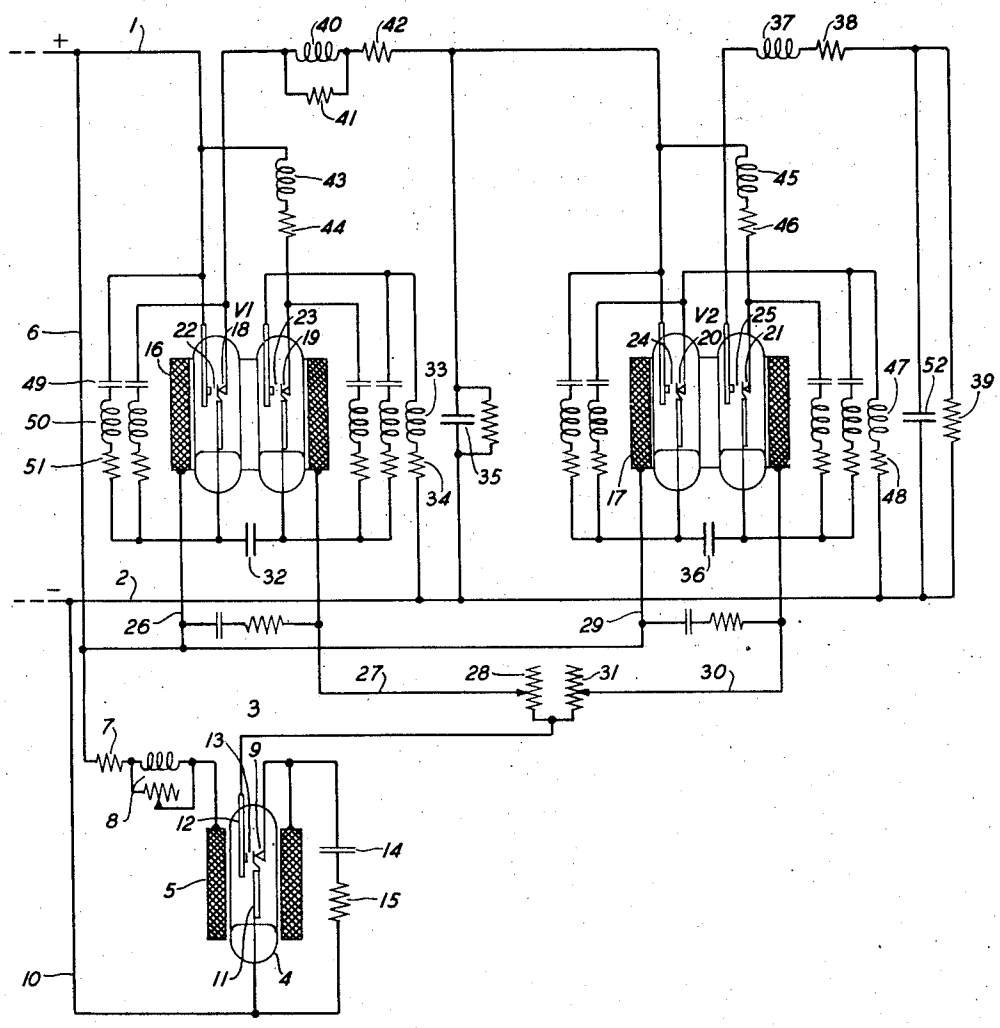
Dec. 21, 1948. A. M. CURTIS 2,456,927

DIRECT CURRENT VOLTAGE MULTIIPLIER

Filed May 2, 1945



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Patented Dec. 21, 1948 2,456,927

UNITED STATES PATENT OFFICE

2,456,927

DIRECT-CURRENT VOLTAGE MULTIPLIER

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Application May 2, 1945, Serial No. 591,487

4 Claims. (Cl. 171—97)

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This invention relates to direct current voltage multiplying arrangements of the vibrator-condenser type.

An object of the invention is to provide an improved system for efficiently multiplying an initial voltage to supply an output circuit with a high direct current potential.

A feature of the invention resides in alternately connecting a primary source of direct current to a first condenser and then discharging the first condenser in series with the source into second and third condensers in parallel which second and third condensers, now charged to substantially twice the initial potential, are then discharged in series into a succeeding condenser network, or work circuit, at substantially four times the voltage of the primary source.

Another feature of the invention resides in employing sealed, mercury contact, switches of the general type disclosed in an application filed July 21, 1944, in the name of E. T. Burton, Serial No. 545,985, which switches have the characteristic of passing at their closed contacts a considerably larger current than they can open without serious sparking.

