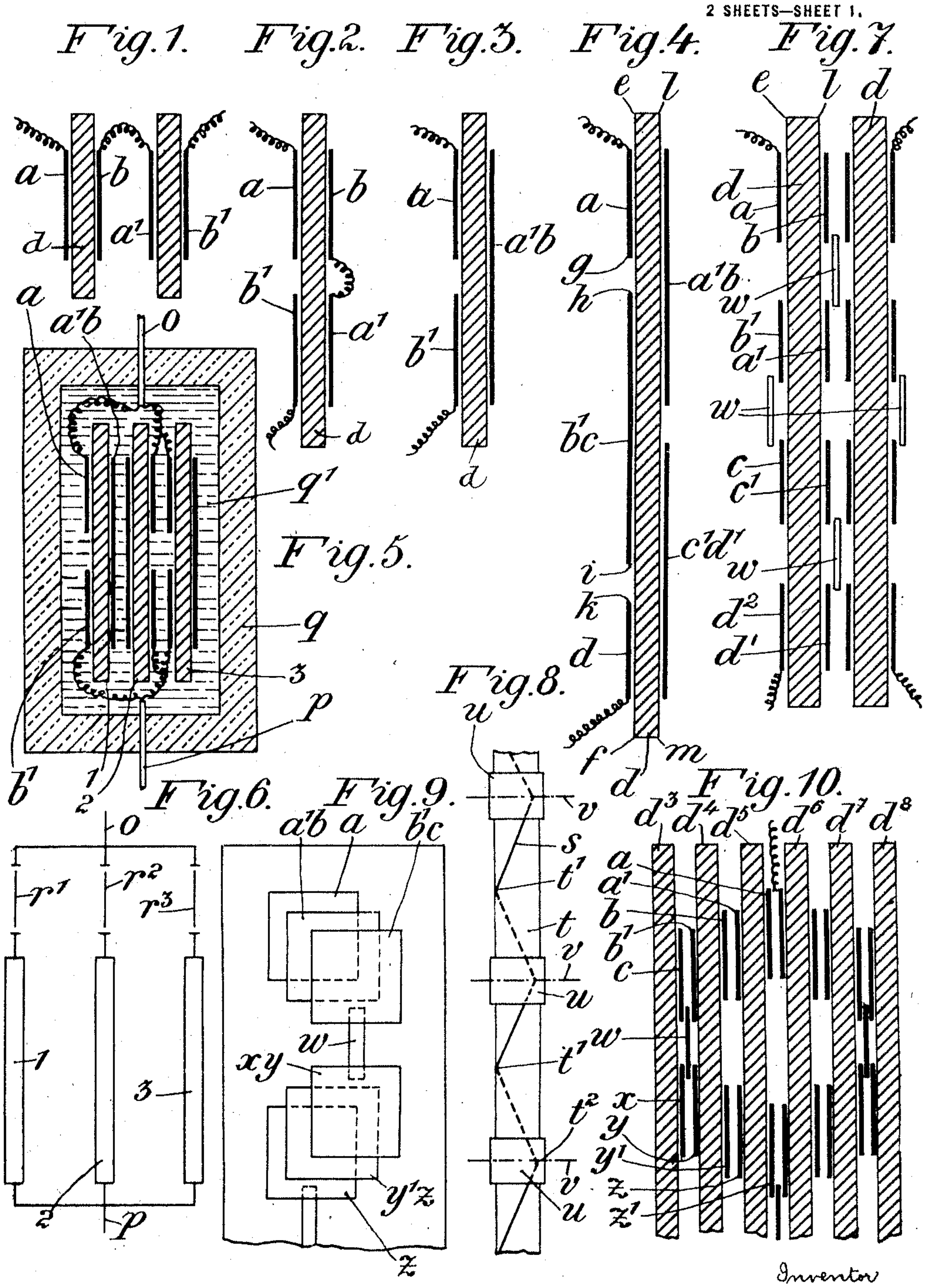
G. GILES.

