Feb. 25, 1930. G. A. BURNHAM 1,748,060

ELECTRIC HIGH TENSION SWITCHING SYSTEM AND APPARATUS

Filed Dec. 13, 1927 2 Sheets-Sheet 1

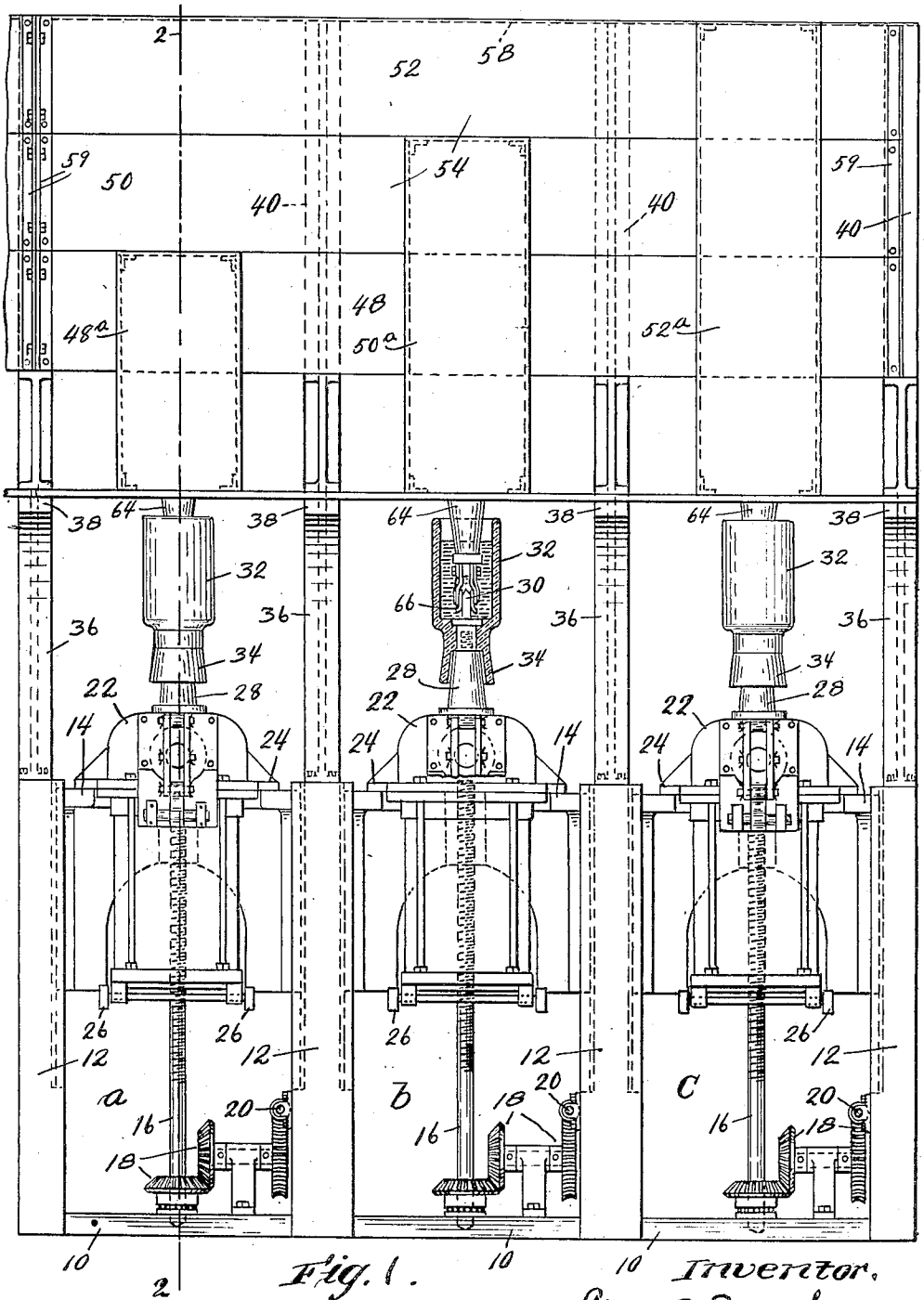


Fig. 1.

