

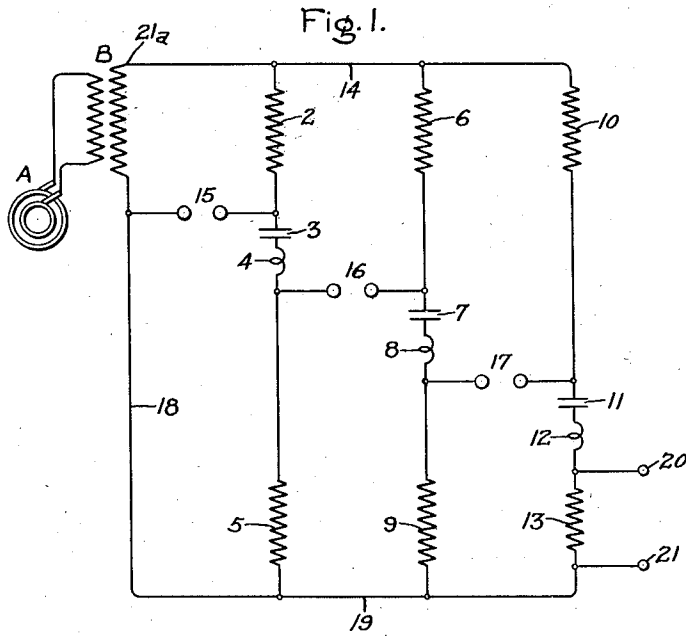
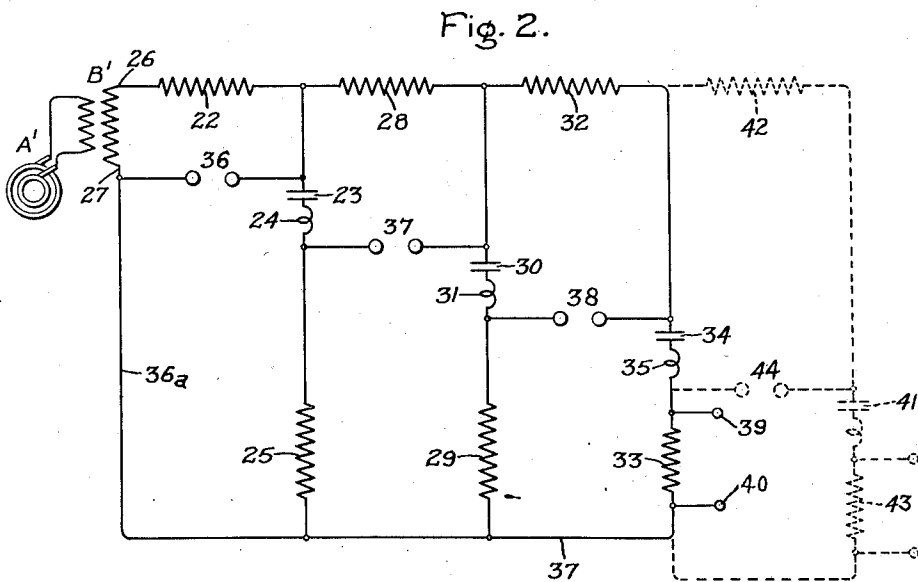
Nov. 5, 1929.

F. W. PEEK, JR

1,734,917

ELECTRIC DISCHARGE DEVICE

Filed Dec. 27, 1928



Inventor:
Frank W. Peek Jr.,
by *Charles V. Tuller*
His Attorney.

UNITED STATES PATENT OFFICE

FRANK W. PEEK, JR., OF PITTSFIELD, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK

ELECTRIC DISCHARGE DEVICE

Application filed December 27, 1928. Serial No. 328,752.

My invention relates to electric discharge devices. More particularly it relates to discharge devices of a type which is especially adapted for use for impulse generators. In electric devices of this character, condensers are used and means are provided for first charging the condensers in multiple from a suitable source of current and thereafter discharging the condensers in series over a suitable circuit to produce the impulse. Prior to my invention, the source of charging current was of the direct current type, which, up to the present, has presented certain limitations, so that the impulse voltage has been comparatively small.

