

L. W. CHUBB.
SHIELDING SYSTEM FOR VAPOR CONVERTERS.
APPLICATION FILED OCT. 7, 1915.

1,281,518.

Patented Oct. 15, 1918.

2 SHEETS—SHEET 1.

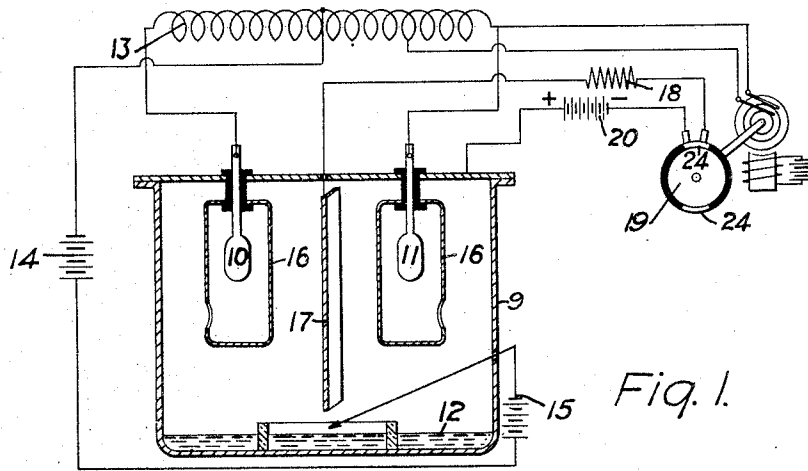


Fig. 1.

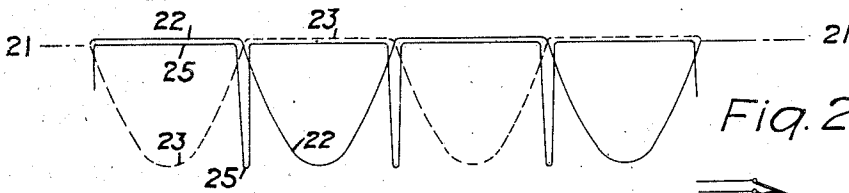


Fig. 2.

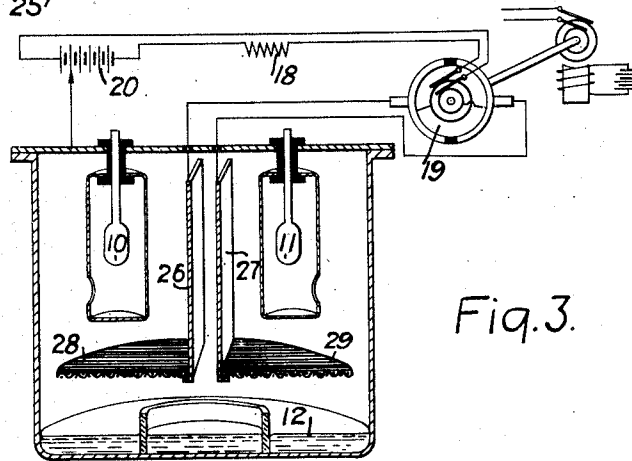


Fig. 3.

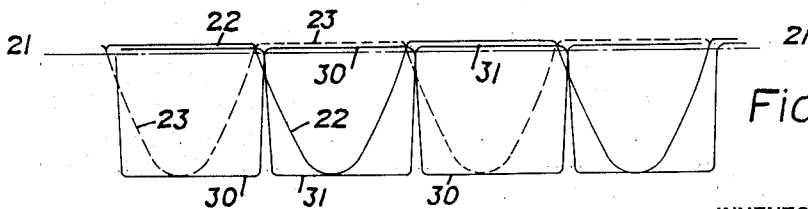


Fig. 4.

