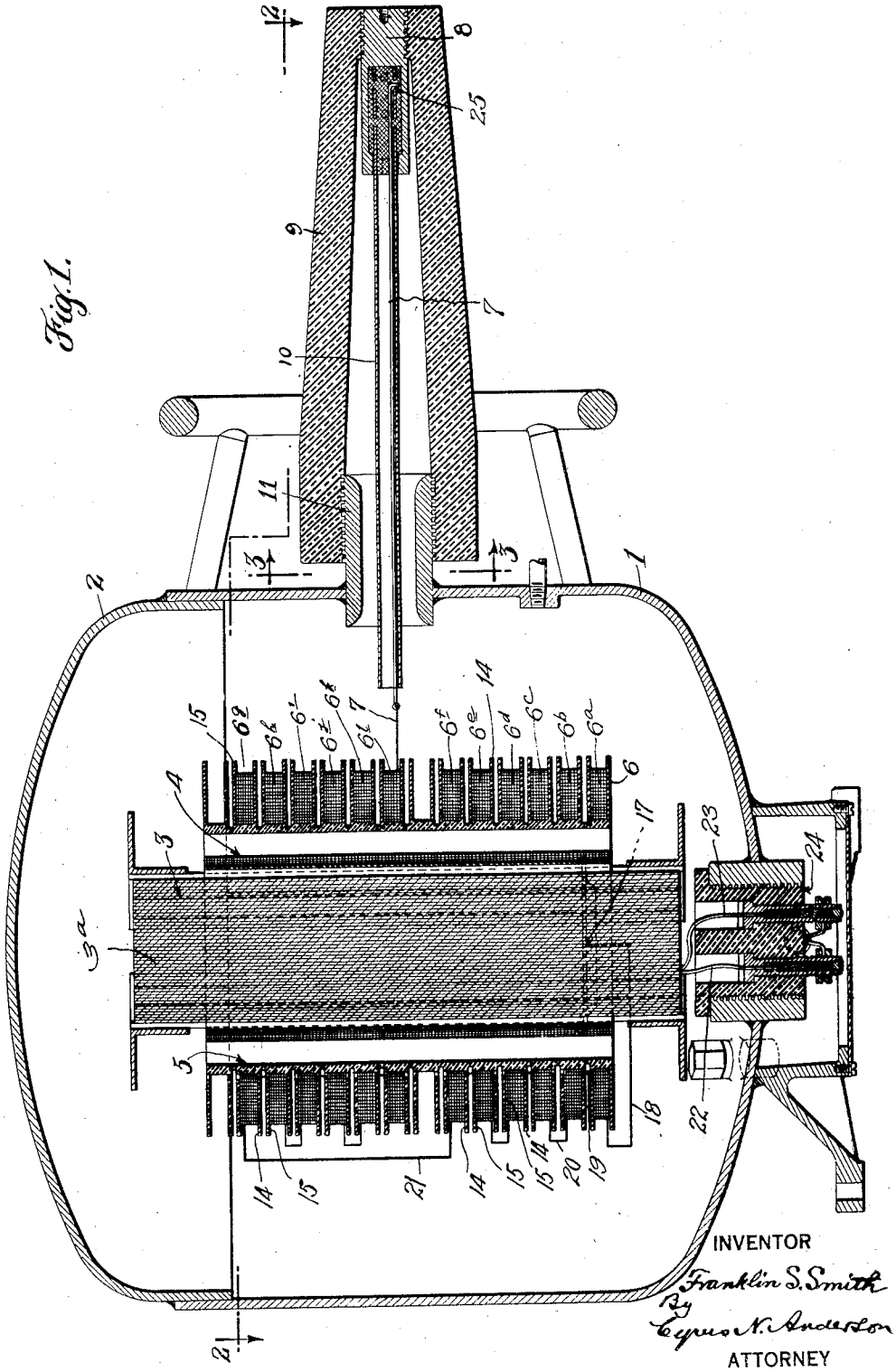
Feb. 26, 1929. 1,703,408

F. S. SMITH

TRANSFORMER

Filed Sept. 14, 1920 2 Sheets-Sheet 1

Fig. 1.



