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IMPULSE SYSTEM

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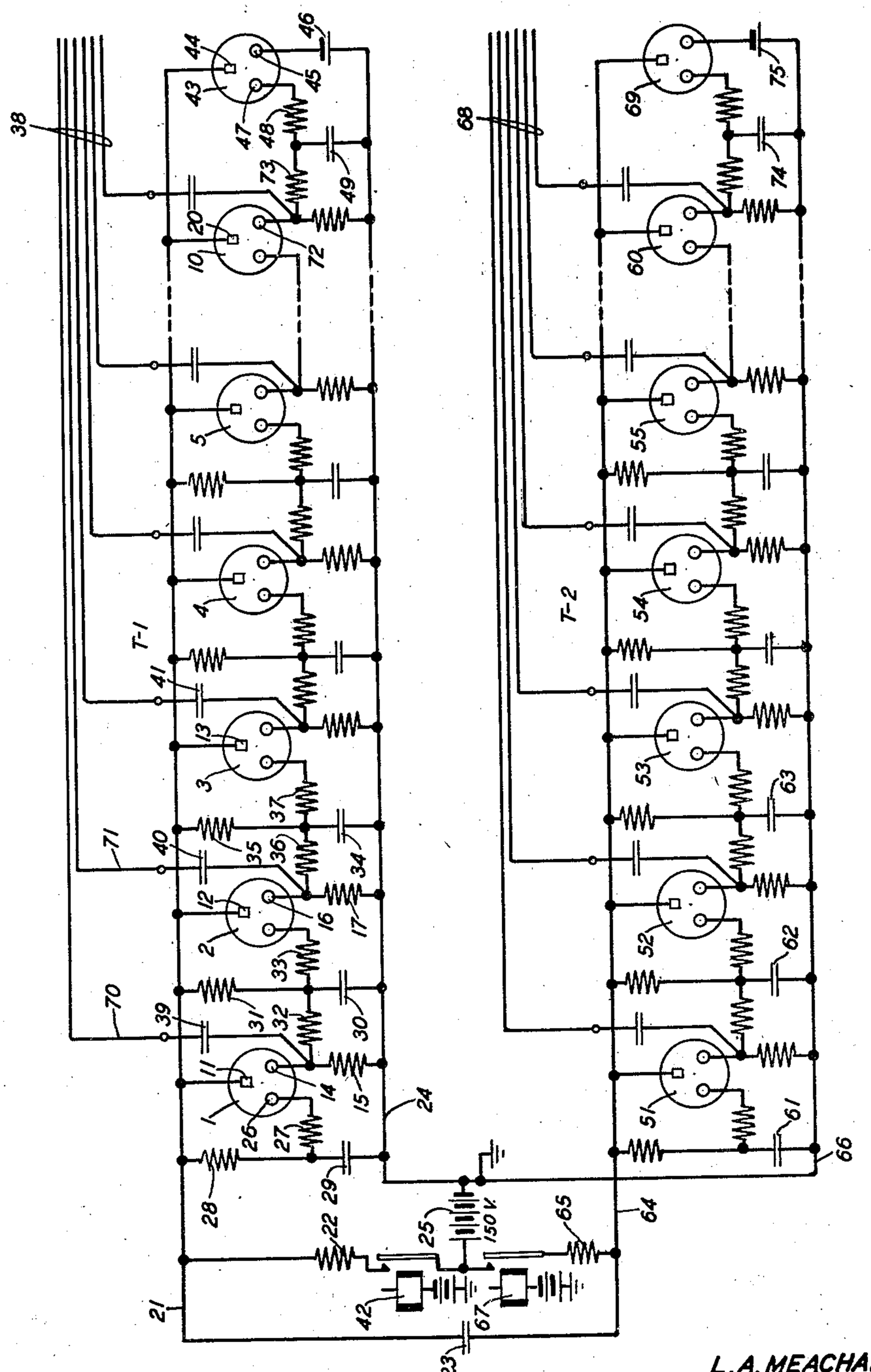

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IMPULSE SYSTEM

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This invention relates to impulse systems and particularly to impulse generating systems.

The objects of the invention are to obtain greater accuracy and uniformity in the production of impulses; to simplify the means used for generating the impulses in series; to enable the generating means to repeat its cycle automatically; and to effect economy and other improvements in impulse systems and devices.