It is an object of my invention to provide an improved impulse generator. It is also an object to provide an impulse generator in which the condensers are charged in multiple directly from an alternating current source, such as a transformer. The nature of the invention will be more fully understood from the following specification and claims, reference being had to the accompanying drawing, in which Fig. 1 shows, diagrammatically, a form of impulse generator embodying the principles of my invention, the generator shown in this figure being what may be termed a three-stage generator, in which three condensers take part in producing the impulse discharge; and Fig. 2 shows diagrammatically another form of impulse generator embodying the principles of my invention. In Fig. 2 the solid lines show circuits corresponding to a three-stage generator, in which only three condensers take part in the discharge; while the dotted lines, taken together with the solid lines, show a four-stage generator, in which four condensers are used.

Referring to the drawing, Fig. 1, an alternating current generator A is shown connected with a transformer B. Connected in series with the secondary winding of this transformer are three branch circuits, one containing a non-inductive resistance element 2, a condenser 3, an inductance element 4, and a non-inductive resistance element 5. These elements 2, 3, 4 and 5 are all connected in series. A second one of the branch circuits comprises a non-inductive resistance element 6, a condenser 7, an inductance element 8, and a second non-inductive resistance element 9. These elements 6, 7, 8 and 9 are also connected in series. The third branch circuit comprises in series a non-inductive resistance element 10, a condenser 11, an inductance element 12, and a non-inductive resistance element 13. With reference to the elements 2, 5, 6, 9 and 10, it will be understood that their impedance is high as compared with that of the element 13, which latter is located in the series circuit and must therefore be comparatively low. As shown in Fig. 1, the first branch circuit is shunted by a spark gap 15; the second branch circuit is similarly shunted by a spark gap 16, and the third branch circuit is shunted by a spark gap 17. The spark gaps 15, 16 and 17 are so set that when the charging wave reaches a given voltage, all of the gaps spark over simultaneously thereby connecting all of the condensers in a series circuit with the impedance element 13. This series circuit avoids the transformer, as well as the resistance elements 2, 6, 10 on one side, and 5 and 9 on the other, and extends as follows: Over the conductors 18 and 19, and through the elements 13, 12, 11, 17, 8, 7, 16, 4, 3 and 15, returning again to the conductor 18. As a result of a flow of current in the series circuit, a voltage is developed across the terminals 20 and 21 of the element 13 which may be as high as approximately the sum of the voltages of the condensers 3, 7 and 11. While I have specified that the spark gaps 15, 16 and 17 may discharge simultaneously, this is not essential inasmuch as one spark may break down before the other. In any event, the sparks are maintained so that all of the gaps are short-circuited during a given interval of time, thereby establishing the series impulse circuit through the impedance element 13 with the result that a difference of potential develops across the terminals 20 and 21 of the element 13 which may approximate the sum of the voltages of the condensers 3, 7 and 11. Therefore, if the voltage of the secondary of the transformer is 1000 kv. the

potential across the terminals 20 and 21 may be in the neighborhood of 3000 kv. The voltage, however, may be much less than the sum of the condenser voltages, depending upon the shape of the wave as determined by the capacitance, resistance and inductance of the circuit. Therefore, the variable transient voltage is the sum of the condenser voltages decreased by a factor depending upon the shape of the wave in the series circuit as determined by the capacitance, resistance and inductance constants of the series circuit.

It will also be understood that while the gaps may be set to spark over at the maximum or crest voltage of the charging current wave, this need not be so inasmuch as the gaps may be set to discharge at different voltages, depending upon the impulse voltage desired across the terminals 20 and 21.