Inventor.
George A. Burnham
by [illegible]
Atty

Feb. 25, 1930. G. A. BURNHAM 1,748,060

ELECTRIC HIGH TENSION SWITCHING SYSTEM AND APPARATUS

Filed Dec. 13, 1927 2 Sheets-Sheet 2

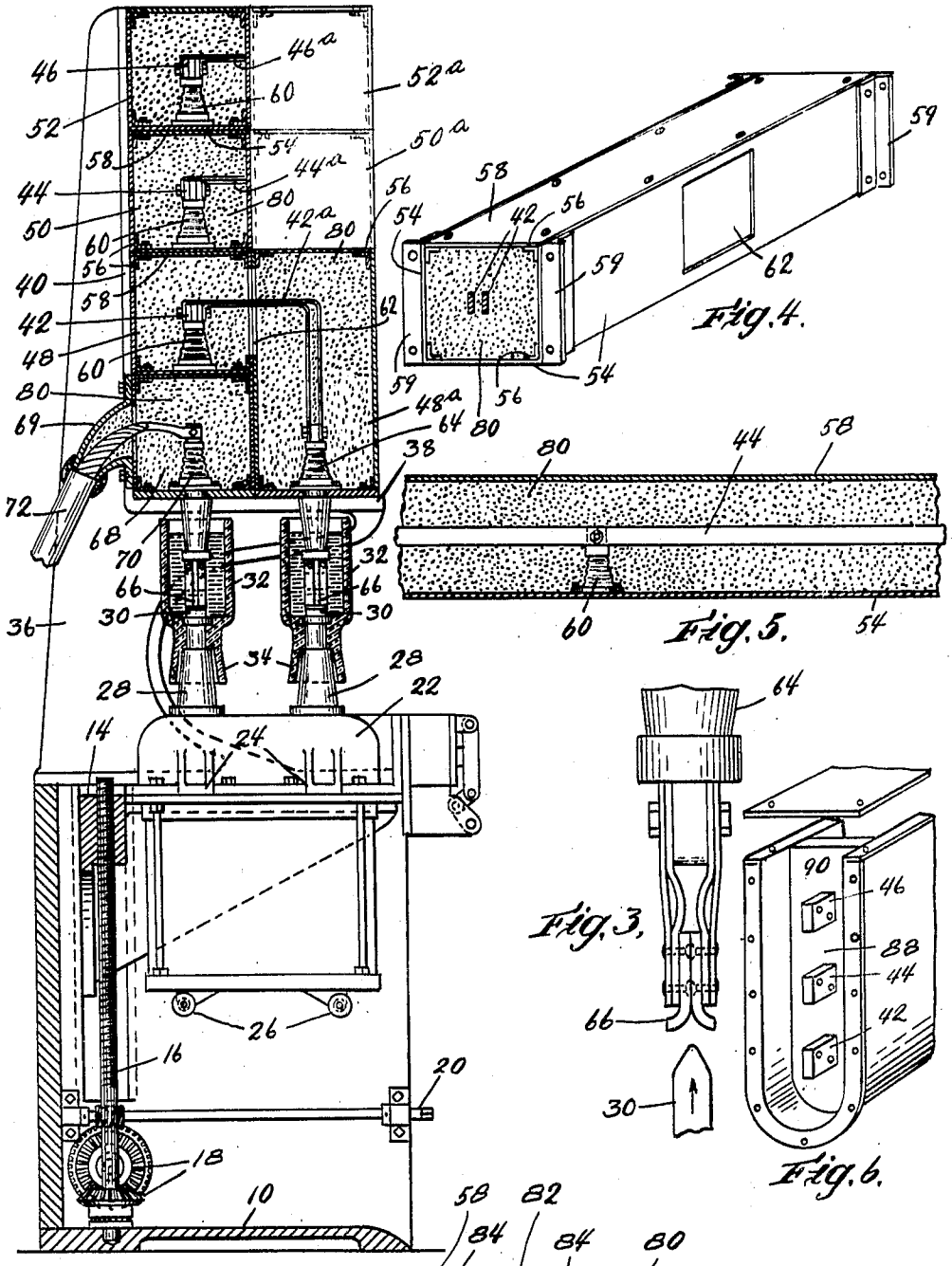


Fig. 2.

Fig. 4.

Fig. 5.

Fig. 3.

Fig. 6.