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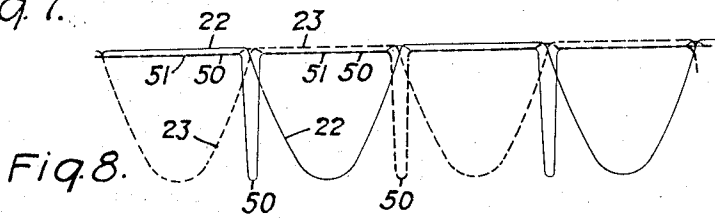
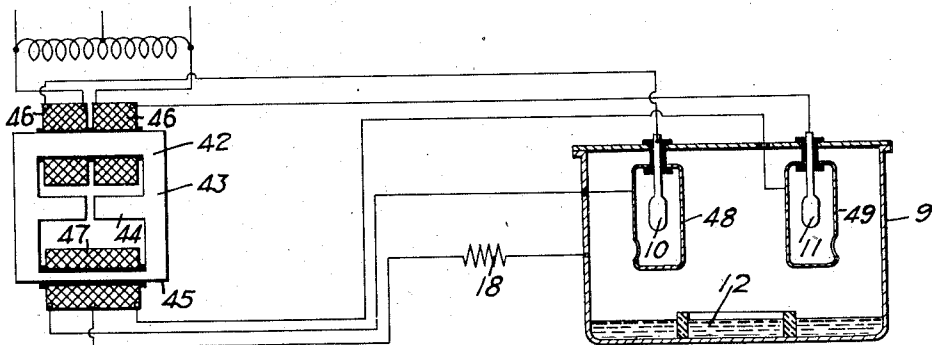
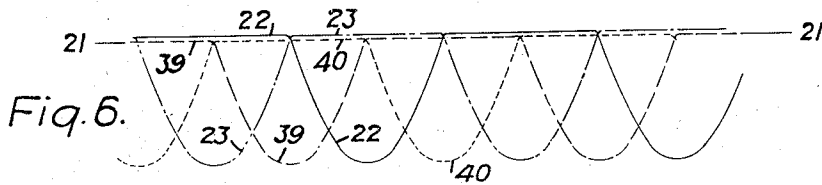
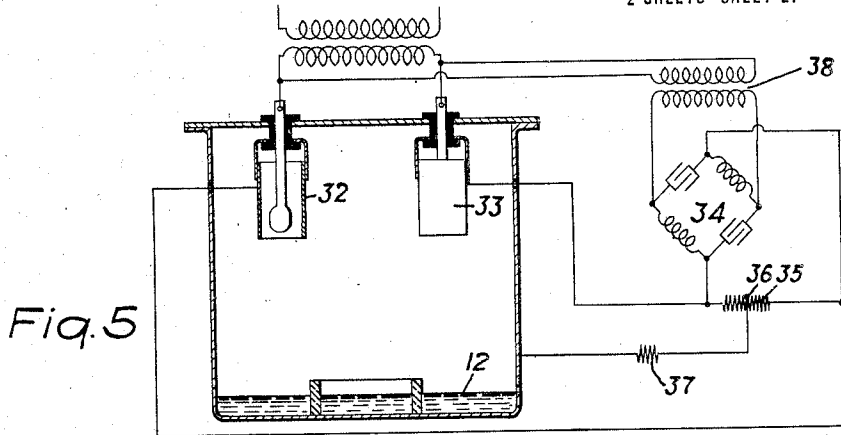
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SHIELDING SYSTEM FOR VAPOR-CONVERTERS.

1,281,518.

Specification of Letters Patent.

Patented Oct. 15, 1918.

Application filed October 7, 1915. Serial No. 54,559.

To all whom it may concern:

Be it known that I, LEWIS W. CHUBB, a citizen of the United States, and a resident of Edgewood Park, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Shielding Systems for Vapor-Converters, of which the following is a specification.

My invention relates to shielding systems for vapor converters, and it has for its object to provide means and apparatus whereby the power arc in apparatus of the character specified may be properly directed and controlled and whereby short circuiting, reverse arcing and other harmful phenomena may be minimized.

In the accompanying drawings, Figure 1 is a side view, partially in section and partially in elevation, of a vapor converter of the metal-case type, together with attendant supply and control circuits, illustrating one embodiment of my invention; Fig. 2 is a diagram illustrating the relation of the voltage waves in the various component parts of the system shown in Fig. 1; Figs. 3, 5 and 7 illustrate various modifications in the system and apparatus shown in Fig. 1; and Figs. 4, 6 and 8, respectively, are diagrams similar to Fig. 2 and illustrating the voltage waves in the accompanying systems.

