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2,965,755

METHOD OF AND MEANS FOR PRODUCING A CORONA DISCHARGE

Filed May 27, 1959

2 Sheets-Sheet 1

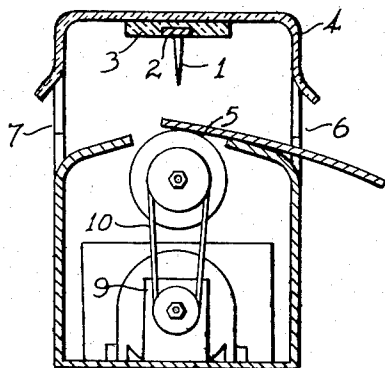


FIG 1

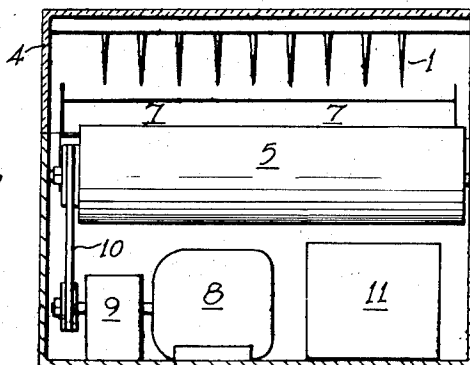


FIG 2

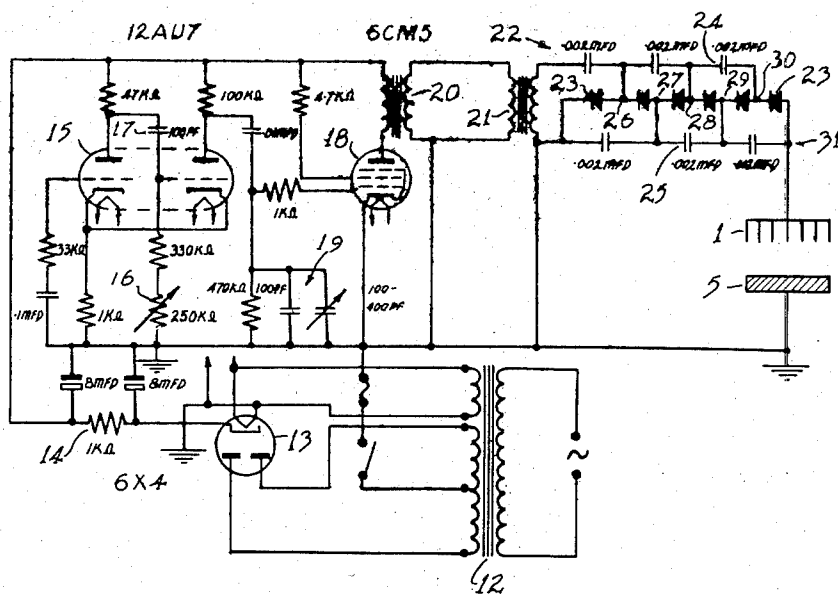


FIG 3

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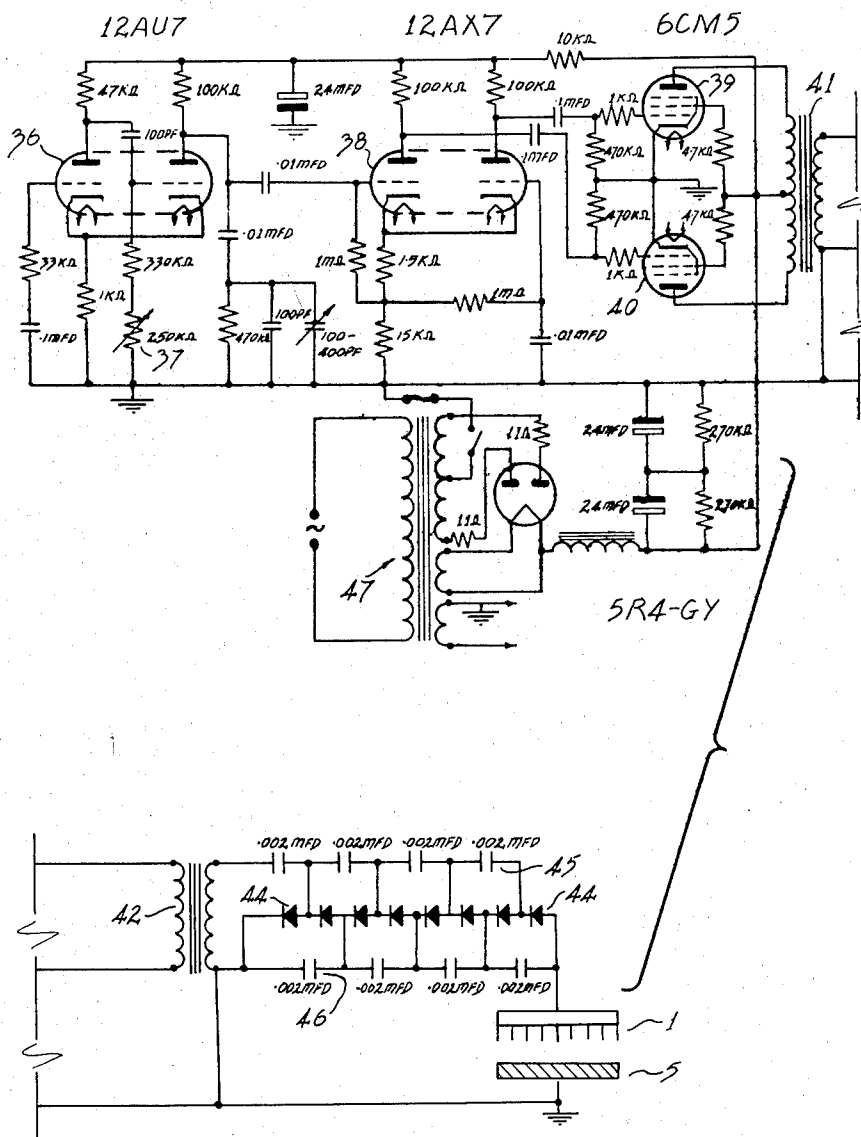


FIG 4

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METHOD OF AND MEANS FOR PRODUCING A CORONA DISCHARGE

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7 Claims. (Cl. 250—49.5)

This invention relates to a method of and means for producing a corona discharge and in particular it relates to a method and means which will produce a discharge suitable for the charging of electro-sensitive photo copying materials, or for use in electrostatic material movement, or for use generally where a high voltage field is required.

It is of course already well known to provide a corona discharge device which can be used for these purposes, but one of the problems is the even charging of the material in electro-photography and the other is the danger which can be involved where the equipment is capable of relatively heavy amperage outputs.

The objects of this invention are to overcome these problems, and also to assure good voltage control.

The method according to this invention consists in generating a saw-tooth wave form having a variable frequency for control purposes which feeds a voltage multiplying circuit embodying rectifiers, the invention being capable of delivering a high voltage at low amperage direct current to the corona discharge head or other device.

Basically the apparatus comprises means to produce alternating current having the required wave form and frequency, such as an oscillating tube system, the output from this section being amplified and fed through a matching device to a step-up transformer, the output of which in turn is fed to a series of half wave rectifiers connected in a voltage multiplying circuit.

In the case of a charging device for photo-conductor purposes in electro-photography the voltage is applied between a roller and a series of discharge points or the like, the paper to be charged passing over the roller and being drawn down on to it by the charge, this arrangement avoiding the heavy drag which otherwise takes place where paper being charged is moved through an electrical field.

Variation of the voltage is possible by simply varying the frequency at which the device operates.

To enable the actual construction to be better understood, the invention will now be described with reference to the accompanying drawings, in which:

Fig. 1 is a transverse section of a charging unit according to the invention,

Fig. 2 is a longitudinal section of the same,

Fig. 3 is a circuit diagram of a low power voltage generator, and

Fig. 4 is a circuit diagram of a heavier duty generator.