While I have represented the inductance elements 4, 8 and 12 as being distributed in the series circuit next to the condensers 3, 7 and 11, respectively, this inductance may be otherwise arranged. For example, the elements 4 and 8 may be omitted and the inductance value of the element 12 may be increased so as to be equal to the sum of the inductances 4, 8, and 12. Furthermore, these elements may be inserted at any convenient point or points in the circuit.

Referring now to the impulse generator in Fig. 2, this generator differs from the one in Fig. 1 in that the impedance elements corresponding to the elements 2, 6 and 10 instead of being connected in multiple with the conductor that leads to the terminal 26 of the transformer, are connected in series with this terminal. As indicated, in this figure the source of supply is the dynamo A' and the transformer B'. The circuit is provided with three branches, one branch comprising the non-inductive impedance element 22, the condenser 23, inductance 24, and non-inductive impedance 25, which elements are all connected in series across the terminals 26 and 27 of the transformer B'. Another branch circuit comprises a pair of non-inductive impedance elements 28 and 29 in series with condenser 30 and with inductance 31. This branch circuit is also in series with the secondary winding of the transformer. The third branch circuit comprises the non-inductive impedance elements 32 and 33 in series with the condenser 34 and inductance 35. This branch circuit is also in series with the secondary winding of the transformer. As shown in the drawing, the first branch circuit is provided with a bridging gap 36, the second branch circuit with a bridging gap 37 and the third branch circuit with the bridging gap 38. These gaps are set to spark over when the voltage of the condensers reaches a desired value. The effect of the sparkover is to connect the condensers in series through the impedance element 33. The impedance of this element, like that of

element 13 in Fig. 1, is comparatively low as compared with that of each of the elements 22, 25, 28, 29 and 32. Under the circumstances, therefore, when the series circuit is closed a very high voltage is developed across the terminals 39 and 40 of the element 33, which approximates the sum of the voltages of the condensers 23, 30 and 34.

It will be understood that while the elements 2, 5, 6, 9 and 10 are legged off from the series circuit through the element 13, the leakage through such elements is substantially negligible because the impedance which they offer to the voltage of the series circuit is sufficiently high to render it so. The same remarks apply with respect to the elements 22, 25, 28, 29, 32 and 42 in Fig. 2.

In Fig. 2, I have indicated in dotted lines how the impulse potential may be increased by adding another condenser 41 in still another branch circuit similar to either one of the other branch circuits in the same figure. The new branch comprises in series with the condenser 41 a high impedance non-inductive element 42 and a low impedance non-inductive element 43 across the terminals of which the impulse voltage is developed. This new branch circuit is shunted by a spark gap 44 similar to the spark gap 38. When the new branch is added the impedance of the element 33 is increased to correspond with that of either of the elements 25 or 29. When this is done, the terminal elements 39 and 40 are omitted.

Therefore, in Fig. 2 I have indicated how three or four, or any other number of condensers may be employed in the generator. If it is desired to increase the voltage of the impulse generator, another branch circuit may be added similar to the one indicated in dotted lines and again the impedance of element 43 will be increased just as the impedance of the element 33 was increased when the new branch was added. In the same way, branch circuits may be added in Fig. 1. If it were desirable to limit the impulse generator to two condensers, the third branch circuit including the impedance elements 10 and 13 could be omitted and the impedance element 9 reduced to correspond with that of the element 13.

Therefore, in the improved generator, the condensers are charged directly from a source of alternating current to the voltage desired, whereupon at that instant, the charging operation is cut off by the spark-over of the limiting gaps. The same operation places the charged condensers in series with an impedance element of proper value, thus setting the generator in operation and producing across the terminals of the impedance element whatever voltage is desired. Furthermore, the characteristic of the impulse discharge may be readily controlled by varying the ele-

ments in the series circuit such as the inductance, the capacitance, or the resistance.

It will be clear from the foregoing that the spark gaps have the following functions: first, to determine the voltage of the generator impulse; second, to eliminate the high impedance elements from the discharge circuit; and third, to initiate the impulse discharge.