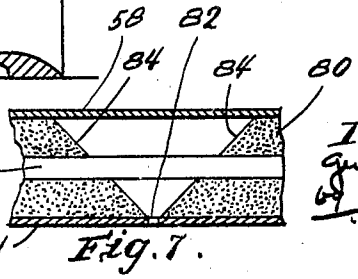


Fig. 7.

Inventor,
George A. Burnham
by Townsend
Atty

Patented Feb. 25, 1930 1,748,060

UNITED STATES PATENT OFFICE

GEORGE A. BURNHAM, OF SAUGUS, MASSACHUSETTS, ASSIGNOR TO CONDIT ELECTRICAL MANUFACTURING CORPORATION, OF SOUTH BOSTON, MASSACHUSETTS, A CORPORATION OF MASSACHUSETTS

ELECTRIC HIGH-TENSION SWITCHING SYSTEM AND APPARATUS

Application filed December 13, 1927. Serial No. 239,790.

This invention relates to electric high tension switching systems and apparatus wherein the high tension buses, usually extended directly from the generators, are contained in ducts and are extended immediately above or beside oil immersed switches which are connected with the buses and also with branch lines which they control. When oil switches are opened under heavy loads or under a short circuit, heated oil and flame are frequently expelled from the switch casings. If the heated vapor or flame comes in contact with the high tension buses it forms a sufficiently low conducting path between them to cause a disastrous arc to form. Since the buses usually are directly connected with the generators without interposed overload circuit breakers therein there is no way of quenching the arc and removing the short circuit from the buses. The arc can thereupon continue indefinitely and cause great damage to the station and cause a loss of service extending over many hours. As a consequence, the buses are usually enclosed in the aforesaid ducts to shield them from contact with conducting gases that may be expelled from the switches.

There are a number of types of bus enclosing systems. In one type, the duct in which the bus is contained is filled with oil which serves not only to shield the bus from contact with gases but also to provide the insulation for the bus. With this system, however, the duct must be made and kept absolutely oil tight, otherwise the oil will leak out and remove the insulation from the bus so that a flash over will occur from the bus to the duct, which usually is made of metal. Danger from fire, due to the ignition of the oil in the duct from a possible flash over, is always present. When a flash over occurs large volumes of explosive gases and vapors and free carbon may be generated; and these may explode and do great damage.

In another type of bus structure the oil is replaced by an insulating compound which is poured into the duct while hot and liquid and cools and solidifies about the bus and thus forms a hard and brittle insulating compound. Danger of leakage of the insulating compound is thus obviated but the fire hazard is not greatly reduced. Since the compound is brittle, it has a tendency to crack when subjected to strains and thus open up a path for a flash-over arc. The arc sets fire to the compound and it burns, with disastrous results.

In yet another system of bus structure, the bus is contained within a duct which contains no especial insulating material, and the duct is made sufficiently large in cross section to prevent flash over between the bus and the conducting walls of the duct. With this type of structure, it has been found that hot gases discharged from the switch will be forced into the duct through seemingly minute crevices and channels between the walls thereof and cause the formation of an arc between the bus and the duct. In some instances, it has been found that the interior walls of the duct and the insulators on which the bus is mounted become coated with carbon expelled from the oil switch and that the carbon provided a conducting path which caused a flash over and the failure of the switching system.

It is an object of the present invention to provide a switching system of the type above set forth with a bus structure at the oil switches so arranged that gas expelled from the switch can not come in contact with the bus; and also so arranged that the troubles and defects of the above enumerated present systems are absent. It is a further object of the invention to provide an electrical switching system and a bus structure therefor wherein the bus is enclosed in an insulating body that is not affected by arcs, will not burn or give off gases, and is mobile so that it can conform itself to changes in shape or dimensions of the bus and enclosing structures due to expansion, distortion and the like and also so that it can be poured or otherwise placed readily in the bus-enclosing duct and also removed therefrom, and, while being freely mobile, yet has such characteristics that only the material immediately at large openings in the duct will escape, while none will escape through small openings.

It is a further object of the invention to provide an electrical switching system composed of oil immersed electric switches and an

enclosed bus structure associated with the switches, with a loose, solid filler in the bus ducts which is composed of discrete, solid, electrically-insulating particles which surround and enclose the bus and prevent the gases discharged from the oil switches from penetrating the filler sufficiently to come in contact with the bus and cause trouble.

