

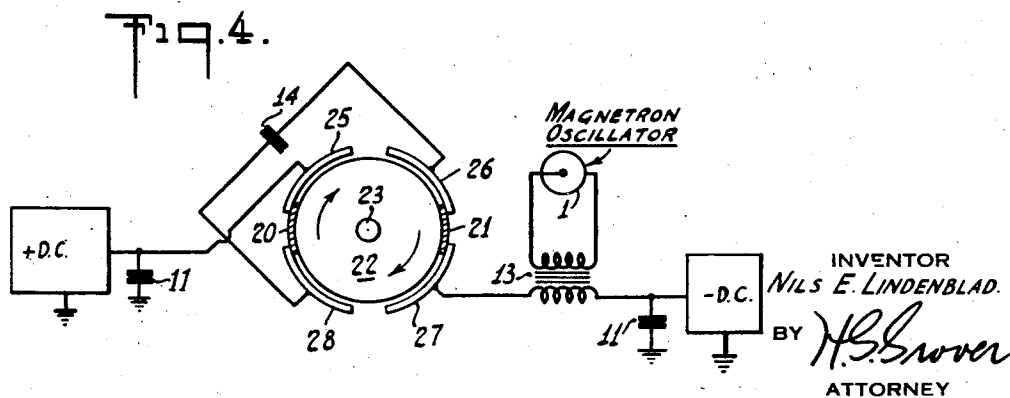
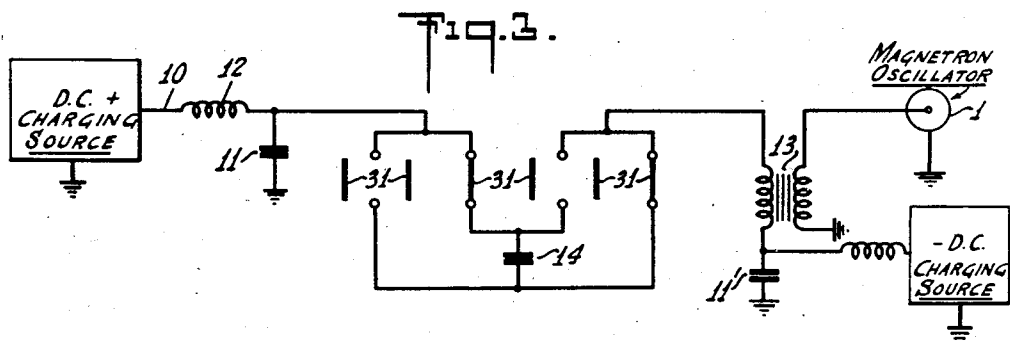
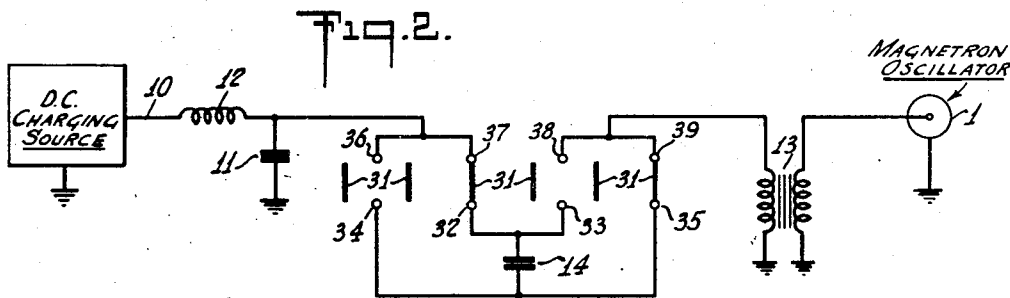
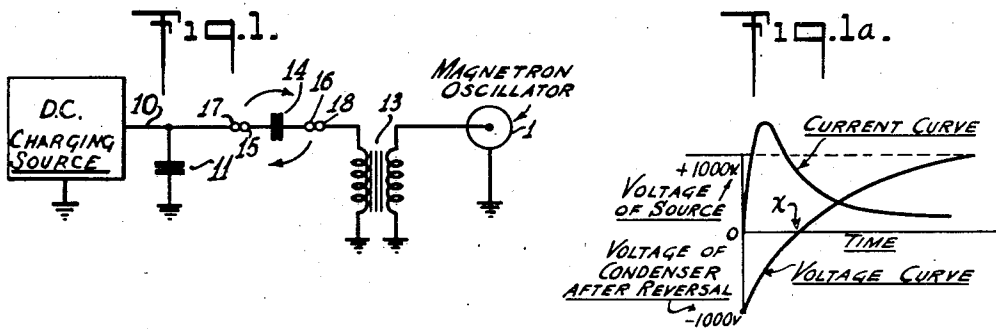
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POWER CONVERTER

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POWER CONVERTER

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The present invention relates to apparatus for converting direct current power to periodically recurring high voltage pulses, suitable for use (by way of example) in exciting an electron discharge device.