A feature of the invention is an impulse generating system comprising a series of space discharge tubes and a corresponding series of condensers for producing a succession of accurately timed impulses, in which the condensers associated with the first and all succeeding tubes are charged simultaneously to an initial potential value insufficient to operate the tubes, the succeeding condensers all remaining at this intermediate potential until the condenser for the first tube in the series reaches the tube operating potential, whereupon the first tube discharges and increases the charge on the second condenser at a definite rate from its initial or intermediate potential value to the operating potential of the associated second tube in the series. The second tube now discharges and causes the third condenser to increase its charge from the initial value to the operating potential of the associated tube. Thus the tubes are discharged in succession to produce a series of timed impulses, and these impulses are delivered to corresponding impulse conductors from which they may be taken and utilized for any desired purpose. An advantage of this feature is that the initial intermediate charge on each condenser assures that said condenser will reach a charge sufficient to ionize the associated tube when the preceding tube discharges and causes the condenser to resume its charging operation. Thus the condenser can be depended upon to rise to the ionizing voltage of the tube, although in practice the tubes may vary somewhat in ionizing values. Another of the advantages of this feature is the high degree of accuracy that is obtained by giving the condensers an initial charge before the tubes are operated. Since each condenser is partially charged in advance, greater accuracy may be had in the measurement of the interval between the operation of the preceding tube and the increase of the condenser charge to the operating potential of the succeeding tube.

Another feature of the invention is an impulse generator in which each of the successive tubes in the series operates and remains in a conducting condition until all tubes in the series have operated and in which a controlling tube, located at the end of the series, discharges after the last impulse tube of the series has operated and in so doing quenches all of the operated tubes by lowering the voltage applied to them below the sustaining value. Thus the impulse producing tubes are restored to normal at the end of each cycle in order that they may proceed with the next succeeding cycle of operation.

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Another feature is an impulse generator in which two series of tubes are arranged to operate alternately, each series of tubes producing its own series of impulses, and in which the controlling tube of each series serves to quench all of the operated tubes in the series and also to quench the controlling tube of the other series. Each controlling tube, once operated to quench its associated impulse tubes, remains operated to maintain them disabled while the other series of tubes are proceeding through their cycle. Thus the operated controlling tube of one series must be quenched to allow its associated impulse tubes to become enabled as soon as the alternate series has completed its cycle, and this is accomplished, as above noted, by the discharge of the controlling tube of the alternate series. By these means the generator is capable of resetting itself automatically to reproduce the impulse cycle indefinitely without the assistance of external agencies.

These and other features of the invention will be described more fully in the following detailed specification.

The drawing accompanying the specification discloses an impulse generating system comprising two series of discharge tubes T—1 and T—2 with associated condensers and resistors. The series T—1 may include any desired number of impulse tubes, it being assumed for the purpose of illustration that ten of these tubes, 1, 2, 3 . . . 10, are provided. The tubes illustrated are of the well-known gas-filled cold cathode type, each having a main anode, a main cathode, and a starting electrode.

The main anodes 11, 12, 13, etc., are all connected over the common conductor 21 to one terminal of the common resistor 22 and to one terminal of the common condenser 23. The main cathode of each tube is connected through an individual resistor and thence over the common conductor 24 to the grounded or negative pole of battery 25. For example, the cathode 14 of tube 1 is connected through the individual resistor 15 to the common conductor 24. Likewise the cathode 16 of the next tube 2, is connected

to the individual resistor 17 to the common conductor 24, and the same is true with respect to the remaining impulse tubes in the series. The starting electrodes of the tubes are connected individually through two resistors in series to the common conductor 21. For instance, the starting electrode 26 of the tube 1 is connected through resistors 27 and 28 to the common conductor 21.

Each tube in the series T—1 is provided with a time measuring condenser for measuring the interval between one impulse and the next. The condenser 29 of the first tube is connected between the common conductor 24 and the junction of resistors 27 and 28. The next condenser 30 is connected between the common conductor 24 and the junction point of the potentiometer formed by resistors 31 and 32. The other terminal of the resistor 32 is connected to the cathode 14 of the preceding tube. In like manner the next condenser 34 (and the same is true of the succeeding condensers in the series) is connected between the common conductor 24 and the junction point of the potentiometer formed by the resistors 35 and 36.

The impulses are produced by the discharge current flowing in the main gaps formed by the anodes and cathodes of the tubes. These impulses appear on the impulse conductors 38, which are connected through individual condensers 39, 40, 41, etc., to the cathodes of the respective tubes.

The energy for charging the condensers 29, 30, 34, etc., is supplied by the battery 25 through the common resistor 22 when the switch relay 42 is operated.