It is a yet further object of the invention to provide an electrical switching apparatus wherein the buses are enclosed in compartments and wherein the compartments contain sand in which the buses are submerged.

A further object of the invention is generally to improve the construction and operation of high tension electric switching systems.

Fig. 1 is a front elevation of a switching system embodying the present invention.

Fig. 2 is a sectional view taken along line 2—2 of Fig. 1.

Fig. 3 is a sectional detail of the contact structure between the switch terminals and the bus terminals.

Fig. 4 is a perspective view of a bus duct embodying the invention.

Fig. 5 is a longitudinal sectional elevation through a bus duct embodying the invention.

Fig. 6 is a perspective detail showing a modified form of bus duct.

Fig. 7 is a sectional detail illustrating the manner in which the sand filler is retained in the duct about an opening therein.

Figs. 1 and 2 illustrate my invention applied to a three phase switching apparatus. As shown in these figures, the apparatus includes a frame having the base or floor 10 and the laterally-spaced vertical side walls 12 which form three cell enclosures *a*, *b*, *c*, respectively, for the three phases of a high tension circuit. A platen or carriage 14 is vertically movable between and is guided by the walls 12 of each cell on a vertically screw threaded shaft 16 which is operated by suitable mechanism 18 from a control shaft 20 to raise and lower the carriage or platen. An oil immersed electric switch 22 of any suitable type is received in an opening in each platen and is supported thereon by the feet 24. The platen can be raised to elevate the switch into an operating position as shown in Fig. 2 and it can also be lowered to lower the switch so that it is supported by its wheels 26 on the floor 10 of the cell and thus can be moved out of the cell and away from the platen for inspection or otherwise.

The terminals 28 of the switch extend vertically thereabove and are provided with vertical contact blades 30 for engagement with the bus terminals hereinafter to be described. Insulating cups 32 surround said terminals and upstand thereabove and are intimately connected mechanically therewith and are adapted to contain oil in which the contact blades and also the terminals of the buses are adapted to be immersed, thereby to shield the live parts of the contact structure from access by the hot gases expelled from the switch. The cups 32 are provided with depending annular flanges 34 which surround the upper ends of the insulators of the switch terminals for the same reason.

Brackets 36 are carried by and upstand above the walls 12 of the switch supporting frame and have horizontal shelves 38 which extend forwardly from the rear of the frame and provide support for the bus structure. Said brackets also have vertical shelves 40 at the rear thereof which also provide support for the bus structure.

The buses 42, 44, and 46, for the three phases of a high tension circuit, are contained in rectangular ducts or compartments 48, 50 and 52 which are disposed in superimposed order against the rear shelves 40 of the supporting brackets and are supported by the horizontal shelves 38. The enclosing ducts or compartments can have any suitable construction but, as here shown, are formed of side and bottom walls 54 secured to longitudinally extended corner angles 56. Each duct is provided with a cover 58 which is removable for access to the interior of the duct. No especial care is taken to make the ducts absolutely fluid tight. The ends of the ducts are provided with outstanding flanges 59 by which horizontally aligned ducts of adjacent switching systems can be attached thereto. The buses are mounted in the middle of the ducts on suitable insulators 60 which are carried by the bottom walls of the ducts. Each of the buses is provided with branch leads 42^a, 44^a, and 46^a which are extended through the middle of openings 62 in the front walls of the ducts and into vertical branch ducts 48^a, 50^a, and 52^a which are disposed in front of the main ducts and above the switches. The branch ducts are constructed in the same manner as the main ducts and have removable top walls or covers and openings in their rear walls which register with the openings in the main ducts; and said openings are practically the full height of the main ducts. Insulating bushings 64 are extended through the bottom walls of the branch ducts, in the middle thereof, and have their upper ends connected with the branch buses and have spring pressed contact jaws 66 at their lower ends which are adapted to be engaged by the contact blades 30 of the switch terminals thereby to connect the switches electrically with the buses. Small compartments or pot heads 68 which may be similarly constructed to the bus ducts are located immediately under the line of bus ducts and in the rear and in line with the branch ducts and above the rear switch terminals. Insulating bushings 70 are extended through the middle of the bottom walls of said pot heads and are adapted to be connected

electrically with the rear terminals of the switches.