The present invention finds particular application in connection with pulse transmission systems wherein it is desired to periodically excite an electron discharge device oscillator with pulses of high voltage momentarily applied to the oscillator, as a result of which it is possible to obtain a higher output from the oscillator than during a normal or continuous steady state. It is in conjunction with such a pulse transmission system that the present invention will hereinafter be described, although it should be understood that this particular application of the invention is given for reasons of exposition, and not by way of limitation.

Briefly stated, the converter of the present invention comprises a trickle source of relatively low voltage direct current (such as 1000 volts by way of example), a storage condenser adapted to be continuously charged by this direct current source, a load such as the primary of a transformer across which it is desired to obtain high voltage pulses of, let us say, 2000 or 4000 volts, and a condenser of relatively small capacity compared to the storage condenser adapted to be connected in series between the large storage condenser and the transformer but whose connections are continuously reversed relative to both the storage condenser and the load. Features of the invention reside in the different forms of apparatus employed for reversing the connections of the small condenser relative to its charging source and its load.

A more detailed description of the invention follows in conjunction with a drawing, wherein:

Figs. 1 to 4 illustrate four different embodiments of the present invention, and

Fig. 1a graphically shows the form of the pulse obtainable from the system of the invention.

All four embodiments of the invention diagrammatically illustrate the power system for supplying a magnetron oscillator 1 with high voltage pulses of microsecond duration. Such a magnetron oscillator may be used in a radio locating system for producing pulses of ultra short waves below one meter in length. It is desired that the pulses be short compared to the interval of time between them. The power supply system constituting the invention is designed to convert direct current power of relatively low voltage supplied through lead 10 to power pulses of rela-

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tively high voltage and to supply these high voltage pulses to an electrode of the oscillator 1, such as the cathode, in order to cause the oscillator to produce oscillations solely during the interval in which the pulses of high voltage appear. Because the oscillator 1 functions momentarily under these conditions, it is possible to obtain a higher output from it than during a normal or continuous steady state. To these ends, the invention contemplates applying to the oscillator a much higher voltage than normally applied to a magnetron electrode but for a very short period of time, thus enabling high output power at short waves to be derived from the oscillator.

Referring to Fig. 1 in more detail, a direct current charging source of, let us say, 1000 volts, is applied to lead 10 for charging the large condenser 11 through a choke coil 12. This direct current charging source may be a rectifier, a direct current generator, or a battery. The choke coil is provided for smoothing purposes. The upper electrode of condenser 11 is connected to the upper terminal of the primary winding of a step-up transformer 13 through a small condenser 14 whose connections between the condenser and the transformer are adapted to be continuously reversed. Condenser 11 is designed to be much larger in capacity than condenser 14, for example ten to fifteen times larger, in order that the voltage at the condenser 11 should not drop appreciably when furnishing charge to the condenser 14. The armatures of the condenser 14 are connected to electrodes 15 and 16 which are shown contacting electrodes 17 and 18, respectively. The reversal of the connections of condenser 14 can be obtained by rotating the condenser in the direction of the arrows, such that at one time the electrodes assume the position in the drawing, while at another predetermined time the electrodes 15 and 16 are reversed to contact the electrodes 18 and 17, respectively.

By thus continuously rotating the condenser 14, or its connections, I am able to obtain pulses at regular intervals through the primary winding of transformer 13 which have an initial voltage of 2000 volts across the primary, or twice the voltage value of the direct current charging source. The reasons for this will now be given: Let us assume that we first connect the circuit in the manner indicated in the drawing of Fig. 1. There will then be produced a pulse through the primary winding of transformer 13 having an initial voltage of the direct current charging source supplied to lead 10. Thus, if the direct current charging source is 1000 volts, there will