In the operation of vapor converters and similar evacuated electrical apparatus, current is conveyed between the electrodes by a stream of electrons, emitted by the cathode and proceeding to the anode. The stream of electrons at the cathode may be excited by any of several well known methods, chief among which are the maintenance of a keep-alive arc to the cathode, the maintenance of the cathode at incandescence, the impact of a stream of positive ions thereagainst, and the impact of a beam of ultra-violet light.

If, in its passage from the cathode to an anode, an electron collides with a particle of residual gas, the particle is broken up into positive and negative ions, both of which receive an initial impulse toward the anode by the impact. The newly freed electron moves on very rapidly because the propelling force of the electrostatic field is substantially coincident in direction with the initial impulse thus given, but the newly freed positive ion moves but slowly and may soon come to rest and even reverse its direction of movement because of the neutral-

izing influence of the electrostatic field upon the initial impulse. Furthermore, the acceleration tending to be imparted to the positive ions by the electrostatic field is much less than that of the electrons because of the vastly larger mass of the former, even though it carry an equal or greater charge. The initial velocity of a gas molecule at the instant of ionization, or other force, may carry the resultant positive ion transversely to the arc path and into a part of the electrostatic field where it will be drawn to the inactive anode (having a negative potential) rather than to the cathode. The initial velocity and that imparted by the electrostatic field may be sufficient to cause a cathode spot when the ion strikes the inactive anode, releasing a stream of electrons and resulting in a short circuit or reverse arcing.

The sudden passage of an anode to a condition of negative polarity with respect to the cathode, such as happens periodically in a vapor converter, finds a large number of free positive electrons afloat in and near the arc path without any well defined motion in any direction. These "tramp" ions are now attracted to the temporarily negative anode and if in sufficient number and sufficiently accelerated, they may also bombard the electrode so energetically as to break down the negative electrode reluctance thereof, causing short circuiting or reverse arcing within the apparatus. This harmful action is especially liable to take place if the positive ions impinge upon a globule of mercury or other foreign matter upon the electrode surface.

In copending applications of S. W. Farnsworth Serial No. 44,429, filed Aug. 9, 1915, and Charles LeG. Fortescue, Serial No. 44,428, filed Aug. 9, 1915, both of which are assigned to the Westinghouse Electric & Manufacturing Company, are disclosed systems wherein a conducting shield is mounted in proximity to each anode and is connected to change in polarity therewith so that, when an anode becomes negative in potential, its attendant shield also becomes negative and tends to collapse the neighboring positive tramp ions. At the instant when an anode is reversing in polarity with respect to the cathode, the number of positive tramp ions in its arc path is near or at a maximum. It would be desirable to have

the ion suppressing means of maximum activity at this instant but, in the devices of both of the above applications, the maximum activity of the suppressing devices is not reached until ninety electrical degrees later. By my invention, I provide means whereby the relation of the instant of maximum activity of a suppressor shield may be accurately timed with respect to the instant of maximum undesirable positive ionization in the associated arc path, thus greatly increasing the effectiveness of operation of a device of the character described.

Referring to the accompanying drawing for a more detailed understanding of my invention, I show the container of a vapor converter of the metal-case type at 9 in Fig. 1. The container 9 is provided with solid anodes 10 and 11 and with a cathode 12, preferably composed of a vaporizable reconstructing material, such, for example, as mercury or suitable amalgams. The anodes 10 and 11 are connected, respectively, to the terminals of a source of alternating current 13, and the cathode 12 is connected to the mid-point of the source 13 through a load 14, as is common in rectifier systems. The cathode 12 may be maintained in an active condition by any suitable means, such, for example, as a keep-alive circuit 15. A shield 16 of any desired type is provided for each of the anodes 10 and 11 in order to minimize short circuiting. A plate 17, formed of conducting material, is mounted between the anodes 10 and 11 and is connected to the cathode 12 through a current-limiting device 18, a synchronously operating contact making device 19 and a potential source 20.