INDUSTRIAL ELECTRICAL CAPACITY BATTERY.

APPLICATION FILED OCT. 16, 1916.

1,255,597. Patented Feb. 5, 1918.

2 SHEETS—SHEET 1.



Inventor

Georges Giles

By [illegible]

his Attorneys

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2 SHEETS—SHEET 2.

Fig. 13.

Fig. 11.

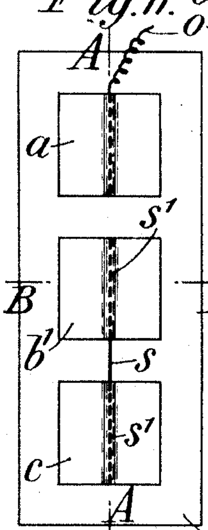


Fig. 12.

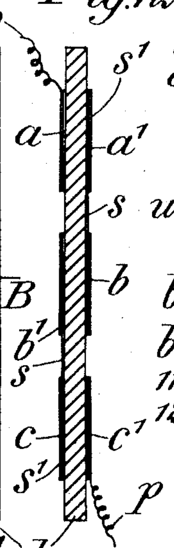


Fig. 15.

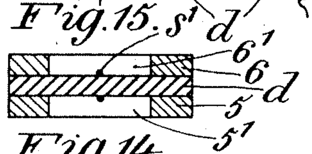


Fig. 14.

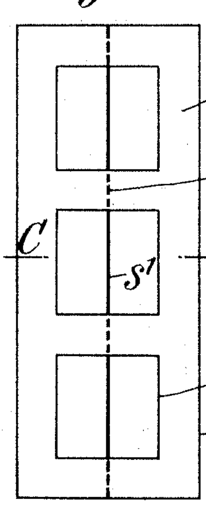


Fig. 19.

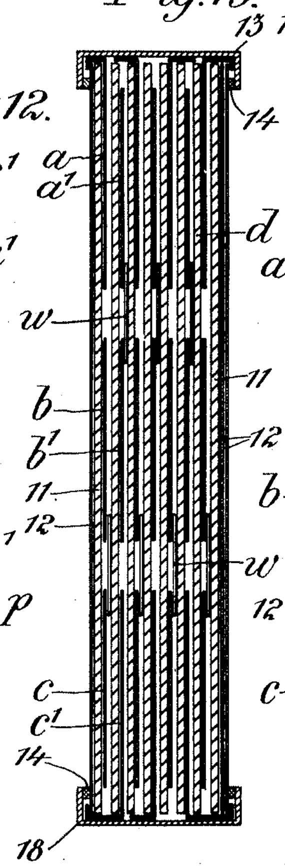


Fig. 18.

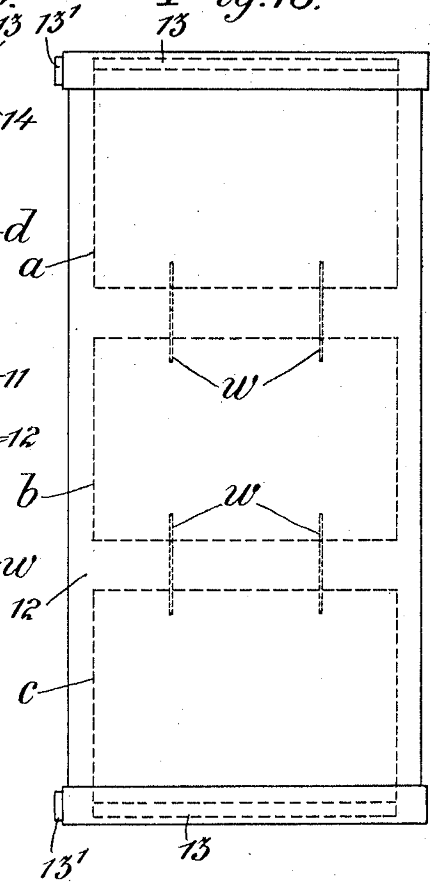


Fig. 16.