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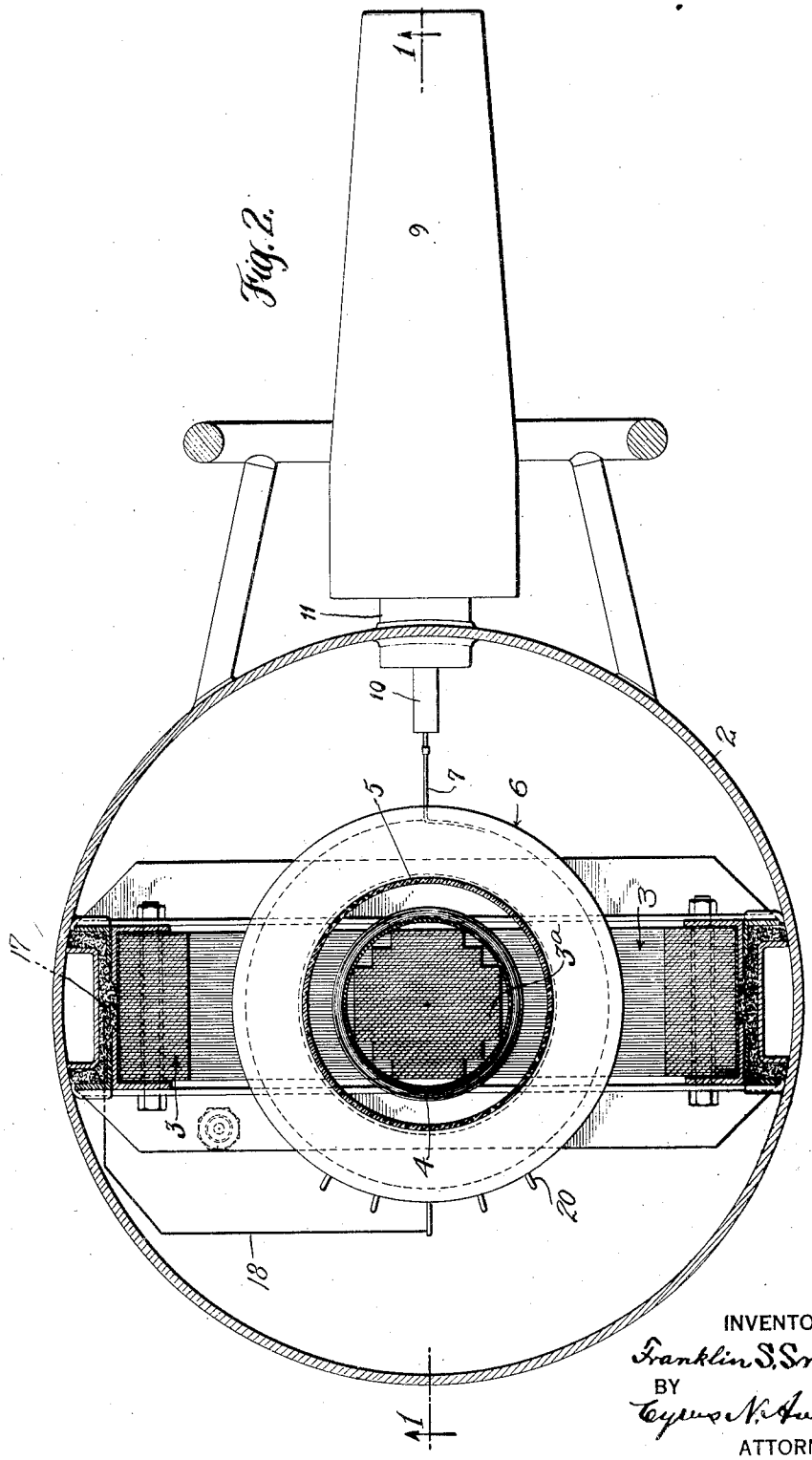
Feb. 26, 1929. 1,703,408

F. S. SMITH

TRANSFORMER

Filed Sept. 14, 1920 2 Sheets-Sheet 2

Fig. 2.



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Patented Feb. 26, 1929. 1,703,408

UNITED STATES PATENT OFFICE.