Having thus described the arrangement of the elements in Fig. 1, the operation is as follows: upon starting the device into operation, the anodes 10 and 11 rapidly alternate in potential with respect to each other between a point slightly above the potential of the cathode and a potential considerably below the same reference voltage. This is shown clearly in Fig. 2 wherein a reference line 21—21 represents the potential of the cathode 12, a line 22—22 represents the potential of the anode 10 and a line 23—23 represents the potential of the anode 11. The lines 22 and 23 rise but little above the lines 21—21 because an anode, when positive and active, differs from the cathode in potential only by the drop through the arc path, said drop being maintained at a minimum amount in the interests of efficiency. The lines 22 and 23, however, drop to a considerable distance below the line 21—21, as an anode, when negative, assumes a potential below that of the cathode by an amount determined by the load drop or substantially one-half the total impressed electromotive force of the transformer winding.

With each successive current impulse from

an anode through a cathode, the arc path formed thereby becomes more or less saturated with positive tramp ions, and it is desirable for successful operation that said ions be suppressed or removed as quickly as possible. I therefore so design the contact segments 24—24 in the synchronously driven contact device 19 that the plate 17 is strongly charged with a negative electromotive force from the source 20 during each instant when the arc is being transferred from one anode to another. The presence of a negatively charged conducting body in the near vicinity of an arc path immediately attracts and collapses substantially all of the harmful positive ions and thus insures reliable operation. The potential of the shield 17 is shown by a line 25—25 in Fig. 2, said line clearly indicating that the member 17 is at a maximum negative potential when the anodes 10 and 11 are passing through a point of zero potential with respect to the cathode.

It may frequently be desirable to maintain a negative suppressing member associated with an anode in a condition of negative potential during the time when the associated anode is positive in potential and therefore active, thus providing means for collapsing the positive tramp ions as generated. It is impossible to arrange a system of this character wherein a single suppressing apparatus affects both anodes, as is shown in Fig. 1, and I, therefore, provide a separate suppressing device for each anode, as shown in Fig. 3. A converter, of the general type shown in Fig. 1, is provided with two conducting plates 26 and 27 associated, respectively, with the anodes 10 and 11, and the plates 26 and 27 are provided, at their lower portions, with laterally extending projecting screen members 28 and 29 for extending the effects of the suppressing fields throughout the arc paths. The contact-making device 19 is so arranged that the shield 26—28 is negatively charged soon after the anode 10 becomes positive and active and the shield 27—29 is negatively charged soon after the anode 11 becomes positive and active all as is illustrated in Fig. 4, wherein the lines 21—21 22—22 and 23—23 have the same significance as in Fig. 2 and wherein the lines 30—30 and 31—31 indicate respectively, in polarity, magnitude and phase, the potentials of the shields 26—28 and 27—29. An anode should be permitted to become active before its associated shield member is negatively charged, as, otherwise, electrons from the cathode cannot reach the anode, and the converter will operate with difficulty. The phasial position of the lines 30 and 31 is therefore somewhat retarded with respect to that of the lines 22—22 and 23—23, as shown in Fig. 4.

The point of attachment of the cathode 12 to the source 20 may be varied so that the

maximum potential imparted to the suppressing members may be adjusted to such an amount as to suppress practically all the undesirable ions without exerting too strong a repulsive action upon the negative electron stream proceeding from the cathode to the anode and constituting the power arc itself.

If desired, by proper adjustment of the contacting device 19, the shielding members 26—28 and 27—29 may be rendered negative when their associated anodes are negative, thus producing an action similar to that indicated in the above mentioned applications of Farnsworth and Fortescue with the exception that the suppressing action is somewhat more pronounced in my device because the potential waves 30 and 31 are square-top in form, thus producing a strong suppressing charge on the shield member in an extremely short period of time after the associated anode has become inactive.

The operation of a contact-making device of the type indicated at 19 is frequently more or less unsatisfactory because of the difficulty of maintaining a predetermined phase relation exactly with any synchronous motor now known. I may therefore avail myself of the well known monocyclic square to obtain the desired displaced electromotive force for the energization of the suppressor shields. A system of this character is shown in Fig. 5 wherein suppressor members 32 and 33 are connected, respectively, to the ends of one diagonal of a monocyclic square 34, the ends of the remaining diagonal being connected to an alternating-current source as shown. A resistance device 35 is connected between the suppressor members 32 and 33 for the creation of an artificial neutral point 36, and said artificial point is connected to the cathode 12 through a current-limiting device 37 so that the potential of the suppressor system may be maintained at any desired value with respect to the cathode 12. By suitable adjustment of the electrical constants of the monocyclic square, any desired phase displacement may be obtained for the members 32 and 33, and the potential thereof may be adjusted by a transformer 38.