be a pulse or kick through the primary winding of transformer 13 of 1000 volts between its terminals. Now, if the connections of condenser 14 are reversed by rotating the condenser and its electrode so that electrode 16 touches electrode 17, and electrode 15 touches electrode 18, there is produced in effect a series circuit of condensers 11 and 14 with the polarities of the condensers in additive relation. There will then be obtained across the primary winding of transformer 13 a pulse having an initial voltage of 2000 volts. This initial voltage of the pulse will, of course, diminish according to the time constants of the associated circuit. With continuous rotation of the condenser 14 or its connections, I am able to obtain periodically appearing pulses through the primary winding of the transformer 13, each of which has an initial 2000 volts. It should thus be noted that only the first pulse through the primary winding of the transformer has an initial voltage equal to the voltage of the direct current charging source, whereas all subsequent pulses have a voltage which is double the voltage of the charging source. The phenomenon may be more readily understood by referring to Fig. 1a, which shows the wave form of the double voltage pulses across the primary winding of transformer 13. It should be noted that the pulse has an initial voltage of 2000 volts which gradually diminishes. Point X on the curve of Fig. 1a may represent, by way of example, the point at which the condenser 14 is completely discharged through the transformer 13 and begins to recharge in the opposite direction. It will thus be seen that the whole complete pulse through the transformer includes both the discharge and the charging of the condenser 14 as one continuous or uninterrupted phenomenon. The particular position in time of the point X on the slope of the pulse of Fig. 1a is dependent upon the values of the circuit elements, such as inductance, capacity and load resistance. The entire duration of the pulse of Fig. 1a may be one microsecond or so.

By designing the transformer 13 as a step-up transformer having a voltage ratio of one to ten, it is thus possible to obtain across the secondary winding a voltage pulse of 20,000 volts for momentary application to an electrode of the magnetron oscillator. If the connections from the condenser 14 are continuously and repeatedly reversed at a rate of 240 per second, it is possible to derive pulses of one microsecond duration from the oscillator which are separated from one another by much longer intervals of time, say of the order of thousands of microseconds.

Fig. 2 shows an alternative form for accomplishing the same results described above in connection with Fig. 1. In Fig. 2, the small condenser 14 is stationary and the connections from the condenser 14 to the condenser 11 and the primary winding of step-up transformer 13 are repeatedly reversed by means of a rotatable discharger which can operate at a speed of 1800 revolutions per minute, by way of example. A rotating discharger in a form generally like a commutator and having a plurality of equally spaced connecting segments 31 serves to reverse the connections to the condenser 14 between each charge. The condenser 14 has its upper charging surface connected to a plurality of brushes or contacts 32 and 33 while the lower charging surface of condenser 14 is connected to a plurality of contacts 34 and 35. The relatively low voltage source applied to lead 10 is connected to a

plurality of contacts 36 and 37, while the upper terminal of the primary winding of transformer 13 is connected to a plurality of contacts 38 and 39. In one position of the discharger, one segment 31 will bridge contacts 37 and 32, while at the same time another segment 31 will bridge contacts 39 and 35, thus producing a complete circuit from the direct current charging source through the condenser 14 and the primary winding of transformer 13. In this position, there is no direct connection between contacts 36 and 34, or between contacts 38 and 33. In another position of the discharger, a segment 31 will bridge contacts 36 and 34, while simultaneously another segment 31 will bridge contacts 38 and 33. At this particular time, there will be no direct current connection between contacts 37 and 32, or between 39 and 35, by virtue of the fact that the segments which previously bridged them have now passed beyond these contacts in their path of travel. In this last position, the circuit will again be complete from the direct current charging source through the condenser 14 and through the primary winding of the transformer 13, but, it should be noted, that the connections of the condenser 14 have now been reversed relative to the first position. As the discharger revolves, this cycle of operations will be repeated, thus producing repeated voltage pulses through the primary winding of the transformer 13 in the same direction but of double the value of the direct current charging source.

Fig. 3 shows a modification of Fig. 2, by means of which it is possible to obtain a pulse across the primary winding of transformer 13 of four times the voltage of the direct current charging source. This is done by supplying another condenser 11' of relatively large value in series with the primary winding of the transformer 13 and by connecting another direct current charging source to the junction between the condenser 11' and the primary winding, as shown. The two direct current charging sources supply the same values of direct current voltage to the system. It should be noted that the polarities of the two direct current charging sources which are connected to condensers 11 and 11' are different. The system thus employs two direct current charging sources, one a positive direct current source and the other a negative direct current source, across opposite terminals of the condenser 14. It is now possible to charge the condenser 14 to twice the voltage of either direct current charge; and by reversing the connections to condenser 14, the system is able to derive a pulse of voltage which has an initial value of four times the voltage of either direct current charging source or twice the voltage across the condenser 14.

In Fig. 3, condensers 11 and 11' must be of large capacity relative to condenser 14 (let us say, ten to fifteen times as large), although the two condensers 11 and 11' may or may not be equal in value.