FRANKLIN S. SMITH, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO THE PRODUCTS PROTECTION CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

TRANSFORMER.

Application filed September 14, 1920. Serial No. 410,279.

This invention relates to electrical apparatus and more particularly to transformer construction, and more especially to such apparatus and construction adapted to operate at relatively high potentials.

One of the objects of this invention is to provide a thoroughly practical construction for electrical transformers which will be of thoroughly reliable and dependable operation and moreover capable of such operation at relatively high potentials. Another object of this invention is to provide a transformer of simple and inexpensive construction, capable of embodiment in compact form, and having a high efficiency. Another object is to provide a transformer in which the copper and iron losses are greatly minimized, in which a closer linkage between the windings and the magnetic circuit may be achieved than has heretofore been possible, and in which the efficiency and regulation of the transformer are in these and other ways greatly improved. Another object is to provide a construction of the above-mentioned character which will have a high space factor and which in operation will require a minimum of manual attention. Another object is to provide an apparatus of the above-mentioned character capable of thoroughly dependable operation at relatively high voltages and characterized by a high degree of protection against over-voltage and against such phenomena as surges, transients, and the like. Another object is to provide a simple and practical protective device for a transformer or like construction and which will be of thoroughly dependable action throughout the varying conditions met with in practical use. While it is among the objects of this invention to improve the mechanical and electrical characteristics of electrical transformers, yet, as will be made more clear hereinafter, certain parts or features of this invention are applicable to, and the many advantages thereof may be achieved in, other types of electrical apparatus, particularly in apparatus in which considerable amounts of electrical energy are dissipated in the form of heat. Other objects will be in part obvious or in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, and arrangements of parts as will be exemplified in the structure to be hereinafter described and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings in which is shown a preferred embodiment of my invention,

Figure 1 is a vertical central sectional view of an electrical transformer embodying my invention, taken on the line 1—1 of Figure 2, and

Figure 2 is a plan view of the apparatus partly in horizontal section, as seen along the line 2—2 of Figure 1.

Similar reference characters refer to similar parts throughout the several views of the drawing.

As conducive to a clearer understanding of certain aspects of this invention, it may at this point be noted that in accordance with certain features of this invention, the transformer or other piece of electrical apparatus, is enclosed in a casing 1—2, preferably sealed, and filled with a gaseous dielectric of the character hereinafter more clearly described, and that more specifically certain structural features and improvements are provided and adapted for taking peculiar advantage of the characteristics of the above-mentioned gaseous dielectric, and for achieving, in coaction with one another, great improvement in the mechanical and electrical characteristics of the apparatus. And although I have chosen as an illustrative embodiment of the invention a transformer which also embodies certain other structural improvements forming no part of the present invention, it is, nevertheless, to be understood that certain features of the present invention are of other application as above noted.

The above-mentioned casing is made up preferably of two parts indicated respectively at 1 and 2 in Figure 1 of the drawings; the parts 1 and 2 may be inter-fitted, as shown in the drawing, and are welded together at their juncture, as at 12, to form an enclosing air-tight casing.

Within this casing 1—2 is supported a suitable transformer core generally indicated at 3 illustratively shown as of the shell type and about the middle leg 3^a is the primary or low tension coil 4 wound on a cylinder 13 of suitable solid dielectric material. The secondary or high tension winding is made up of a suitable number of coils, 6^a, 6^b, 6^c,

6^a, 6^e, 6^f, 6^g, 6^h, 6^i, 6^j, 6^k, 6^l, suitably supported upon a cylindrical support 5 of solid dielectric material. Each coil may be wound or formed between a pair of flanges 14 and 15, each of suitable solid dielectric material and each suitably mounted upon or carried by the cylindrical support 5. Adjacent flanges 14 and 15 of adjacent coils (for example of coils 6^g and 6^h) are spaced from one another as at 16 in the direction of the axis of the member 5. The detailed features of construction of the secondary or high tension winding and its support form no part of the present invention and need not be described in further detail. The coils of the high tension winding are connected in series, as shown in Figure 1; more particularly, the outer terminal of coil 6^a is grounded to the apparatus, conveniently to the transformer casing, as at 17, by way of the conductor 18 (see also Figure 2). The inner terminals of coils 6^a and 6^b are connected together as at 19 and the outer terminals of coils 6^b and 6^c are connected together as at 20; thus coils 6^a—6^f are connected in series whence a conductor 21 connects the outer terminal of coil 6^f to the outer terminal of the uppermost coil 6^g of the coil stack, coils 6^g—6^l being thence connected in series, the outer terminal of coil 6^l terminating in the conductor 7.