It will be understood that while I have disclosed my invention in connection with specific circuits and apparatus, I do not wish to be so limited inasmuch as I contemplate variations and modifications which do not depart from the spirit of the invention or from the scope of the claims contained herein. For example, under certain conditions it may be desirable to insert on either or both sides of the spark gap 36 a high resistance non-inductive element, each element being shunted by a small spark gap as compared with the spark gaps 36, 37 and 38 in order to prevent the spark gap 36 from sparking over prematurely, as for example, when corona discharges take place along the line leading from the terminal 26 of the transformer B'. I also contemplate substituting for the non-inductive resistance elements in the branch circuits any other suitable form of impedance, as well as modifying the circuit of Fig. 1 by omitting the element 2 and connecting the condenser 3 directly to the conductors 14.

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

1. In a discharge device, a source of alternating current, a plurality of condensers, each in a separate branch circuit, each branch circuit containing in series with the condenser, an impedance, said branches being connected each in series with said source whereby said condensers may be charged in multiple, and means for connecting all of said condensers in series with an impedance, all of said impedances save the last one mentioned, and said source of alternating current, being located outside of said series circuit whereby said condensers may be discharged in series for producing an impulse discharge between the terminals of said impedance in said series circuit.

2. In a discharge device, a source of alternating current, a plurality of condensers each in an individual branch circuit in series with an impedance element on each side thereof, said branches being connected each in series with said source whereby said condensers may be charged in multiple, and means for connecting said condensers in a series circuit with one of said impedances, all of the other impedances and the said source being located outside of said series circuit, said means comprising a spark gap between each condenser and the next one to it in the series circuit, said gaps being set whereby when the charging voltages reach a given value the gaps will spark over and close the said series circuit to

permit the condensers to discharge in series therethrough and create a potential across the terminals of the impedance in the series circuit and whereby an impulse discharge may be obtained from said terminals, the impedance in the series circuit being comparatively low in value as regards the series circuit discharge and all the other impedances being comparatively high in value as regards the series circuit discharge.

3. In a discharge device, a source of alternating current, a plurality of condensers each located in an individual branch circuit in series with a high impedance, said branch circuits being each connected in series with said source whereby said condensers may be charged in multiple, and means for connecting said condensers in a series circuit, all of said impedances and said alternating current source being located outside the series circuit, a non-inductive low impedance being in series with said condensers in said series circuit, said means consisting of spark gaps between each condenser and the next one to it in the series circuit, said gaps being set whereby when the charging voltage reaches a given value the gaps will spark over and close the series circuit whereby a potential is produced at the terminals of the said low impedance.

4. In a discharge device, a source of alternating current, a plurality of condensers each located in an individual branch circuit in series with a high impedance, said branch circuits being connected each in series with said source, and means for connecting said condensers in a series circuit, all of said impedances and said alternating current source being located outside the series circuit, a non-inductive low impedance in series with said condensers in said series circuit, said means consisting of spark gaps between each condenser and the next one to it in the series circuit, said gaps being set whereby when the charging voltage reaches a given value the gaps will spark over and close the series circuit whereby a potential is produced at the terminals of the said low impedance, one of said gaps being located across the two points common to all of the charging circuit of the condenser whereby the source of supply is short-circuited with respect to the condensers when the sparkover takes place.

5. In a discharge device, a source of alternating current, a plurality of condensers each in an individual branch circuit in series with a high impedance, all of said circuits being connected in multiple across the said current source whereby they may be charged in multiple, means for connecting said condensers in a series circuit, said current source and said impedance being located outside of the series circuit, and an impedance in said series circuit and in series with said condensers whereby when the condensers are connected in series

a discharge takes place through said impedance in the series circuit and a potential is created across its terminals for producing an impulse discharge.

5 In witness whereof, I have hereunto set my hand this 24th day of December, 1928.

FRANK W. PEEK, JR.

10

15

20

25

30

35

40

45

50

55

60

65