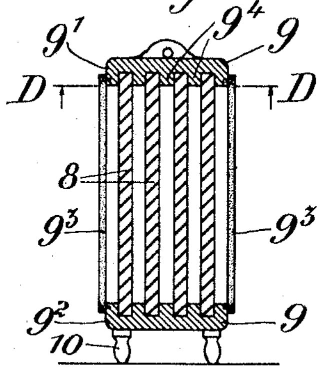
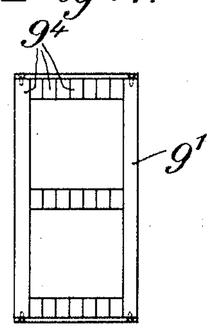


Fig. 17.



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Georges Giles
By [illegible]
his Attorneys.

UNITED STATES PATENT OFFICE.

GEORGES GILES, OF FRIBOURG, SWITZERLAND.

INDUSTRIAL ELECTRICAL CAPACITY-BATTERY.

1,255,597. Specification of Letters Patent. Patented Feb. 5, 1918.

Application filed October 16, 1916. Serial No. 125,947.

To all whom it may concern:

Be it known that I, GEORGES GILES, a citizen of the United States of America, residing at Fribourg, Canton of Fribourg, in the Confederation of Switzerland, have invented certain new and useful Improvements in Industrial Electrical Capacity-Batteries, of which the following is a specification.

This invention relates to electrical capacity-batteries.

It is known that the main difficulty in the manufacture of electrical condensers arises from the fact that the disruptive stress is much greater at the margin of the armature than at any other part of surface of the dielectric owing to the needle effect. Several contrivances however may be employed to overcome this inconvenience.

(*a*). The dielectric may be reinforced at the margin of the armature. This contrivance is efficient, but unfortunately the breaking voltage approximately increases as the square root of thickness of the dielectric. Thus, for instance in order to answer to a double voltage, the thickness of the dielectric at the margin of armature must be increased four times.

(*b*). The margin of the armature may be formed with a conveniently rounded conducting surface which will eliminate the needle effect at the margin of armature.

(*c*). The condensers may be arranged in series. In order to double for instance the resistance against destruction by this contrivance, it will be sufficient to arrange two condensers in series, that is to say to double the thickness of the dielectric.

This latter contrivance has the advantage over the first of requiring a smaller total thickness of the dielectric at the margin of the armature. However it might seem at the first look more inconvenient with regard to the thickness needed for the body of the condenser. In the case of the first contrivance there might be given for instance to the condenser the shape of a bottle whereof the dielectric would have the thickness of one millimeter at the body and four millimeters at the neck which would give a breaking resistance twice as high as if the dielectric had everywhere a thickness of two millimeters. The capacity however of this condenser would be that corresponding to one having a thickness of dielectric of one millimeter. In the case of the third contrivance two condensers with a dielectric of a uniform thickness of one millimeter would be put in series, which would give the same resistance at the margin of armature, but a capacity not higher than the one corresponding to a thickness of dielectric of two millimeters and representing therefore half of the one obtained with the first contrivance.

It must be mentioned here that this inconvenience, the smaller capacity, is only a seeming one. Indeed, if the dielectric of a bottle-shaped condenser should be made for instance with a thickness of half a millimeter, which would resist for instance a voltage of 20000 volts at the edge of armature, it could resist during a prolonged service only 6000 volts on account of the general heating of the condenser. If therefore a coefficient of security of 3.3 be considered as sufficient, it would scarcely be practical to employ the first contrivance by reinforcing the neck; on the other hand, the thickness of the body cannot be made any smaller on account of the heating. Now if it is desired to construct a condenser to resist, during prolonged service a tension of 12000 volts with a breaking tension of 40000 volts at the margin of armature, the dielectric must have at the body a thickness of one millimeter and at the margin of the armature of four times half a millimeter, that is two millimeters. The same result may be obtained by the arrangement in series of two condensers whereof the dielectric has a uniform thickness of half a millimeter. The two contrivances of examples *a* and *c* will both permit the use of a dielectric, such as glass for instance, for a given capacity of the condenser or condensers.