The terminals of the primary or low tension coil 4 are indicated in Figure 1 of the drawing at 22 and 23 respectively and are carried through the portion 1 of the casing 1—2 through a suitable insulating bushing construction generally indicated at 24, in order to permit suitable connection to be made to the winding 4 from the exterior of the casing. The detailed features of this bushing construction 24 form per se no part of the present invention and hence need not be described in further detail.

The secondary lead 7 passes through one side of the transformer casing 1—2 and is anchored as at 25 in a terminal plug 8 at the outer end of a terminal lead structure which includes a tube-like housing 9 of solid dielectric material. The terminal plug 8 is exposed exteriorly of the outer end of the housing 9, as is clearly shown in Figure 1, and by way of the plug 8 electrical connection may be made to the secondary lead 7 from the exterior of the transformer casing. The inner or left-hand end of the housing 9 is mounted upon a metallic tube or bushing 11 welded into a suitable opening in the side of the transformer casing. The terminal plug 8 has also anchored therein the outer or right-hand end of a tube 10 of conducting material, the secondary lead 7 being in electrical contact with the tube 10 and passing through the latter, as is clearly shown in Figure 1. The metallic tube 10 through which the lead 7 extends passes centrally through the bushing 11 and is separated from the inner surface of the latter by a space which is in open communication with the interior of the casing 1—2 so that when the casing is filled with a gaseous dielectric the space between the tube 10 and the inner surface of the bushing 11 will also be filled with this dielectric. Certain features of the terminal lead construction thus far briefly described form the subject matter of my co-pending application for Letters Patent Serial No. 449,212, filed March 2, 1921, are not claimed herein, and need not therefore be described in detail herein.

Within the casing 1—2 and hence also within the space between the conducting tube 10 and the bushing 11, as well as in the open-ended annular space between the cylindrical support 5 and the primary or low tension winding 4 of the transformer, is a gaseous dielectric under pressure for coaction with the various structural features hereinbefore pointed out. This gaseous dielectric preferably takes the form of that described in my co-pending application, Serial No. 410,280, filed of even date herewith, and in that application I have described and claimed a gaseous dielectric having all the requisite electrical, thermal, and chemical characteristics and consisting of a mixture of two or more gases, one or more of the gases having the requisite high dielectric strength and the other or others having the desired thermal characteristics. The particular mixture of gases which I prefer to employ, in so far as certain features of the present invention are concerned, is a mixture of helium with nitrogen, but whatever gases are used in connection with the above-mentioned certain features of this invention, it is preferred and highly advantageous that one or more of the gases shall have high dielectric strength, that another or others shall have the requisite thermal characteristics to permit the dissipation of the heat generated, that the mixture shall be substantially inert chemically with respect to the metal and the solid dielectric portions of the apparatus and devices with which it comes in contact, and that the constituent gases shall be incapable of forming a dangerously explosive mixture with one another or with air in the presence of an electric spark. Also, the gaseous dielectric will ordinarily be employed at pressures substantially exceeding atmospheric pressures.

As pointed out in my above-mentioned application, Serial No. 410,280, the properties of this preferred form of gaseous dielectric may be varied through quite a wide range by varying the proportions and the densities of the constituent gases. By way of explanation merely, it might be noted at this point that by the term "density" and/or "densities", is not meant such a characteristic of a gas as is otherwise known as its specific gravity or its molecular weight

but rather the "denseness" of the gas or the number of molecules of the gas per unit volume. The dielectric strength increases with increase in the density and proportion of nitrogen present, the mixture being found to have approximately the dielectric strength of nitrogen at the density at which the nitrogen is present in the mixture. The thermal conductivity and specific heat are increased as the proportion of helium is increased, the mixture being found to have approximately the thermal conductivity of helium at the proportion at which the helium is present in the mixture. Hence the particular mixture of gases to be employed in any particular transformer or other electrical apparatus wherein the mixture is, in accordance with certain features of my invention, to coact with certain parts of the apparatus, may be calculated when the expected potential difference and the expected dissipation of energy in the form of heat are known. Of course proper allowance will be made for an appropriate margin of safety in accordance with good engineering practice.