A further feature resides in the provision of means for controlling the wave form of the charging current for said condensers so that the current, at the instant of make and break of the relay contacts, is a small fraction of the current required to perform the work of charging the condensers, said means also serving to prevent the charged condensers from losing a portion of their charge, by discharge through a preceding lower potential stage, due to the so-called bridging characteristic of the mercury contact relays employed.

The invention will be understood from the following description when read in connection with the accompanying drawing, the single figure of which represents the circuit arrangement of a system for delivering to a work circuit a direct current potential substantially four times that of a primary direct current source.

Referring to the drawing, direct current potential from a source, not shown, is supplied over conductors 1 and 2. As the circuit functions under control of continuously vibrating contacts, or circuit closing devices, V1 and V2, a source of pulsating current must first be provided. This pulsating current in the present arrangement is produced by a relay 3 which comprises a single-pole, double-throw, mercury contact switch surrounded by a single energizing winding 5. When potential is applied to conductors 1 and 2, current

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flows from conductor 1, for example, over conductor 6, resistance 7, inductance-resistance network 8, winding 5, contacts 9 and conductor 10 to the other supply conductor 2.

With the back contacts 9, of relay 3, closed current builds up through network 8 until it reaches the operating value of relay 3 whereupon armature 11 is attracted by magnetic element 12 thereby opening back contacts 9 and closing front contacts 13. The current through winding 5 continues to flow through condenser 14 and resistance 15 after contacts 9 are open and therefore winding 5 remains energized and the contacts 13 are held closed until condenser 14 has been charged sufficiently to reduce the current flowing through winding 5 to the release value of the relay whereupon the armature returns to its original position and recloses contacts 9 at which time condenser 14 is discharged in series with resistance 15 and contacts 9 whereupon the cycle repeats thus alternately closing and opening contacts 13 at a predetermined rate in accordance with the constants of the circuit and the characteristics of armature 11. Suitable adjustment of the resistance 7 and network 8 is effective to regulate the vibration frequency of armature 11.

The periodic closure of contacts 13 of switch 3 causes vibrating switching devices V1 and V2 to alternately open their back contacts 18, 19, 20 and 21 and to close their front contacts 22, 23, 24 and 25. The circuit for operating device V1 including conductors 6 and 26, winding 16, conductor 27, adjustable resistance 28, contacts 13, and conductor 10, and the circuit for V2 including conductors 6 and 29, winding 17, conductor 30, adjustable resistance 31, contacts 13 and conductor 10. By adjusting resistances 28 and 31 the operating currents for windings 16 and 17 can be controlled.

On the first operation of devices V1 and V2 their front contacts 22, 23, 24 and 25 are closed and contacts 18, 19, 20 and 21 are opened whereupon condenser 32 is connected across the supply conductors 1 and 2 in series with inductance 33 and ohmic resistance 34 of such values that the current in the circuit at the initial closing of the contacts is small thus preventing excessive sparking. Condenser 32 receives a charge at this time substantially equal to the potential connected to conductors 1 and 2. At the same time condensers 35 and 36 are connected in a series circuit which can be traced from the upper plate of condenser 35, closed front contact 24 of device V2, condenser 36, front contacts 25, inductance 37, ohmic resistance 38, load resistance 39 in parallel with

storage condenser 52, and back to the lower plate of condenser 35. It is assumed, however, that condensers 35 and 36 are at zero potential at this time and therefore there will be no current surge through the load resistance and condenser 52.

When the driving or pulse relay 3 releases for the first time and opens its front contacts 13 devices V1 and V2 will be deenergized to open their front contacts 22, 23, 24 and 25 and to close their back contacts 18, 19, 20 and 21 thus disconnecting condenser 32, now charged, from the supply circuit conductors 1 and 2, and connecting this condenser (32) in series with the supply source and in parallel with condensers 35 and 36, whereby these two latter condensers (35 and 36) each start to receive a charge from the potential stored in condenser 32 plus the potential of the supply source which initially will be somewhat less than twice the potential of the source. The circuit at this time can be traced from the left-hand plate of condenser 32, contacts 18 of V1, inductance 40, shunted by resistance 41, resistance 42, condenser 35, supply conductor 2, through the supply potential source to conductor 1, inductance 43, ohmic resistance 44, and back contacts 19 of V1 to the right-hand plate of condenser 32. The parallel circuit for condenser 36 can be traced from the upper plate of condenser 35, inductance 45, ohmic resistance 46, back contacts 21 of V2, condenser 36, back contacts 20, inductance 47 and ohmic resistance 43, back to the lower plate of condenser 35.