The object of the present invention is an industrial electrical capacity-battery consisting of one or more elements each formed by at least two condensers set in series in a peculiar manner. For this purpose, the different armatures of each of the elements are located on the two surfaces of a common dielectric plate, so as to form with this plate condensers arranged in steps after the order of the increasing potentials in one of the longitudinal dimensions of the plate (height, width, length, as may be required by the case).

On the other hand an industrial capacity battery is usually and in principle composed of a certain number of elements connected in parallel each being provided with its safety fuse so that the destruction of one does not necessarily cause the removal from service of the whole battery. This arrangement is shown in Figure 6 of the annexed drawing. The battery consists for example of three separate elements 1, 2, 3, each of which is provided with its own safety fuse r^1, r^2, r^3 inserted between the conductors o, p, between which the operating voltage exists. The fuses must be made so as not to blow by the action of discharges of high tension which may arise from atmospheric disturbances when the battery is used as a lightning arrester or from other causes when the battery is used in an alternating current circuit. In another respect the fuses have to be made so as to sustain the whole working voltage, for indeed, if one of the elements is destroyed, the lower support of the fusible wire will have the potential of the conductor p while the upper support will have the one of the conductor o. Likewise a distance answering to the working voltage must exist between their lower support and the corresponding supports of the neighboring fuse or fuses. For this reason the elements 1, 2, 3 have been put at a relatively great distance from each other in order to avoid arcs being formed between any of the elements in times of accident. Moreover for high tensions the length of fuse becomes very considerable because this length increases much more rapidly than the voltage. The battery must therefore be increased both in width and in height.

This difficulty of bulkiness may be overcome by the invention and to this end between certain armatures of the condenser succeeding each other in each element fuses are inserted in order to put said armatures in series and are arranged on the same face of the plate and within the extent of the same.

Each of the plates may thus be provided with a certain number of fuses instead of each element having but one.

The fuses may be made of metallic wire held by a band of insulating matter and partly surrounded with metallic bands intended to insure contact with the armatures when being laid down upon the same. The fusible wire may also be laid closely down upon the dielectric plate and may be maintained in place by a thin metallic layer which is secured by a spraying process, thereby forming the armature and covering the fuses at certain places. It may also be constructed as follows: On one or on both faces of a dielectric plate a metallic body designed to form the fuse is put on at the very place which is to be occupied later on by the armatures, then the metal which is to form the armatures is deposited by a spraying process and will cover the dielectric plate, and also the body forming the fuse, thus maintaining the latter in place. The parts of the body at the places where no metallic connection ought to exist may then be easily removed.

The corresponding armatures or fuses located on the faces of contact of each pair of insulating plates of a group may be replaced two by two by one single armature or one single fuse.

The element or elements of a battery may be inclosed within a cover made totally or partly of insulating material and filled with a mass impregnated with an insulating matter.

Each element may consist not of a single plate of dielectric matter, but of a pile of several plates set closely together with their faces one against the other and provided with armatures between the single plates, so as to form groups of condensers arranged in series transversely to the battery, that is in a sense along a line standing vertically upon the faces of the plates, the groups themselves being arranged in series according to one of the two surface dimensions (length and width) of the faces, by means of the fuses.

The battery may also be composed of one or more groups of elements each element comprising dielectric plates set closely together with their faces against each other and fitted on their faces with armatures and fuses so as to have an armature and a fuse in common to two adjacent plates and further comprising protecting plates made of insulating matter, all these plates being inclosed within a cover of insulating matter leaving free however the ends of the plates at the two extremities of a group and being provided there with metallic caps whereon the electrical connections are fixed, said caps forming with the cover a closed casing in the inside of which all hollow spaces are filled up with insulating material.