Considering now certain of the structural features of this invention, and the coaction therewith of the preferred form of gaseous dielectric above-described, it may first be noted that the dissipation of the heat generated within the apparatus involves the transfer of this heat through the gaseous dielectric by radiation, conduction and convection to the walls of the enclosing casing, and its removal from the walls of the casing to, for example, the surrounding atmosphere, all at a rate sufficient to maintain a state of equilibrium without an excessive rise in temperature. It has been found that the improved gaseous dielectric hereinabove described has thermal characteristics such that it effects the transfer of heat generated in the apparatus, by, for example, radiation, conduction and convection to the walls of the enclosing casing, in a manner not only equal to but materially better than the oil dielectric which is now commonly used in transformers. According to certain of the above-mentioned features of this invention, however, this beneficial effect is increased and thus there is achieved a further limiting of the rise in temperature of the parts of the apparatus when in use; thus, for example, by carrying the leads out of the transformer casing at the bottom or sides thereof and forming the upper portion of the casing to which the heated gaseous dielectric rises and with the interior of which it is free to make intimate contact, a large substantially unbroken heat dissipating surface is effectively provided.

Moreover, the annular open-ended and vertically extending space between the primary winding 4 and the secondary winding 6 provided an adequate passage in which heated gaseous dielectric may rise to contact with the upper portion of the casing, whence it may be deflected outwardly and downwardly into contact with the sides and bottom of the casing, and upon being cooled by contact with the latter, may be passed or thus circulated back into the lower end of this annular space. Where relatively large amounts of electrical energy are dissipated in the form of heat, as is usually the case with an electrical transformer, the coacting of the preferred form of gaseous dielectric, for example, a mixture of nitrogen and helium, with such features of construction as have just been described, achieves a highly efficient and reliable prevention of excessive rise in temperature of the apparatus.

Considering now certain other features of this invention and their coaction with a gaseous dielectric under pressure, it might first be pointed out that many thoroughly practical advantages are dependably and effectively achieved. To illustrate some of these advantages, it might first be noted that when oil is used as a dielectric in transformers, it is necessary, because of such factors as the unavoidable occurrence of moisture in the oil, and the limited dielectric strength of oil, to separate the secondary winding from the primary winding by a large space and to interpose in that space suitable barriers of solid dielectric material. But I provide a dielectric whose effective dielectric strength it is possible, according to the present invention, to increase well above that possible with oil; as will be clear in view of what has been hereinbefore set forth and by way of possible further explanation, I achieve such an increased dielectric strength by increasing the density of the gaseous dielectric, that is, by increasing the number of molecules thereof per unit volume, and this I effect by subjecting the gaseous dielectric to a corresponding suitable pressure. Because of the resultant increased dielectric strength of the gaseous dielectric, as compared with oil, it is possible to do away with intervening solid dielectric barriers and to place the secondary winding in closer proximity to the primary winding than would be possible in an oil-filled transformer. Such an arrangement is illustratively shown in the drawings and gives rise to further important advantages both electrically and mechanically. The spacing of the secondary winding closer to the primary winding decreases the magnetic leakage and consequently improves the regulation of the transformer; also, less copper can be used and the decrease in length of both magnetic circuit and the electrically conductive circuit decreases the losses and the electrical efficiency of the transformer is improved. When the barriers of solid dielectric are

omitted, heat dissipation is more readily effective, due, for example, to the less impeded convection currents.