As before mentioned condensers 35 and 36 each initially receive a charge which is somewhat less than twice the potential of the supply source, i. e., the potential of initially charged condenser 32 plus the potential of the source. On the next operation of the pulse relay 3, its front contacts again close and drive V1 and V2 to again open their back contacts and close their front contacts thus reconnecting condenser 32, now partially discharged, to the supply conductor whereby this relay is recharged to the source of potential.

As the back contacts of V1 and V2 are now open, condensers 35 and 36 are again connected in a series circuit including load resistance 39 and in an aiding direction with respect to the polarities of their respective charges whereby the potential applied across the condenser 52 and load resistance is substantially the sum of the potential charges on condensers 35 and 36, i. e., somewhat less than four times the potential of the supply source.

The circuit for condensers 35, 36, 52 and load resistance 39 at this stage of the operating cycle can be traced from the upper plate of condenser 35, front contacts 24 of V2, condenser 36, contacts 23, inductance 37, resistance 38, condenser 52 and load resistance 39 in parallel and back to the lower plate of condenser 35.

The foregoing cycle of operation continues to alternately charge and discharge condensers 32, 35 and 36 under control of devices V1 and V2 which are, in turn, alternately energized and deenergized due to the pulsating current supplied by relay 3, and, in a short time, i. e., after a few successive operations of devices V1 and V2, condenser 52 builds up a potential across the load which is substantially equal to four times the voltage of the supply source minus a quantity depending upon the losses in the devices, V1 and V2 and the circuit elements.

In the above connection it should be understood that devices V1 and V2 may be operated by any other suitable means, in substitution for relay 3 as, for example, by a rotary interrupter.

Spark killing networks including series capacity, inductance and ohmic resistance shunt the respective contacts 18 and 25, inclusive, of devices V1 and V2 to limit the current thereacross and prevent excessive arcing at the moment of final break, as for example condenser 49, inductance 50 and ohmic resistance 51 connected in shunt to contacts 22.

Condenser 52, connected in parallel with load resistance 39, serves as a storage reservoir from which the load draws continuous energy as otherwise the load would not receive any input while condensers 35 and 36 were being charged. Condenser 52 also acts as a filter to by-pass and prevent any alternating component of the current from appearing in the load circuit.

What is claimed is:

1. In a voltage multiplying system, a source of direct current, a load circuit, a plurality of condensers, and vibratory means for successively changing a first one of said condensers to the potential of said source, discharging it in series with said source into second and third condensers in parallel, and then simultaneously recharging said first condenser from said source and discharging said second and third condensers in series into said load circuit.

2. In a voltage multiplier, a source of direct current potential, a storage condenser, a load circuit, a plurality of condensers, a pair of magnetic switching devices having reed armatures adapted to vibrate between front and back contacts, and means for periodically vibrating said armatures at a predetermined rate, said devices being so arranged and connected that when the armatures of said devices are on their front contacts, a first one of said condensers will be connected to said source of potential and the second and third condensers will be connected in a series circuit including said storage condenser and load circuit in parallel, and when the armatures of said devices reverse their position said first condenser will be connected in series with said potential source and with said second and third condensers in parallel.

3. In a voltage multiplier, a source of direct current potential, a plurality of switching devices each comprising a pair of vibrating switches having front and back contacts, first, second and third condensers, a storage condenser, a load circuit, electromagnetic means for operating each of said switching devices to open their back contacts and close their front contacts, means including a source of pulsating direct current adapted to alternately energize and deenergize said electromagnetic means to operate said switching devices at a predetermined rate, circuit means for connecting said first condenser to said source of potential when a first one of said switching devices closes its front contacts, other circuit means including the back contact of both of said switching devices, for connecting said first condenser in series with said source and in parallel with said second and third condensers, and circuit means including the front contacts of said second switching device for connecting said second and third condensers in series with each other and with the storage condenser and load circuit in parallel.

4. In a voltage multiplier in combination, a source of direct current potential, a load circuit, a plurality of condensers including a storage condenser, a plurality of magnetic switching devices having mercury wetted front and back

contacts and a reed armature adapted to vibrate therebetween, means for periodically vibrating the armature of said devices at a predetermined rate, means for limiting the flow of current through said contacts during the initial making and final breaking period thereof, said means comprising inductance in series with said contacts and series resistance and capacity in shunt thereto, said contacts being so connected that when the armatures of two of said devices close their respective front contacts a first one of said condensers will be connected to said source of potential and second and third condensers will be connected in a series circuit including said storage condenser and load circuit in parallel, and when said armatures reverse their positions

and close their respective back contacts, said first condenser will be connected in series with said potential source and in parallel with said second and third condensers.

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