If there are several groups of such elements in a battery they may be placed within supports maintaining the groups sufficiently far from each other to permit of the air freely circulating around the same.

In order to more fully explain the nature of the invention the annexed drawings illustrate several working examples of the battery.

Fig. 1 is a diagram of a known form of battery.

Figs. 2, 3, 4, 5 are diagrammatic sections through four forms of working examples.

Fig. 6 already mentioned in the introduction is a diagram of a well known arrangement of elements.

Fig. 7 is a vertical cross section of elements of a fifth working form.

Fig. 8 relates to the manufacture of fuses.

Figs. 9 and 10 respectively are a front view and a vertical cross section of a sixth form.

Fig. 11 is a front view of a seventh form of a battery.

Figs. 12 and 13 respectively are sections on lines A—A, B—B of Fig. 11.

Fig. 14 relates to the manufacture of the form, shown in Figs. 11, 12 and 13, and Fig. 15 is a section on line C—C of Fig. 14.

Fig. 16 is a vertical section of an assembled group of units as illustrated in Fig. 19.

Fig. 17 is a bottom plan of the top member or cap as illustrated in Fig. 16.

Fig. 18 is a side elevation of the form of battery shown in Figs. 16 and 19, and

Fig. 19 is a cross section taken on line D D, Fig. 16.

Heretofore the third contrivance mentioned in the introduction has been employed according to Fig. 1, two condensers being set in series, and each consisting of two armatures a, b, a^1, b^1 and a dielectric plate d. The two plates d are separated from each other.

In a first working example of the battery (Fig. 2) a single dielectric plate d is provided on its two faces with four armatures a, b, a^1, b^1 of the two condensers arranged in series.

As the two armatures b, a^1 on the same face of plate d are electrically connected there is nothing to prevent uniting the said armatures into one a^1—b as is shown in Fig. 3.

The number of electric condensers arranged for voltage and having one dielectric plate d in common may be greater than two and may for instance be equal to four (Fig. 4). The armatures of the succeeding condensers designed to be connected electrically are united into one piece.

Owing to this arrangement plate d has a resistance exactly equal to four times that of a structure in which there is only one armature on each of its faces. If this plate has a thickness of 1 millimeter, the sum of resistances between the edges of the extreme armatures is four times the one obtained with one single condenser whereof the plate has the same thickness of 1 millimeter and is equal to that of a single condenser whereof the dielectric is four millimeters in thickness at the body and has a reinforced margin of about 16 millimeters. This arrangement will therefore permit construction of capacity-batteries for very high voltages; a capacity of 100000 volts for instance being obtained by the arrangement in series of five condensers with a resistance of 20000 volts and with one dielectric plate in common.

Besides always based on the chosen arrangement, the potentials are evenly distributed on the whole length of the plate. For instance on the face e—f of plate d (Fig. 4) one half of the total difference of potential acts between the points g and h and the other half between the points i and k. On the face l—m of the plate d this difference of the total potential is distributed between three intervals. This even distribution is very important and very advantageous. If batteries have to be made for high voltages it is very difficult to avoid marginal discharges between the edges of armatures along the dielectric; for the needed distances between these margins increase very much faster than the voltages. By an arrangement in series of the condensers of capacity on the same dielectric plate these distances are proportional to the voltages.

The advantage would naturally be still greater if there were a greater number of condensers to be put in series; for instance eight or ten on the same dielectric plate.

It is likewise advantageous to arrange in series on the same dielectric plate all the armatures of the condensers and for the following reason: Even in the case where this dielectric plate is of glass, it will have nearly a uniform thickness throughout its whole extent, which will insure a uniform distribution of potential between the different condensers. On the other hand two plates of glass seldom have the same thickness, wherefore there will result a difference of distribution of potential between the condensers in series.