Furthermore, when different dielectrics are arranged in series the total dielectric stress is distributed between them inversely as their permittivities, and the dielectric stresses are distributed in accordance with the thicknesses of the dielectrics employed; on account of the high dielectric strength and low permittivity of a gaseous dielectric under pressure, the stresses upon the solid dielectric when arranged in series with the gaseous dielectric are decreased. Because of the resultant decrease in the stresses on the solid dielectric in such an arrangement, a materially smaller thickness of solid dielectric may be employed than is the case where oil is used, and thus a reduction in bulk and weight, greater compactness, and decreased losses may be achieved. Such features and advantages as these may be fully achieved even though the gaseous dielectric comprises a suitable single gas.

Referring to Figure 1 of the drawings, it may be pointed out that the secondary or high tension winding 6 is separated from the primary or low tension winding 4 by the solid dielectric member 5 in series with the gaseous dielectric under pressure in the annular intervening space, and these elements are illustrative of a preferred relation for achieving such advantages as immediately above noted.

Recurring now to the relation between the bushing 11 and the metallic tube 10 (which is in electrical contact with the secondary or high tension lead 7), the radial distance between the outer surface of the tube 10 and the inner surface of the bushing 11 is so chosen with respect to the potential differences intended to be developed within the transformer and with respect to the strength of the gaseous dielectric as to afford a safety device adapted to protect the conductors and the solid dielectric of the transformer from destruction upon the occurrence of excessive potential differences within the transformer. To this end the radius of the outer surface of the tube 10 and the radius of the inner surface of the bushing 11 are so chosen as to produce a fast gap which will arc-over without preceding corona and which has a critical voltage less than that voltage which would injure any part of the transformer or other apparatus within the casing. This fast gap is in shunt relation to the high voltage winding, as will be clear from the drawings; thus, the bushing 11, which forms one electrode of the gap, is welded to the casing 1—2 and is thus in electrical connection with the one terminal 18 of the high tension winding 6 which as hereinbefore noted is grounded to the casing at 17 while the metallic tube 10, which forms the other electrode of this gap, is, as already noted, in electrical connection with the other terminal of the high tension winding 6, namely, the secondary lead 7.

With this arrangement the occurrence of a dangerous potential difference such as may be due to a surge or a transient, for example, will break down the gaseous dielectric between the surfaces of the bushing 11 and tube 10 and will permit the discharge of the high potential to ground through the transformer casing; the gap being in shunt relation to the high voltage winding as above noted, thus shunts away from the apparatus any potentials that would injure the latter. As soon as the disturbing conditions have been removed the gaseous dielectric which is in no wise destroyed or injured by the discharge will automatically reestablish the insulation between the outer surface of the tube 10 and the inner surface of the bushing 11; in this way, the self-restoring characteristics of the gaseous dielectric cooperate with the improved structure to protect the entire apparatus from injury and, moreover, to maintain the protective device in a consistently effective protective condition.

A peculiarly advantageous feature in this connection resides in the fact that the gaseous dielectric interposed in the space between the electrodes of the "fast gap" is characterized by a very low dielectric time lag, and particularly low as compared with that of oil such as is commonly used in transformer construction; upon the occurrence of a potential high enough to injure the transformer parts, this relatively low dielectric time lag of the gaseous dielectric permits the gap to break down with such rapidity that the time elapsed is insufficient to permit whatever value of this high potential that may be impressed upon the transformer parts to cause the latter any harm.

Where herein or in the following claims the unmodified term "fast gap" is used, I wish it to be understood that I mean a gap in such form and of such characteristics that disruptive discharge will not be preceded by corona or brush discharge, and that the electrodes thereof are separated by a dielectric having low dielectric time lag. I wish also to note at this point that in so far as this "fast gap" is concerned, it is not essential that the gaseous dielectric comprise a mixture of helium and nitrogen or of gases having the relatively high thermal conductivity of such a mixture; as has already been made clear, such a mixture of gases is of great advantage where considerable amounts of electrical energy are dissipated in the form of heat and where it is impracticable to use alone any single gas, it being noted that there is no known gas which possesses at once the required electrical,

thermal, and chemical characteristics to meet all the requirements where considerable amounts of electrical energy have to be dissipated in the form of heat. Hence, I wish it to be understood that many features and advantages of the protective spark gap of my invention may be fully achieved irrespective of whether or not the gaseous dielectric coacting therewith comprises a mixture of such gases are helium and nitrogen; for example, I may achieve such features and advantages where the gaseous dielectric coacting with the protective gap is a suitable single gas.