Fig. 4 illustrates still another embodiment of the invention and differs from Fig. 3 solely in the arrangement for reversing the connections between condenser 14 and the condenser 11 and the primary winding of step-up transformer 13. In Fig. 4, there is employed a rotating brush arrangement having a pair of metallic brushes 20 and 21 mounted on an insulating disc 22. This insulating disc is adapted to be rotated at a speed of 3600 revolutions per minute by means of drive shaft 23, in turn linked to a small motor

(not shown). The brushes 20, 21 are adapted to contact four stationary segments 25, 26, 27 and 28 mounted in the four quadrants of a circle, as the disc 22 revolves. Thus, in the position shown in the drawing, the brush 20 will bridge stationary segments 25 and 28 and provide a path from the direct current charging source and the condenser 11 through the segments 25 and 28 to one plate of the condenser 14. At the same time, the segment 21 will bridge the stationary segments 26 and 27, completing a path from the other plate of the condenser 14 through the primary winding of the transformer 13. At another position during the rotation of the disc 22 in the direction of the arrow, the brush 20 will bridge the stationary segments 25 and 26, while the brush 21 will bridge the stationary segments 27 and 28, thus reversing the connections of the condenser 14 in an obvious manner. Except for the arrangement for reversing the connections of the condenser 14, the system is substantially the same as that of Fig. 3. It should be understood, of course, that the rotating brush and stationary segment arrangement of Fig. 4 can be used in a similar capacity for the equivalent elements in Figs. 1 and 2.

For want of a better name for the connecting device of condenser 14, I have used the time honored name "discharger." It is evident that the device may be called either a commutator or a rotary spark gap. It is a commutator in the sense that the stationary and the moving contacts are actually brought into contact with one another. On the other hand, the device is a rotary gap because the microsecond pulse is all completed before actual contact is made. Due to the relatively low voltage of 1000 to 2000 volts, it is difficult to maintain the required small electrode spacing in any other way than to eventually let it reach zero.

What is claimed is:

1. Apparatus for converting direct current power to periodically repeated spaced pulses of short duration, comprising a condenser having in electrical parallel relation thereto the series circuit of another condenser and an inductance coil, one of said condensers having a capacity which is at least several times larger than the other, a source of direct current charging voltage connected across said condenser of larger capacity, and means for periodically reversing the connections of the smaller of the two condensers relative to the larger condenser and the inductance coil, and a load coupled to said inductance coil.

2. Apparatus for converting direct current power to periodically repeated spaced pulses of short duration, comprising a source of direct current charging voltage, a storage condenser of relatively large value coupled to and arranged to be charged by said source, a load, a condenser of relatively small value connected in series relation between said storage condenser and said load, and means for periodically reversing the connections of said small condenser relative to the larger condenser and the inductance coil, whereby the charges on both condensers additively combine each time said connections are reversed to produce a pulse through said load with an initial value of voltage greater than the voltage of said direct current source, and said small condenser recharges in the opposite direction from the charge stored on said storage condenser.

3. In combination, a source of direct current

voltage, a storage condenser, a connection from one terminal of said storage condenser to said source, a connection from the other terminal of said storage condenser to ground, a connection from said source to a contact, another contact and a connection from it to one terminal of an inductance coil whose other terminal is connected to ground, a load coupled to said inductance coil, a condenser which is relatively small compared to said storage condenser, and means for connecting said small condenser between said contacts and for periodically reversing the connections from said small condenser to said contacts, whereby recurring pulses of the same polarity but of initial values of voltage higher than the voltage of said source are passed through said load.

4. Apparatus for converting direct current power to periodically repeated spaced pulses of short duration, comprising a source of direct current charging voltage, a storage condenser connected across said source, a commutator arrangement having a plurality of spaced bars, four pairs of brushes aligned in such manner that the first pair of brushes is connected together at the same time that the third pair is connected together, at which time the brushes of the other pairs are not connected together, and the second pair is connected together at another time when the fourth pair is also connected together, a connection from a brush of the first pair and a correspondingly located brush of the fourth pair, a connection from a brush of the second pair and a correspondingly located brush of the third pair, a condenser connected between said last two connections, said last condenser having a relatively small capacity compared to said storage condenser, a connection between the other brush of said first pair and the other brush of said second pair, and a lead from said last connection to one terminal of said source, a connection between the remaining brushes of said third and fourth pairs, an inductance coil, a lead from one terminal of said coil to said last connection, and a connection from the other terminal of said coil to the other terminal of said source.

5. Apparatus in accordance with claim 4, including a condenser which is relatively large compared to said small condenser serially connected in said last connection, and another source of direct current charging voltage connected across said last condenser, said last direct current charging source supplying a voltage whose polarity is opposite to that of said first source.