According to Fig. 5 the electrical capacity-battery is composed of a certain number of elements 1, 2, 3 arranged in parallel between the conductors o, p between which the voltage exists for which the battery is built.

Therefore if one of these elements should be put out of service by an accident the other two would still continue to serve. Each of these elements comprises as in Fig. 3 a dielectric plate d. On one of the two faces of this plate, the parts of the armatures, a, b^1, of two condensers set in series, are located, while on the other face of the plate the other parts of armatures are located, and are united in a single armature, a^1 b. The plates are placed vertically and parallel to each other within a casing q made of insulating matter and are embedded within a solid insulating mass q^1 which will insure the perfect insulation of the whole. In order to introduce this mass into the casing it is liquefied by heat and poured into the casing, where first a vacuum has been created for this purpose. The mass will become solid after cooling.

By measuring the capacity of each element and by fixing the number of the same, a capacity of any given value may be easily obtained.

Any other suitable matter than glass may be employed as a dielectric material and a casing may or may not be employed.

In the fifth form of battery (Fig. 7) certain armatures are connected two to two by fuses. Each fuse w is composed of a metallic wire s (Fig. 8) led in a zigzag path between two series of notches t^1, t^2 cut within the edges of a strip of paper. At certain intervals the strip and the wire are surrounded by a collar u formed of thin sheet metal, for instance of tin, which is designed to insure the contacts of the fuse. This fuse strip is cut on the dotted lines v. Fig. 7 represents two plates with the armatures provided with this form of fuses. As will be seen this figure only differs from Fig. 4 by having the armatures a^1, b, b^1, c, c^1, d^1 cut in two. These parts of the armatures are metallically connected by the fuses w. The various dielectric plates are pressed together so as to bring the fuses w into contact with the armatures of the opposed faces of the two plates and then the impregnating mass is introduced to fill up the hollow spaces.

By this arrangement the following advantages are obtained:

(1). Great reduction of the bulkiness.

(2). The arrangement of a great number of rows of fuses set in parallel.

(3). If one plate alone is destroyed only this plate and the adjacent plate are put out of service in the circuit so that a whole group of elements remains working.

(4). It is very difficult to construct a fuse for 100000 volts and very easy to make one for 20000 volts. By the way indicated a fuse for 100000 is replaced by five for 20000 volts.

It would be important to employ as dielectric plates window glass having a thickness of about two millimeters as it is cheaper than the thicker glasses. This thin glass is destroyed at about 30000 volts, presents very little heating at 15000 volts, and insures a safe working at 7,000 to 10000 volts. It would therefore answer very well for a working voltage of 7500 volts, and for one hour's trial at 15000 volts or one minute's trial at 22500 volts. If it is desired to have a voltage of 100000 volts between the extreme armatures of the condensers of one and the same dielectric plate there must be employed

$$\frac{100000}{7500} \sim 13 \text{ armatures}$$

which would give too great a height of the plate and of the apparatus. In order to reduce this height it would therefore be necessary to employ a dielectric plate of greater thickness; but it must be observed that if a plate of twice the thickness should be employed the resistance against destruction would only be increased at about 40 per cent. because this resistance increases approximately as the square root of the thickness. The use of glass would therefore be bad in this case.

In order to improve the conditions for using it and in order to double the resistance when doubling the thickness of the glass the arrangement according to Figs. 9 and 10 may be employed. The armatures a a^1—b b^1—c—x—y y^1 and z z^1 of the various condensers are located on one of the faces of three glass-plates d^3, d^4, d^5 as shown in Fig. 10 each for instance two millimeters thick and the three plates set parallel to each other at small intervals. These armatures are displaced out of line with regard to each other as is shown by the drawing. The armatures b^1, c and x, y are connected together two to two by fuses w applied like the armatures against the plates 1, 2 and 3 as shown in Fig. 5. The whole is embedded within an insulating matter which also fills the spaces between the plates.