Reference will first be made to Figs. 1 and 2 of the drawings, which show a charging machine usable with the high voltage generator device, forming the basis of this invention.

The device comprises a number of in-line evenly spaced corona discharge points 1 which are interconnected by a bar 2 and mounted on an insulating strip 3 of high resistivity, isolating it from the body 4 of the machine, the discharge point assembly being mounted above a

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metal roller 5 which is kept at earth potential. The points 1 form the one electrode assembly while the roller 5 forms the other.

Electro-sensitive photo copying material is fed into a slot 6 in the side of the machine and it acquires an immediate electrostatic charge, which causes it to be drawn down on to the metal roller 5. This action is advantageous in three ways, firstly in that it creates an automatic friction drive causing the material to be drawn evenly through the charging device, secondly it ensures constant spacing between the corona discharge points 1 and the material to be charged, and thirdly the curvature of the roller 5 causes concentration of the electrostatic field applied to the active surface of the electro-sensitive material. The photo-copying material leaves through the slot 7.

The roller is driven by a motor 8 situated in the body 4, the drive being transferred through a reduction gear box 9 and chain 10 to give correct linear speed for charging.

The high voltage generator unit is housed in the compartment 11 in the body 4 and of course the two output leads are connected respectively to the points 1 and the roller 5.

Referring now to the circuit diagram of Fig. 3:

Alternating current obtained from a transformer 12 fed from the mains or from a vibrator supply is fed to a rectifier 13 and smoothing circuit 14 and the supply so obtained is then fed to a twin triode tube 15 coupled to operate as an oscillator to produce a saw tooth wave form, a variable resistance 16 changing the frequency of oscillation by varying the bleed from the decoupling condenser 17 between the plate of the first stage and the grid of the second stage.

The output from this saw-tooth generator is fed to an amplifying valve 18 which has a tuned grid circuit 19 for peak operation, the amplified wave then passing to an output transformer 20 where the voltage is preferably stepped down and fed into a high voltage coil 21 which can conveniently be the type of coil used in motor ignition circuits, the secondary of this coil being fed to the voltage multiplier circuit 22.

The voltage multiplier circuit 22 comprises a series of half wave metal rectifiers 23 connected in cascade and fed by two banks of series condensers 24 and 25, the output from this voltage multiplier having very limited current flow and this being selectable by appropriately choosing the internal resistance of the rectifiers 23.

It will be noted that the rectifiers 23 are series connected and the connection points 26, 27, 28, 29 and 30 are alternately connected to the opposite series condenser bank.

The polarity can of course be varied by suitably arranging the rectifiers, and such a voltage multiplier has the advantage that it is relatively simple and provided the rectifier elements are correctly spaced and insulated and condensers of the required voltage range are used, will ensure that a very high voltage can be built up which however has limited current output so that if there is an accidental contact by the operator with the live terminal 31, it is unlikely that the operator would be injured mainly because of the high frequency and the limited current which would produce only surface effects on the operator.

With regard to the heavy duty embodiment shown in Fig. 4 it will be noted that the saw tooth generator consists of a double triode tube 36 which has its frequency varied by a variable resistor 37 in the grid circuit of the second section of the tube 36, this generator tube 36 feeding a double triode phase splitter tube 38 which in

turn feeds a pair of power tubes 39 and 40, the plates of which are coupled to an output transformer 41.

The voltage at the output transformer 41 can be varied by varying the resistor 37 to vary the frequency of oscillation of the generator, this affording a very simple and effective method of controlling the output voltage of the unit.

The output transformer 41 is coupled to an induction coil 42 which in turn is connected to a voltage multiplier comprising a line of cascade connected rectifiers 44 fed between alternate rectifiers from two lines of series condensers 45 and 46, the arrangement serving as a voltage multiplier having a relatively high internal resistance so that dangerous amperes do not exist on the discharge points 1.

The system, like the system of the first described lower power unit is fed from a power supply 47 of any suitable form.