The series of impulse tubes T—1 is provided with a common control tube 43, the purpose of which is to quench all of the tubes of the series T—1 at the end of their cycle and to maintain them disabled until the alternate series of tubes T—2 has performed its impulse generating cycle. The anode 44 of tube 43, like the anodes of the impulse tubes, is connected to the common conductor 21. The cathode 45 is connected through the biasing battery 46 to the ground conductor 24. The starting electrode 47 is connected through resistor 48 to one terminal of the condenser 49, the other terminal of the condenser being connected to the common conductor 24.

The other series of tubes T—2, which is identical with the series T—1, comprises ten impulse tubes 51, 52, 53, 54, 55 . . . 60. The tubes of this series are also provided with condenser 61, 62, 63, etc., and with resistors corresponding to those of the series T—1. The common conductor 64, to which the anodes of the tubes 51, 52, etc., are connected, is joined to one terminal of the common resistor 65 and also to the common condenser 23. The other common conductor 66, to which the condensers and the cathodes of the tubes are connected, is, like the common conductor 24 of the series T—1, connected to the negative or grounded pole of battery 25. The battery 25 serves to charge the condensers 61, 62, 63, etc., through the common resistor 65 when the switching relay 67 is operated.

The impulses generated by the series T—2 are delivered to the impulse conductors 68, which are connected individually through condensers to the cathodes of the tubes 51, 52, 53, etc.

The series T—2 is also provided with a common control tube 69 which serves to quench all of the operated tubes in the series at the end of the generating cycle and to maintain these

tubes disabled until the alternate series T—1 has performed its impulse generating cycle.

The operation of the impulse generating system will now be described. To start the generation of the impulses the switching relay 42 is operated in any suitable manner to close its contacts. As soon as the relay 42 operates, a circuit is completed from the positive pole of battery 25, contacts of said relay, common resistor 22 and thence in parallel through resistors 28, 31, 35 etc., and the respective condensers 29, 30, 34, etc., to the common conductor 24 which is connected to the negative pole of battery 25. The condensers are charged in this circuit at a rate determined by the values of the associated resistors. Since condenser 29 is included in series only with the common resistor 22 and the individual resistor 28, it will continue to charge until it reaches a potential sufficient to cause the ionization of the control gap formed by the electrodes 14 and 26 of the tube 1. The second condenser 30, however, is connected to the potentiometer formed by resistors 31, 32 and 15. This condenser, therefore, will cease to charge as soon as it has reached an intermediate potential which is substantially less than the ionizing potential of the associated tube 2. Likewise, each of the succeeding condensers will cease to charge as soon as it has reached the intermediate potential.

The condenser 29 will, as noted, continue to charge until it reaches the ionizing potential of the tube 1, whereupon the control gap of this tube ionizes in a circuit traceable from one pole of condenser 29, resistor 27, electrodes 26 and 14, resistor 15 to the other pole of the condenser. As soon as the control gap ionizes, ionization transfers to the main anode 11, and the main discharge current flows in a circuit from the positive pole of battery 25, contacts of relay 42, resistor 22, conductor 21, anode 11, cathode 14, resistor 15 to the grounded conductor 24. The potential of the cathode 14 is transmitted through the condenser 39, and an impulse is delivered to the conductor 70 while the condenser 39 is becoming charged. The flow of current through the resistor 15 also increases the potential of the junction between the resistors 31 and 32, and the charging of condenser 30 is resumed, raising its potential from the intermediate value at which it initially stands toward the ionizing value of the tube 2. The rate at which the condenser 30 charges from its intermediate value to the ionizing value of the tube is accurately fixed by the values of the associated resistors. At the end of this measured interval the condenser 30 reaches the ionizing potential, and the control gap of the tube 2 ionizes. Thereupon discharge current flows in the main gap circuit of the tube, including the anode 12, cathode 16 and the resistor 17. The potential of the cathode 16 caused by the discharge of the main gap causes the delivery of an impulse through the condenser 40 to the impulse conductor 71. Also the potential of the cathode raises the potential of the junction point of resistors 35 and 36, and the next condenser 34 resumes its charging operation and raises its potential from the intermediate value to the value required for the ionization of the associated tube 3. In this manner the impulse tubes are discharged at regularly measured intervals, and the impulses are produced in the associated conductors 38.

Each one of the tubes that discharges remains in its discharged condition until all tubes have been operated. Following the operation of the last impulse tube 10 in the series, charging cur-

rent flows from the cathode 72 through resistor 73 and condenser 49 to conductor 24. Condenser 49 charges until its potential, when added to the voltage of battery 46, is sufficient to ionize the control tube 43. As soon as the control gap of the tube 43 ionizes, a low impedance circuit is closed from common conductor 21, anode 44, cathode 45, battery 46 to the grounded conductor 24. The current flowing in this low impedance path lowers the potential of the anodes of all of the impulse tubes to a point insufficient to maintain ionization of the main discharge gaps. Thereupon the tubes 1, 2, 3 . . . 10 are quenched. The control tube 43, however, continues to conduct current and in so doing maintains the potential on conductor 21 below the operating value of the impulse tubes. Hence the series T—1, having completed an impulse generating cycle, is maintained disabled by the control tube 43 in order that the alternate series T—2 may perform its cycle.