Any number of elements thus formed may be employed for a battery of capacity and the fuses may also be made in any other manner than that shown and described.

The element shown in the Figs. 11 to 13 consists of three condensers arranged in series, the various armatures a, a^1, b, b^1, c, c^1 of said condensers being all of like dimensions and being fixed to the plate by means of a spraying process, are located on the two faces of the common dielectric plate d so as to form with the latter condensers set stepwise in the sense of the longitudinal extension of the plate and in the sense of increasing potentials. The armatures a^1 and b of the one of the faces and b^1 and c of the other face are connected two to two by fuses s applied directly against the said plate d. This fuse consists of cylindrical metallic wire made for instance of silver and running at s^1 under these armatures so as to be kept in place thereby on plate d.

Between the armatures a and c^1 and the plate d are likewise the parts s^1 of the wire which are of no use and have remained from the process of manufacturing the battery.

By the fact that the fuses s are inserted between the armatures a^1 and b, b^1 and c of the succeeding condensers on the two faces of plate d all the height taken by fuses r^1, r^2, r^3 in Fig. 6 has been gained; for the distance to be maintained between these armatures is given by the voltage which is distributed between the various condensers and does not have to be increased on account of the insertion of the fuses. Besides the total thickness of the element has been reduced to a minimum on account of the fact that the fuses *s* are directly applied against the plate *d* and are maintained in place by the armatures themselves, which being put on by the spraying process, are extremely thin.

It must be observed that in the Figs. 11 to 13 the relative dimensions of the dielectric plate *d*, of the armatures and fuses do not correspond to the real dimensions, as they are exaggerated for clearness sake.

This working form of a battery may be manufactured as follows:

Two wires s—s^1 (Figs. 14 and 15) are placed directly upon the plate *d* and extend over the spaces which are to be occupied by the armatures a, a^1, b, b^1, c, c^1 and are thus stretched over the whole length of the two faces of the dielectric plate *d* which is then taken between two frames 5, 6 made of wood and of the same width and height as the plate and provided with the two openings 5^1, 6^1 the size of which corresponds to the size to be given to the armatures a, a^1, b, b^1, c, c^1. By any spraying process the metal is deposited on both sides and upon the free spaces of the plate *d*. Therefore the metal will not only cover the said plate but also the parts s^1 of the wires s—s^1 within the space of the openings and will secure said wires to the plate. Then the framings 5, 6 are removed and likewise the parts of the wires s—s^1 which are not covered with metal and which are not needed for connecting any two armatures. These parts are those which are between the edge of the plate *d* and the armatures a, a^1, c, c^1 and those between the armatures a and b^1, b and c^1. Thus besides the parts s^1 of the wires only the fuses *s* will be left.

The element or elements which constitute the battery are then embedded within an insulating mass.

The spraying of the metal may be effected by the well known Schoop process and by means of a Schoop pistol. The latter is an apparatus projecting finely pulverized metal obtained by the melting of a wire by means of a blow pipe and carried in the shape of metallic vapors by a strong gaseous current against the plate. Any other suitable process of projection may be employed.

The number of condensers in each element may be different from three and the number of fuses different from two. The armatures of the condensers need not have like dimensions and the fuses may be formed by a non-cylindrical metallic body.

The number of elements taken to form a battery according to this invention may be one, two, three or more. The element or elements are embedded within insulating matter.