By way of further explanation merely, and as conducive to a clearer understanding of certain features of this invention, I might note that I have in practice achieved such advantages as those noted above where I have used in the apparatus a gaseous dielectric under a pressure on the order of sixteen atmospheres.

In some of the following claims the preferred form of gaseous dielectric of my invention is defined as a mixture of helium and nitrogen, but it will be understood that this definition is used to include not only those gases specifically named but any other gases which in admixture have the properties hereinabove described in connection with helium and nitrogen. Where in others of the following claims, the dielectric is defined as a "gaseous dielectric", the latter term is not to be limited to a mixture of gases but is to be understood as including either a suitable single gas or two or more gases in admixture.

It will thus be seen that there has been provided in this invention an apparatus in which the various objects hereinbefore noted, as well as many thoroughly practical advantages are successfully achieved, and that the apparatus is well adapted to meet the varying conditions of hard practical use.

As many possible embodiments may be made of the above invention and as many changes might be made in the embodiment above set forth, it is to be understood that all matter hereinbefore set forth or shown in the accompanying drawing is to be interpreted as illustrative and not in a limiting sense.

What I claim is:

1. An electrical apparatus which in operation dissipates considerable energy in the form of heat, comprising a sealed casing filled with a gaseous dielectric composed of helium and nitrogen in admixture.

2. The combination of an electrical apparatus which in operation dissipates considerable energy in the form of heat and a sealed casing filled with a gaseous dielectric composed of helium and nitrogen in admixture, the relative proportions of helium and nitrogen present varying with the differences in potential which may be developed and with the amount of energy to be dissipated.

3. An electrical transformer having a sealed casing comprising an element which constitutes a part of a fast gap structure, which casing is filled with a gaseous dielectric, a secondary lead which is separated by a portion of the gaseous dielectric from said element of the casing, which element is in electrical connection with the opposite side of the secondary, and means for supporting said lead in fast gap relationship to the said element, the gap between the exterior surface of said lead and the coacting surface of the said element having a critical voltage less than that voltage which would injure the other parts of the secondary of the transformer.

4. An electrical transformer having a sealed casing filled with a gaseous dielectric consisting of a mixture of gases one of which possesses high dielectric strength and the other of which possesses relatively high thermal conductivity, a tubular bushing extending through the casing and a lead from the secondary of the transformer which extends centrally through the bushing, the radii of the secondary lead and of the inner surface of the bushing being such as to produce a fast discharge gap having a critical voltage less than the voltage which would injure the other parts of the secondary of the transformer.

5. An electrical transformer having a core, a primary winding surrounding the core, a secondary winding and a dielectic support for the secondary winding, the secondary winding and its support being separated from the primary winding by a narrow space filled with a gaseous dielectric comprising a mixture of nitrogen and helium of a density greater than air at atmospheric pressure.

6. An electrical transformer having a hermetically sealed casing filled with a gaseous dielectric comprising a mixture of nitrogen and helium under pressure, the said casing having at its upper part an extended surface of large heat dissipating capacity freely exposed to contact with the gaseous dielectric, and means whereby free circulation of said dielectric with relation to the transformer within the casing is effected.

7. In apparatus of the character described, in combination, a transformer adapted to operate at relatively high voltage, and means forming a circuit in shunt relation to the high voltage winding of said transformer and having included therein electrode members of such relative configuration as to preclude the formation of corcona preceding spark-over and sepa-

rated by a self-restoring dielectric of invariable dielectric strength, thereby to form a fast spark gap across which spark-over is effected at a fixed critical voltage.

8. In apparatus of the character described, in combination, an electric transformer located within a grounded container which is filled with a gaseous dielectric under pressure, and a circuit in shunt relation to the high voltage winding of said transformer, which circuit includes means forming a fast spark gap one side of which is grounded upon said container, and the said gap being filled with the said gaseous dielectric.

9. In apparatus of the character described, in combination, an electric transformer having a circuit in multiple with its high voltage winding, said circuit including spaced electrode means of such relative configuration as to preclude the formation of corona preceding spark-over, and a gaseous dielectric under pressure for insulating and cooling said transformer, said gaseous dielectric under pressure being included in the space between said electrode means, the latter forming thereby a fast spark gap.

