in any suitable manner, as shown at I, to normally close a small opening in the plate. If the parts become excessively heated or arcing occurs, especially at the surface of the oil, gases will be generated. In case of this formation of gases within the casing the cover C will be lifted thereby to permit their escape and thus prevent their accumulation to such an extent as to cause an explosion. In case of fire the cover C tends to remain closed and the fire will be smothered, the cover being opened only to permit the escape of the gases, since it is automatically closed by gravity when the lifting pressure of the gases ceases, and therefore no air is permitted to enter within the casing to support combustion.

In order that the heat absorbed and conducted by the casing from the fluid may be

quickly carried off into the atmosphere, the casing should have the minimum thickness consistent with strength. In order to increase the effective interior and exterior surfaces of the casing, it is made to have a wave shape, thus exposing a greatly-increased surface of the casing to the heated oil and a greatly-increased surface to the atmosphere, at the same time maintaining the minimum uniform thickness. It should be particularly noted that the wave-shaped surfaces of the casing are of uniform thickness throughout, so that all portions offer the same minimum resistance to the conductance of heat from the transformer parts. The recessed portions or troughs of the external surface are formed with wider mouths and greater extent of surface than the troughs of the interior surface, as shown in Fig. 3, in order to economize in the amount of oil necessary, and also in order that the heat conducted from the oil by the metal casing may be more rapidly dissipated into the atmosphere. If the interior and exterior troughs had the same extent of surface, the external radiative and convective power would not be sufficient to carry off all the heat which can be transferred from the oil which fills the interior troughs of the casing. By making the trough of the shape shown the amount of heat which can be transferred to the casing from the interior is not materially decreased, whereas the amount of heat which can be radiated and conveyed from the exterior of the casing is materially increased. As the radiation of heat takes place in lines normal to the radiating surface, heat will be radiated from a large portion of the surface of troughs of the shape shown directly to the free-air space outside the trough instead of being radiated from side to side of the trough, as would be the case if the outside troughs were narrow, like the inside ones. Considerable difficulty was at first experienced in casting casings having the wave shape desired, but methods were adopted by which their manufacture is now practicable.

The casing is made in sections, each of which has the above-described wave-surface. As ordinarily constructed, the complete casing is rectangular or square in form; but the general outline might be of any desired shape, as circular, in certain cases. The ends of each section terminate at the crest of a wave, the ends being bent at a slight angle. Each section has other sections joined to it by bolts K, so that each joint forms a complete wave, as shown in Fig. 3. Unless great precautions are taken the oil within the casing will creep through these joints and flow down the outside of the casing. To prevent this, a groove is cored in the surface of the end of each section which is to form part of the joint, so that when two sections are joined together a hole G is formed which extends the entire length of the joint. If the oil creeps or is forced through the joint as far as the hole G, it will descend through the latter to be collected from the pipe L or in any other suitable manner for future use. As with this construction it is not necessary that the joint be tight beyond the hole G, a groove is cored in the end surface of each section beyond the groove which forms a part of the hole G, so that when the sections are brought together a hole O is formed. This not only permits the use of less metal, but obviates the necessity of planing large surfaces in order to form a good joint.

The casing W is secured in the base B to form a fluid-tight joint therewith in the following manner: As shown at 3 in Fig. 2, the wave-surfaces, excepting those formed at the joints, are graded off to form straight edges. These edges are placed in a groove 5 in the base, which corresponds in configuration with that of the edges. The edges are heated and soft metal 6 is poured into the groove and adheres to the edges when cool. The grooves are formed with sides which converge toward the top, and projections 4 are formed in the lower edges of the casing to prevent the separation of the latter from the base.

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

1. The combination with a fluid-cooled electrical apparatus, of a casing therefor, a member which closes an opening in the casing, said member being itself formed with an opening, and a cover which is movably secured to said member, whereby it can be moved from its closing position by increase of pressure within the casing, and will automatically resume its closed position.

2. The combination with a fluid-cooled transformer, of a casing therefor, a plate which closes the casing and is provided with an opening, and a cover for said opening, which is movably secured to said plate, whereby it can be moved from its closed position by increase of pressure within the casing, and will automatically resume its closed position.

3. The combination with a transformer, of a heat-conducting casing therefor, containing a fluid which absorbs heat from the transformer, which casing has walls of uniform thickness throughout, the interior and exterior surfaces of which walls have substantially a wave shape with the grooves on the exterior of the casing wider than the grooves on the interior.

4. The combination, with a transformer, of a heat-conducting casing therefor, containing a fluid which absorbs heat from the transformer, which casing has walls of uniform thickness throughout, the interior and exterior surfaces of which walls have substantially a wave shape, for the rapid conduction of heat from the casing, the troughs of the external surface having wider mouths and greater extent of surface than the troughs of the interior surface.