6. Apparatus for converting direct current power to periodically repeated spaced pulses of short duration, comprising a source of direct current charging voltage, a storage condenser coupled to said source, four equal length stationary metallic segments arranged end to end on a circle and having gaps between adjacent ends, a pair of rotating brushes adapted to bridge opposite gaps, simultaneously, a condenser of relatively small capacity compared to the storage condenser connected between the first and third segments, a connection between one terminal of said source and the second segment, a load, a connection from one end of said load to the fourth segment, and a connection from the other end of said load to the other terminal of said source.

7. Apparatus for converting direct current power to periodically repeated spaced pulses of short duration, comprising a source of direct cur-

rent charging voltage, a storage condenser coupled to said source, four equal length stationary segments arranged end to end on a circle and separated from one another, electrically, a pair of rotating brushes one of which is adapted to bridge the adjacent ends of two of said segments while the other brush is adapted to bridge the adjacent ends of the other two segments, a condenser of relatively small capacity compared to the storage condenser connected between the first and third segments, a connection between one terminal of said source and the second segment, a load, a connection from one end of said load to the fourth segment, a connection from the other end of said load to the other terminal of said source, and a condenser which is at least comparable to said storage condenser serially arranged in said last connection, and another source of direct current charging voltage connected across said last condenser, said two direct current sources supplying voltages of different polarities to said apparatus.

8. Apparatus for converting direct current power to periodically repeated spaced pulses of short duration, comprising a source of direct current charging voltage, a storage condenser coupled to said source, four equal length stationary metallic segments equally spaced from one another and arranged in the four quadrants of a circle, a pair of rotating brushes oppositely disposed on a diameter of said circle and adapted to bridge the ends of adjacent segments as they rotate, a condenser of relatively small capacity compared to said storage condenser connected to two oppositely located segments on said circle, an inductance load, and connections from the other two oppositely located segments on said circle to said source and load, respectively.

9. Apparatus for converting direct current power to periodically repeated spaced pulses of short duration, comprising a source of direct current charging voltage, a storage condenser coupled to said source, four equal length stationary segments arranged end to end on a circle and separated from one another electrically, a pair of rotating brushes one of which is adapted to bridge the adjacent ends of two of said segments while the other brush is adapted to bridge the adjacent ends of the other two segments, a condenser of relatively small capacity compared to the storage condenser connected between the first and third segments, a connection between one terminal of said source and the second segment, a load, a connection from one end of said load to the fourth segment, a connection from the other end of said load to the other terminal of said source.

10. Apparatus for converting direct current power to periodically repeated spaced pulses of short duration, comprising a condenser having in shunt thereto the series circuit of another condenser and an inductance coil, one of said condensers having a capacity which is at least several times larger than the other, a source of direct current charging voltage coupled across said condenser of larger capacity, means including a commutator and brush arrangement for periodically reversing the connections of the smaller of the two condensers relative to the larger condenser and said coil, and a load coupled to said coil.

11. Apparatus for converting direct current power to periodically repeated spaced pulses of

short duration, comprising a condenser having in shunt thereto the series circuit of another condenser and an inductance coil, one of said condensers having a capacity which is at least several times larger than the other, a source of direct current charging voltage coupled across said condenser of larger capacity, means including a rotating brush and a plurality of stationary segments for periodically reversing the connections of the smaller of the two condensers relative to the larger condenser and the coil, and a load coupled to said coil.

12. Apparatus for converting the output of a direct current voltage source to periodically repeated spaced pulses of short duration and of greater voltage, comprising a source of direct current voltage, a condenser coupled to and arranged to be charged by said source, a load through which said condenser discharges, and a rotating discharger having a plurality of spaced stationary brushes and a plurality of spaced conducting segments mounted on a rotating support for periodically reversing the connections between said condenser and said load.

13. Apparatus for converting direct current power to periodically repeated spaced pulses of short duration, comprising a source of direct current charging voltage, a commutator arrangement having a plurality of spaced bars, four pairs of brushes aligned in such manner that the first pair of brushes is connected together at the same time that the third pair is connected together, at which time the brushes of the other pairs are not connected together, and the second pair is connected together at another time when the fourth pair is also connected together, a connection from a brush of the first pair and a correspondingly located brush of the fourth pair, a connection from a brush of the second pair and a correspondingly located brush of the third pair, a condenser connected between said last two connections, a connection between the other brush of said first pair and the other brush of said second pair, a lead from said last connection to one terminal of said source, a connection between the remaining brushes of said third and fourth pairs, a load, a lead from one terminal of said load to said last connection, and a lead from the other terminal of said load to the other terminal of said source.

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