Branch line cables 72 extend upwardly from the rear of the switching frame and have their lead sheaths secured in a fluid tight manner to the depending and rearwardly extended necks 69 of said pot heads while the insulated portion of the cable extends into the middle of the pot heads and is electrically connected to the upper ends of the bushings therein.

In accordance with this invention, the electric conductors are located in the middle of the ducts or enclosing compartments and the distance between the conductors and the side walls of the ducts which are made of metal is adapted to be sufficiently great to provide a suitably high factor of safety against flash over when the ducts are filled with air.

As above stated when the oil immersed switches open under severe overload or on short circuit, they sometimes expel into the surrounding atmosphere hot oil, vapors, gases, fume and flame which if allowed to come in contact with the high tension buses or conductors will cause a flash over between the buses and the casings and the enclosing ducts and thereby often cause great damage and extended loss of service. Consequently, and in accordance with this invention, I fill the ducts with a loose, electrically-insulating fireproof body 80 which completely surrounds the ducts and provides an effective barrier against access of heated gases and conducting particles expelled from the switch thereto. Also, in accordance with this invention, the above described body is composed of sand which is the best material known to me at present. Sand has properties which are of particular value in connection with this invention. Sand is fireproof, and will not burn as oil does. The sand occupies the ducts as a loose body 80, and can be easily removed from the duct if it is desired to replace the bus with one of different current carrying section, or for other reasons. The sand can also be put into the ducts when the covers thereof are removed without any especial tools or without the exercise of any especial care except to see that the ducts are full. The branch ducts and pot heads are also filled with sand so that all bare high tension conductors are completely submerged in the sand. It is not necessary to exercise extreme diligence in sealing the ducts against small cracks or crevices as is the case with oil because the sand will not leak out of small crevices since it bridges them over and forms an arch which prevents the sand from falling out. Even though the crevices or openings are unduly large or a hole is burned in the bottom wall of a duct by some extraneous arc, the damage is slight for, because of the relatively steep angle of respose of the sand, the sand on each side of the opening, as the opening 82 of Fig. 7, will assume the slope 84 so that only the sand immediately above the opening will be lost while the remainder of the sand in the duct will remain in place. The sand is effective in preventing hot gases from reaching the bus for the sand cools the gases as they flow therethrough so that they are cooled below a point at which they are deleteriously conducting before they have penetrated the sand body to any harmful distance. Furthermore, the sand body offers great resistance to the flow of gas thereinto, and so also prevents access of gas to the bus. If oil or carbon is blown into the duct through small crevices or channels the oil and the carbon are entrapped in the voids between the small discrete particles of sand at the outermost surfaces of the sand body and so can not penetrate to the interior of the sand body. Sand is a good electrical insulator. It also provides mechanical support for the bus at all points along its length so that fewer insulating supports for the bus are needed and the bus is restrained by the sand from being forced out of its original position by strong magnetic forces acting upon it, as is often the case. Should an abnormally high potential be impressed upon the bus and an arc occur through the sand to the wall of the duct, no permanent damage will be done since the sand particles can move in to close any void formed by the arc; although experiments have failed to disclose the presence of any void. The sand also acts as a cooling medium and tends to cool the arc and quench it so that the arc has a strong tendency to go out when the voltage of the bus is lowered. The presence of sand also prevents the formation of corona in the space between the bus and the duct at a value of potential that would cause corona in air. This is due to the greater dielectric capacity of the sand over that of air so that the electrostatic flux passes through the sand particles rather than in the air filled voids between them.

Preferably, the sand is a quartz sand and free from conducting particles, or metallic compounds, as an iron compound, although it appears that sand containing some amounts of iron oxide or other iron compounds usually found in sand gives satisfactory results. Sand taken from many sources, and sand of various grades of fineness, beach sand and sand approximating in size fine gravel, seem to perform about equally well. Preferably, the sand should be free from silt or decayed vegetable matter and foreign substances. The dimensions of the sand particles can vary within rather wide limits. I have found that sand particles ½ mm. in thickness give satisfactory results. Preferably, the sand should be of sufficient fineness so that corona in the air spaces between the sand particles is minimized. The character of the sand particles,

whether smooth or sharp seems to be unimportant. Preferably, the sand should be dry but small amounts of moisture do not appear to be harmful and I propose to run the buses at such temperature, due to the current traversing them, as to heat the sand sufficiently to maintain it without harmful quantities of moisture.