At any suitable time the switching relay 67 is energized to initiate the operation of the series T—2. When the relay 67 attracts its armature, a circuit is closed from the positive pole of battery 25, contacts of relay 67, common resistor 65 to the conductor 64. In the manner already described the tubes 51, 52, 53 of the series T—2 are operated in succession to produce measured impulses in the impulse conductors 68.

When the last impulse tube 60 has operated, condenser 74 charges and causes the ionization of the control tube 69. Discharge current now flows over the common conductor 64 through the main gap of the tube 69, battery 75 to conductor 66. This flow of current lowers the potential on conductor 64 to quench all of the operated tubes of the series T—2 and to maintain them in a disabled condition in order that the series T—1 may perform the next impulse cycle.

The discharge of the control tube 69 not only quenches the impulse tubes of the series T—2 but also quenches the control tube 43 to reenable the impulse tubes of the series T—1. At the time the relay 67 operated to start the cycle of the series T—2 a circuit was closed from the positive pole of battery 25, contacts of relay 67, resistor 65, condenser 23, conductor 21, anode 44, cathode 45, battery 46 to the grounded conductor 24. The condenser 23 assumes a charge in this circuit while the impulse series T—2 is performing its cycle of operation. At the instant the control tube 69 discharges, following the completion of the cycle of series T—2, a discharge circuit is closed as follows for condenser 23: from one terminal of said condenser over conductor 64, anode and cathode of the tube 69, battery 75, conductor 66, battery 25, contacts of relay 42, resistor 22 to the other terminal of condenser 23. The discharge current flowing in this circuit lowers the potential of conductor 21 below the sustaining value of the tube 43, and this tube quenches. As soon as tube 43 quenches, the potential on conductor 21 again rises to the operating value of the tubes of the series T—1, and this series immediately repeats this impulse generating cycle. At the end of its cycle the tube 43 again discharges and in so doing causes the quenching of the control tube 69 in a manner similar to that already described.

Thus the two series of tubes T—1 and T—2 operate alternately to produce accurately measured impulses and each series at the end of its operating cycle renders the other series operative.

From the foregoing discussion it will be seen that the system disclosed provides a means for generating a large number of impulses with accuracy and economy of equipment. By giving the condensers an initial charge it is possible to bring each condenser fully up to the ionizing voltage of the associated tube in response to cathode potential produced by the operation of the preceding tube. This insures a sufficient final voltage on each condenser to operate its associated tube, although the tubes may vary in practice. Moreover, the method of measuring the interval of time between pulses by the resumed charging of a condenser gives greater accuracy to the measurement, since the charging operation is taking place on the steep part of the time-voltage characteristic of the condenser.

What is claimed is:

1. The combination in an impulse system of a series of discharge devices, a series of condensers associated respectively with said discharge devices, means for charging a first one of said condensers to the operating potential of the associated discharge device, means for charging the succeeding condensers simultaneously to an initial potential which is below the operating potential of the associated discharge devices, means effective to operate the associated discharge device when said first condenser reaches said operating potential, means effective upon the operation of said first discharge device for charging the second condenser from said initial potential to said operating potential and for operating the second discharge device when said second condenser reaches said operating potential, means effective in response to the operation of said second discharge device and each succeeding discharge device for charging the next succeeding condenser from said initial potential to said operating potential, and means for supplying an impulse in response to the operation of each succeeding discharge device.

2. The combination in an impulse system of a series of discharge devices, a series of condensers associated respectively with said discharge devices, means for charging a first one of said condensers to the operating potential of the associated discharge device, means for charging the succeeding condensers simultaneously to an initial potential which is below the operating potential of the associated discharge devices, means effective to operate the associated discharge device when said first condenser reaches said operating potential, means effective upon the operation of said first discharge device for charging the second condenser from said initial potential to said operating potential and for operating the second discharge device when said second condenser reaches said operating potential, means effective in response to the operation of said second discharge device and each succeeding discharge device for charging the next succeeding condenser from said initial potential to said operating potential, resistors for timing the charging of said condensers to introduce a predetermined interval between the operation of each discharge device and the operation of the next succeeding discharge device, and means for supplying an impulse in response to the operation of each succeeding discharge device.