5. The combination with a transformer, of a heat-conducting casing therefor, containing a fluid which absorbs heat from the transformer, which casing is made up of separately-formed sections bolted together at their ends, each section being of substantially uniform thickness and having surfaces of substantially a wave shape.

6. The combination with a transformer, of a heat-conducting casing therefor, containing a fluid which absorbs heat from the transformer, which casing has walls of uniform thickness throughout, the interior and exterior surfaces of which walls have substantially a wave shape, the walls being formed in sections which terminate at the crest of a wave, which sections are joined together at their ends to form a joint having a width substantially equal to the height of the wave, and each joint forming a complete wave.

7. The combination with an electrical apparatus, of a sectional casing therefor, which contains a fluid which absorbs heat from said apparatus, each section of the casing having substantially uniform thickness, and having both surfaces of substantially wave form, the sections being joined together at their ends and having a passage which extends throughout the length of the joint.

8. The combination with an electrical apparatus, of a sectional casing therefor, each section of the casing being of uniform thickness of material and having exterior and interior surfaces of substantially wave shape, the ends of each section being adapted to be joined to the ends of another section at an angle thereto.

9. The combination with an electrical apparatus, of a sectional casing therefor, which contains fluid for absorbing heat from said apparatus, each section of the casing being of uniform thickness of material, and having interior and exterior surfaces of substantially wave shape, the ends of each section being adapted to be joined to the ends of other sections at an angle thereto, in such manner as to make the exterior wave-surface continuous.

10. The combination with an electrical apparatus, of a sectional casing therefor, which contains a fluid for absorbing heat from said apparatus, each section of the casing being of uniform thickness of material, and having exterior and interior surfaces of substantially wave shape, the ends of each section being adapted to be joined to the ends of the other sections at an angle to such sections, in such manner as to preserve the exterior curvilinear outline, and a passage extending throughout the length of each joint, through which passage flows the fluid which creeps through the joint to the passages, the ends of each section being cored to form a groove in the surfaces which form a joint with another section, at a point beyond said passage, to obviate the necessity of planing that portion of the surface.

11. The combination with an electrical apparatus, of a sectional casing therefor, which contains fluid for absorbing heat from said apparatus, each section being of uniform thickness of material, and having exterior and interior surfaces of substantially wave shape, the ends of each section being cored out to form a groove, so that when the sections are joined together passages will be formed which extend throughout the length of the joint.

12. The combination with an electrical apparatus, of a casing therefor, which is adapted to contain a liquid for absorbing heat from said apparatus, said casing being of uniform thickness and having exterior and interior surfaces of substantially wave shape, a base having a suitable groove for the reception of one end of the casing, and a metallic packing between the casing and the base.

13. The combination with an electrical apparatus, of a casing therefor, which contains fluid for absorbing heat from said apparatus, said casing being of uniform thickness and having interior and exterior surfaces of substantially wave shape, one end of the casing having the wave surfaces graded off to form straight edges, and a base having a suitable groove for the reception of that end of the casing.

14. The combination with an electrical apparatus, of a casing therefor, which contains a liquid for absorbing heat from said apparatus, an independent base formed with a groove for the reception of the edge of the casing, and a metallic filling in said groove, about the edge of the casing, applied to make a liquid-tight joint.

15. The combination with an electrical apparatus, of a casing therefor, which contains a fluid for absorbing heat from said apparatus, the edges of the casing having a projection serving as an anchor, a base formed with a groove for the reception of the edges of the casing which have the projection, and a filling in said groove about the edges of the casing, applied to make a fluid-tight joint.

16. The combination with an electrical apparatus, of a casing therefor, which contains a fluid for absorbing heat from said apparatus, the edges of the casing having a projection serving as an anchor, a base formed with a groove having converging sides, for the reception of the casing, and a filling in the groove and about the edge of the casing, applied to make a fluid-tight joint.

17. The combination with an electrical apparatus, of a casing therefor which contains fluid for absorbing heat from said apparatus, the casing being formed of sections which have both surfaces of substantially a wave shape and which are secured together to form non-leaking joints.

18. The combination with a transformer, of a casing therefor, which contains a liquid for absorbing heat from said apparatus, which casing has interior and exterior surfaces of

substantially a wave shape with the external grooves wider than the internal grooves, and a base formed with a groove for the reception of the lower edge of said casing, to form a liquid-tight joint therewith.

19. The combination with a transformer, of a casing therefor, which is adapted to contain liquid for absorbing heat from the transformer, said casing comprising an independent base formed with a groove, and sectional wave-shaped portions, the sections being secured to each other and in the groove in the base, so as to form liquid-tight joints.

In witness whereof I have hereunto set my hand this 25th day of May, 1900.

WALTER S. MOODY.

Witnesses:
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