In the modification shown in Fig. 6, the buses for the three phase system are disposed in spaced vertical alignment in a common duct 88 and are held in place and insulated from each other and from the walls of the duct by insulating plates 90 through apertures in which the ducts are passed. The spacing between the buses, and between the buses and duct, is sufficient to prevent flash over in air, and the duct is completely filled with sand in the manner described above.

I claim:

1. An electric high tension switching system comprising the combination of oil immersed electric switches, high tension buses located in the immediate vicinity of said oil immersed switches and connected therewith, enclosures containing said buses, and electrically insulating pulverulent mobile bodies of loose discrete, solid insulating fireproof particles contained in said enclosures about said buses, and constituting means to prevent access of a conducting gas to said buses.

2. An electric high tension switching system comprising the combination of an oil immersed electric switch, a high tension conductor adjacent said oil immersed switch, an enclosure for said conductor, and an electrically insulating mobile body composed of loose discrete solid insulating fireproof particles contained in said enclosure and about and enclosing said conductor, and constituting means to prevent access of a conducting gas to said conductor.

3. An electric high tension switching system comprising the combination of an oil immersed electric switch, a high tension conductor adjacent said oil immersed switch, an enclosure for said conductor, and a body of loose sand contained in said enclosure and by which said conductor is enclosed, and which constitutes means to shield said high tension conductor against access of a conducting gas thereto.

4. An electric high tension switching system comprising the combination of an oil immersed electric switch, a high tension conductor located within the zone of switch gases that may be expelled from said oil immersed switch, and means to insulate said high tension conductor from contact with such gases and also to insulate said conductor electrically consisting of a thick mobile mass of small discrete solid insulating and heat resistant particles disposed about and in enclosing relation with said conductor at its extent in said gas zone.

5. An electric high tension switching system comprising the combination of an oil immersed electric switch, a high tension bus located at said switch and having a branch connected with a terminal of said oil immersed switch, a duct containing said bus having a branch containing said bus-branch, and a mobile insulating body contained in said duct and the branch thereof and enclosing said bus and its branch, and composed of loose discrete solid insulating particles, and constituting means to prevent access of a conducting gas to said bus and said branch.

6. An electric high tension switching system comprising the combination of an oil immersed electric switch, a high tension bus located at said switch and having a branch connected with a terminal of said oil immersed switch, a duct containing said bus having a branch containing said bus-branch, and an insulating body contained in said duct and the branch thereof and enclosing said bus and its branch, and composed of discrete solid insulating particles of sand, and constituting means to prevent access of a conducting gas to said bus and said branch.

7. An electric high tension switching system comprising the combination of a switch, and a high tension conductor, and a mobile, insulating, inert, non-combustible body of loose solid material enclosing said conductor, and constituting means to prevent access of conducting gas to said high tension conductor.

8. In a high tension electric distribution system, the combination of an electrical apparatus capable of giving off electrically conducting gas and fume, a high tension conductor associated with said apparatus, and a mobile body of loose particles of insulating, non-combustible solid material enclosing said conductor and isolating it from said gas and fume.

9. The combination of electrical apparatus capable of giving off electrically conducting gas and fume, a high tension conductor associated with said apparatus, insulators supporting said conductor, an enclosure for said conductor and insulators, and a mobile body of insulating, non-combustible solid material contained in said enclosure about said conductor and insulators and enclosing both against said gas and fume.

10. The combination of an electric conductor operated at such elevated potential that when the conductor is within the influence of an electrically conducting gas a current arc passes through the gas from the conductor to a lower potential part, and means to maintain said conductor out of the influence of such conducting gas consisting of an enclosing envelope therefor composed largely of discrete particles of loosely compacted insulating and fireproof material which is capable of flowing, whereby to occupy voids

that may occur within the envelope, the envelope being of sufficient thickness to prevent the formation of an arc from the conductor to the surface of the envelope at the normal elevated potential of the conductor.

11. The combination of a high tension conductor and a body of loosely-compacted electrically-insulating and fireproof particles surrounding and enclosing said conductor, the voids between the particles being so small and the body having such thickness as to prevent its being penetrated to the conductor by an external conducting gas.

In testimony whereof, I have signed my name to this specification.

GEORGE A. BURNHAM.