3. The combination in an impulse system of a series of discharge tubes, a series of condensers associated respectively with said tubes, means for charging said condensers simultaneously to an initial potential less than the operating potential

of said tubes, means effective upon the operation of any one of said tubes for causing current to flow to the next succeeding condenser to increase its charge from said initial potential to the operating potential of the associated tube, means for utilizing the charge on said succeeding condenser to operate the associated tube, means effective in response to the operation of said associated tube and to the operation of each succeeding tube for causing the flow of charging current to charge the next succeeding condenser from said initial potential to said operating potential, and means for supplying an impulse in response to the operation of each succeeding discharge tube.

4. The combination in an impulse system of a series of discharge tubes, means for operating said tubes in succession including a series of condensers associated respectively with said tubes, means for charging said condensers to an initial potential below the operating potential of said tubes and for increasing the charge on one of said condensers until the associated tube operates, means effective in response to the operation of any one of said tubes for charging the next succeeding condenser from said initial potential to the operating potential of the associated tube to cause the operation of said associated tube, means effective following the operation of the last impulse tube in said series for quenching the discharge in all of said tubes, and means for supplying an impulse in response to the operation of each succeeding tube.

5. The combination in an impulse system of a series of impulse discharge tubes, each tube having electrodes forming discharge gaps, means for operating said tubes in succession including a series of condensers associated respectively with said tubes, means for charging said condensers to an initial potential below the operating potential of said tubes and for increasing the charge on one of said condensers to cause the operation of the associated discharge tube, means responsive to the operation of each tube for causing the charge on the next succeeding condenser to increase at a predetermined rate from said initial potential to the operating potential of the associated tube, means for supplying an impulse in response to the operation of each succeeding tube, and a control tube for reducing the potential on the electrodes of all impulse tubes to quench the discharge thereof.

6. The combination in an impulse system of a series of impulse discharge tubes, each tube having electrodes forming discharge gaps, means for operating said tubes in succession including a series of condensers associated respectively with said tubes, means for charging said condensers to an initial potential below the operating potential of said tubes and for increasing the charge on one of said condensers to cause the operation of the associated discharge tube, means responsive to the operation of each tube for causing the charge on the next succeeding condenser to increase at a predetermined rate from said initial potential to the operating potential of the associated tube, means for supplying an impulse in response to the operation of each succeeding tube, a control tube for quenching the discharge in all of the impulse tubes and for maintaining them in a disabled condition, and means for quenching said control tube to restore said impulse tubes to their enabled condition to produce the next series of impulses.

7. The combination in an impulse system of two series of discharge tubes, condensers associated respectively with said tubes, means for charging the condensers of each series to an initial potential which is substantially less than the operating potential of the associated tubes and for increasing the charge on one of said condensers until the associated tube operates, means effective upon the discharge of any one of said tubes for charging the next succeeding condenser at a predetermined rate from said initial potential to the operating potential of the associated tube, means for utilizing the charge on each condenser when it reaches said operating potential for discharging the associated tube, means for producing impulses in response to the operation of said tubes, and means for utilizing said series of tubes alternately to produce alternate series of impulses.

8. The combination in an impulse system of two series of discharge tubes, means for operating said tubes in succession including condensers associated respectively with said tubes, means for charging the condensers of each series to an initial potential which is substantially less than the operating potential of the associated tubes and for increasing the charge on one of said condensers until the associated tube operates, means effective upon the discharge of any one of said tubes for charging the next succeeding condenser at a predetermined rate from said initial potential to the operating potential of the associated tube, means for utilizing the charge on each condenser when it reaches said operating potential for discharging the associated tube, means for producing impulses in response to the operation of said tubes, and a control tube for each of said series of tubes serving to quench the operated tubes of the associated series and to maintain them in a disabled condition while the other series of tubes is producing impulses.

9. The combination in an impulse system of two series of discharge tubes, means for operating said tubes in succession including condensers associated respectively with said tubes, means for charging the condensers of each series to an initial potential which is substantially less than the operating potential of the associated tubes and for increasing the charge on one of said condensers until the associated tube operates, means effective upon the discharge of any one of said tubes for charging the next succeeding condenser at a predetermined rate from said initial potential to the operating potential of the associated tube, means for utilizing the charge on each condenser when it reaches said operating potential for discharging the associated tube, means for producing impulses in response to the operation of said tubes, and a control tube for each of said series of tubes, each control tube serving to quench the discharge in all of the tubes of the associated series and to maintain said tubes disabled while the alternate series of tubes are producing impulses, each control tube also serving to quench the discharge in the control tube of the alternate series to enable the impulse tubes of said alternate series.

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