A desirable arrangement of voltage waves in the system of Fig. 5 is indicated in Fig. 6, wherein the potentials of the anodes 10 and 11 are indicated by lines 22—22 and 23—23 and wherein the potentials of the members 32 and 33 are indicated respectively by lines 39—39 and 40—40, reaching a maximum negative value when the corresponding anode ceases activity.

Still another method of energizing suppressing shields is shown in Fig. 7 wherein an impulse transformer 42 is provided, said transformer comprising a core member 43 provided with a leakage path 44 and a leg

45 of small cross section. Two opposing primary windings 46—46 are mounted on the core member 43 and inserted respectively in the connections to the anodes 10 and 11 of a vapor converter 9. A single secondary winding 47 is mounted on the constricted leg 45 and its terminals are connected respectively to suppressor members 48 and 49 associated with the anodes 10 and 11. The mid point of the secondary winding 47 is connected to the cathode 12 through a current-limiting device 18.

In operation, the abrupt flux change in the restricted leg 45 at the beginning and end of saturation produces a momentary voltage wave or impulse of great intensity, as is well known in the art. By the proper connection, said impulses may be made use of in charging the suppressor members 48 and 49 in any desired manner. In the diagram of Fig. 8, the potential of the shield 48 is indicated by a line 50—50 and that of the shield 49 by a line 51—51.

Throughout this description, I have explained the action of my device in accordance with the theory which seems most plausible in view of the present knowledge of the underlying phenomena. I desire it to be distinctly understood, however, that I do not confine myself to said theory of operation but merely present the same to aid in an understanding of the case.

While I have shown my invention in its preferred form, it will be obvious to those skilled in the art that it is susceptible of various minor changes and modifications without departing from the spirit thereof and I desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or are specifically set forth in the appended claims.

I claim as my invention:

1. In a vacuum-type converter, means for providing an arc path which is intermittently active, a conducting member associated with said arc path, and means for negatively charging said member at the conclusion of each active period.

2. In a vacuum-type converter, the combination with an electrode which is alternately positive and negative in polarity, of a conducting member mounted adjacent thereto, and means for negatively charging said member at the conclusion of each positive period of the electrode.

3. In a vacuum-type converter, the combination with a cathode, of a plurality of anodes, means for causing a power arc to operate successively from each of said anodes, a conducting member associated with each of the arc paths thus determined, and means for temporarily imparting a negative charge to each conducting member at the conclusion of an active period of the associated anode.

4. In a vacuum-type converter, the combination with a cathode, of two anodes, means for causing said anodes to alternately pass from positive to negative potential with respect to said cathode and for a power arc to flow therefrom to said cathode when positive with respect thereto, a conducting member associated with each arc path thus determined, and means for momentarily imparting a negative charge to each conducting member at the conclusion of an active period of the associated anode.

5. In a vacuum-type converter, the combination with a cathode, of two anodes, means for causing said anodes to alternately pass from positive to negative potential with respect to said cathode and for a power arc to flow therefrom to said cathode when positive with respect thereto, a conducting member associated with each arc path thus determined, and means for impressing alternating electromotive forces upon each of said members which lead the electromotive force of the associated anode by substantially ninety electrical degrees.

6. In a vacuum-type converter, the combination with a cathode, of two anodes,

means for causing said anodes to alternately pass from positive to negative potential with respect to said cathode and for a power arc to flow therefrom to said cathode when positive with respect thereto, a perforated conducting member mounted across each arc path thus determined, and means for impressing alternating electromotive forces upon each of said members which lead the electromotive force of the associated anode by substantially ninety electrical degrees.

7. In a vacuum-type converter system, the combination with a cathode, of a plurality of anodes, means for applying an alternating electromotive force between said electrodes, and means for imparting a pulsating electromotive force of double frequency to the interior of said container intermediate said anodes, said double-frequency electromotive force having its negative crests displaced by substantially 90° with respect to the electromotive force applied to said electrodes.

In testimony whereof, I have hereunto subscribed my name this 28th day of Sept., 1915.

LEWIS W. CHUBB.