For the foregoing it will be realised that the method consists essentially of a multi-vibrator circuit producing an output voltage of saw-tooth wave form and having a variable frequency of the required range, usually from eight kilocycles to fifteen kilocycles per second. This voltage, after amplification in the tube or tubes, is transformer coupled to a high-voltage step-up transformer which in turn feeds the voltage multiplying circuit.

The voltage multiplying circuit contains a series of high impedance half wave metal rectifiers which deliver very high voltage but at a low amperage direct current to the corona discharge head.

The direct current potential delivered to the corona discharge or charging head is continuously variable from approximately two to twenty kilovolts for the lower power unit and from approximately thirty to one hundred kilovolts for the higher power unit by varying the frequency of the multi-vibrator.

The aforementioned factors, plus the low ripple content of the charging head supply voltage, occasioned by the high frequency drive to the voltage multiplier rectifier unit, contribute to improved performance of the charging unit. In addition the high impedance of the voltage multiplier circuit automatically limits the output current to a safe working value.

I claim:

1. The method of producing a corona discharge comprising generating a saw-tooth wave of a selected but variable frequency, amplifying the said wave, transforming the voltage to a higher level, and multiplying and rectifying the voltage, the final voltage being dependent on the selected frequency.

2. Means for producing a corona discharge comprising a thermionic generator tube circuit means producing a saw-tooth wave form of selected but variable frequency, a voltage amplifier coupled to said means for amplifying said wave form, a voltage multiplier circuit coupled to the amplifier to multiply the voltage and serve as a current limiter, and rectifier means coupled in said multiplier circuit and limiting current flow from the latter.

3. Means for producing a corona discharge comprising a thermionic generator tube circuit producing a saw-tooth wave form of selected but variable frequency, a phase splitter fed by the said generator circuit, voltage ampli-

fier tubes fed by said phase splitter, an output transformer and step-up transformer coupled to said voltage amplifier tubes, a voltage multiplier circuit to build up the output of the amplifier and serve as a current limiter, and rectifier means coupled in said multiplier circuit and limiting current flow from the latter.

4. Means for producing a corona discharge comprising a thermionic generator tube circuit producing a saw-tooth wave form of selected but variable frequency, a thermionic tube to amplify the output voltage of the said generator tube circuit, an output and step-up transformer coupled to the amplifier tube, and a voltage multiplier and current limiter connected to said step-up transformer and comprising two banks of series connected condensers and a set of series connected rectifiers coupled to the condensers and fed thereby at alternate points.

5. Means for producing a corona discharge comprising a thermionic generator tube circuit producing a saw-tooth wave form of selected but variable frequency, a phase splitter fed by said generator circuit, a pair of thermionic tubes to amplify the output voltage of the said phase splitter, an output and step-up transformer coupled to the amplifier tubes, and a voltage multiplier and current limiter connected to said step-up transformer and comprising two banks of series connected condensers and a set of series connected rectifiers coupled to the condensers and fed thereby at alternate points.

6. A device for charging photo-conductor surfaces on a base material comprising a roller electrode to feed the base material forward, means to drive the said roller electrode, a series of insulated spaced discharge points spaced from the said roller, and means for producing a corona discharge between the said points and the said roller electrode comprising a thermionic generator tube circuit producing a saw-tooth wave form of selected but variable frequency, means to amplify the output voltage of the said generator tube circuit, and a voltage multiplier and current limiter to further amplify the said voltage and comprising two banks of series connected condensers and a set of series connected rectifiers coupled to the condensers and fed thereby at alternate points.

7. A device for charging photoconductor surfaces on a base material comprising a roller electrode to feed the base material forward, means to drive the said roller electrode, a series of insulated spaced discharge points spaced from the said roller, and means for producing a corona discharge between the said points and the said roller electrode comprising a thermionic generator tube circuit producing a saw-tooth wave form of selected but variable frequency, a thermionic tube circuit to amplify the output voltage of the said generator tube, an output and step up transformer in circuit with the amplifier tube, and a voltage multiplier and current limiter comprising two banks of series connected condensers and a set of series connected rectifiers coupled to the condensers and fed thereby at alternate points.

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