10. In apparatus of the character described, in combination, an electric transformer including primary and secondary windings and solid dielectric material, a circuit in shunt relation to the high voltage winding of said transformer, said circuit including means forming a fast spark gap, a container in which said transformer and fast gap are located, and a gaseous dielectric under pressure in said container for insulating and cooling said transformer, said gaseous dielectric under pressure being included in said gap, the critical spark-over voltage of said fast gap being less than the voltage which would rupture any part of the solid dielectric of said transformer.

11. In apparatus of the character described, in combination, a hermetically sealed container having therein a transformer adapted to operate at relatively high voltage and containing a substantially chemically neutral gaseous insulating and cooling medium under pressure, and a circuit in shunt relation to the high voltage winding of said transformer, said circuit including spaced electrode-forming means of such relative configuration as to preclude the formation of corona preceding spark-over and subjected to said insulating and cooling medium under pressure, thereby to form a fast spark gap of such constant critical spark-over voltage that the said spark gap is dielectrically the weakest point of the high voltage insulation.

12. In combination, a transformer element comprising concentric primary and secondary windings, a tubular member of dielectric material inclosing the primary winding and spaced therefrom, said secondary winding being wound around and supported by said tubular member of dielectric material, a sealed casing within which said transformer element is located, said casing containing a gaseous dielectric of substantially constant density greater than atmospheric and the opposite sides and ends of said transformer element being spaced from the said casing to provide spaces between the said transformer and the said casing whereby free circulation of the said gaseous dielectric through the space between the said tubular member of dielectric material and the primary winding and around and in contact with the opposite sides and ends of the said transformer element and with the inner surface of the said casing is permitted.

13. In combination, a transformer element and a hermetically sealed casing within and by which the said transformer element is situated and supported, a lead structure projecting from a wall of the said casing, the interior of said lead structure being in communication with said casing and the said casing and lead structure containing a gaseous dielectric of substantially constant density greater than atmospheric, a lead extending from one side of the high voltage winding of said transformer element into the said lead structure, a grounded element in spaced relation to said lead, the space between the said lead and the said grounded element constituting a gap in shunt relation to the said high voltage winding, the dimensions and configuration of the parts forming the said gap and the density of the said gaseous dielectric being such that spark-over is effected at a substantially constant critical voltage less than the voltage which would rupture any other part of the dielectric of said transformer.

14. In apparatus of the character described, in combination, an electric transformer, a circuit in shunt relation to the high voltage winding of said transformer, said circuit including spaced electrode-forming means of such relative configuration as to preclude the formation of corona preceding spark-over, the space between said electrode-forming means being filled with a gaseous dielectric under pressure, thereby to form a fast spark gap across which gap spark-over is adapted to occur at a predetermined voltage, and a hermetically sealed container for confining said gaseous dielectric under pressure.

15. In apparatus of the character described, in combination, a hermetically sealed casing adapted to withstand relatively high pressures and having therein an electrical apparatus adapted to operate at relatively high voltage, a tube-like housing of

solid dielectric material projecting from said casing and arranged to be in connection therewith, a gaseous dielectric under pressure within said casing and said housing, a relatively rigid conducting lead connected at one end thereof to a high voltage part of said electrical apparatus and extending into said housing but spaced therefrom, thereby to be surrounded by said gaseous dielectric, and means passing through an end portion of said housing remote from said casing for making electrical connection from the exterior thereof to said lead.

16. In apparatus of the character described, in combination, a hermetically sealed casing having therein an electrical apparatus adapted to operate at relatively high voltage, a circuit shunted about the high voltage terminals of the apparatus within said casing, said circuit including spaced electrode-forming means of such relative configuration as to preclude the formation of corona preceding spark-over, and a gaseous dielectric under pressure filling the space between said electrode-forming means, thereby to form a fast spark gap, said gap having a critical voltage less than that which said electrical apparatus can safely withstand.

In testimony that I claim the foregoing as my invention, I have hereunto set my hand this 13th day of Sept., A. D. 1920.

FRANKLIN S. SMITH.