In the last form of battery (Figs. 16–19) a number of groups 8 of elements of prismatic shape are held parallel to each other within a bracket 9 provided with feet 10 of insulating material. Each group 8 consists of six plates *d* of glass and each face of the plates is provided with three armatures a, b, c, a^1, b^1, c^1 and a fuse *w*. These armatures and fuses lie within the plane of contact between every two adjacent plates and therefore every two armatures and fuses are combined into one as is shown in Fig. 19. On the outer faces of the block formed by the plates set closely together there are provided two protecting plates 11 of glass and of the same size as the plates *d*. All the plates *d*, 11 are surrounded by a cover 12 made for instance of paper which is in two layers on the right hand side and leaves free the margins of the plates at the two extreme ends of the block. The armatures a, c^1 reaching beyond the margins of plates *d* are folded there over the same. Two metallic caps 13 are placed over the plates *d*, 11 and the cover 12, said caps serving as electrical connections of the elements owing to their contact with the armatures a, c^1 and forming together with the cover 12 an air-tight casing because a tight joint 14 has been provided between the caps and the cover, by means of monoxid of lead for instance. Each cap 13 is provided with a threaded ferrule 13^1 designed to receive a pipe for the introduction of the impregnated insulating matter and after the casing is filled receives a threaded conductor in order to have the group electrically connected to others.

The bracket 9 wherein the various groups are held is composed of two frames, an upper one 9^1 and a lower one 9^2 held together by the pieces 9^3 of insulating material. These forms are provided at their ends and on an intermediate cross piece with teeth 9^4 between which the caps of the various groups are held fast. A conducting rod fastened at each framing and connected to the corresponding metallic conductors of these groups insures the electrical connection between frame and armatures. Owing to the teeth 9^4 and to the openings in the frames there are spaces left between the groups 8 of elements so as to permit the circulation of air for cooling the battery.

The manufacture of this working form of a battery may be carried out as follows:

On one of the plates 11 laid down horizontally the armatures, the plates *d* and the second plate 11 are piled up in the desired order, the projecting parts of the armatures a, c^1 are folded down over the margins of the plates and the cover 12 is put on. The two caps 13 are then fixed to the extremities of the block thus obtained and strips of a suitable matter are laid into the spaces left between cover and caps, whereupon the joint is made perfectly tight by means of monoxid of lead or litharge. It remains now to screw to the ferrules 13^1 pipes of different length, one designed for the escape of air from the casing and the other designed for the introduction of the insulating mass. The group of elements is thus put into an air tight insulating vat with the pipes and the opening of the cover 12 turned upward. The insulating then takes place in a thorough manner by first creating a vacuum within the vat and by introducing the insulating matter and then by restoring the atmospheric pressure again. The insulating matter will thereby be forced to thoroughly fill up all the free spaces even the smallest left within the casing formed by cover and caps.

It must be observed that in Fig. 17 the thickness of all the plates has been exaggerated for clearness sake.

I claim:—

1. In an industrial electrical capacity-battery an element comprising a delectric plate, armatures applied directly to the faces of the plate, and fuses inserted between certain of the armatures of succeeding condensers and extending between same with portions thereof lying between the armatures thus connected and the dielectric plate.

2. In an industrial electrical capacity-battery an element comprising a dielectric plate, armatures applied directly to the faces of the plate, fuses inserted between certain of the armatures of succeeding condensers and extending between same with portions thereof lying between the armatures thus connected and the dielectric plate, and an insulating material in which the said dielectric plates and parts associated therewith are embedded.

3. In an industrial capacity-battery an element comprising a dielectric plate, armatures applied to the faces of the plate so as to form therewith condensers stepped relatively to their varying potentials, and metallic fuses extending between predetermined armatures of adjacent condensers and held in position between the same and the surface of the dielectric plate on which the said armatures are fixed.

4. The hereinbefore described process of manufacturing industrial electrical capacity-batteries consisting in placing metallic bodies designed to form fuses on the respective surfaces of a dielectric plate and causing the same to extend across the spaces to be occupied by the armatures, depositing metallic bodies on the opposite sides of the dielectric plate to form condenser armatures thereon and to extend over and secure the said fuse wires in position on the plate, and then removing part of the fuse wires from the plate and from between the armatures thereon where no electrical connection is necessary.

In testimony whereof I have affixed my signature in presence of two witnesses.

GEORGES GILES.

Witnesses:
W. MERSELMEIG,
EDM. EMMANUEL.