Dec. 3, 1968 R. R. HOFFMAN 3,414,769

POWER SUPPLY WITH SIMULTANEOUSLY PEAKING POSITIVE AND NEGATIVE OUTPUT VOLTAGES

Filed Feb. 14, 1966

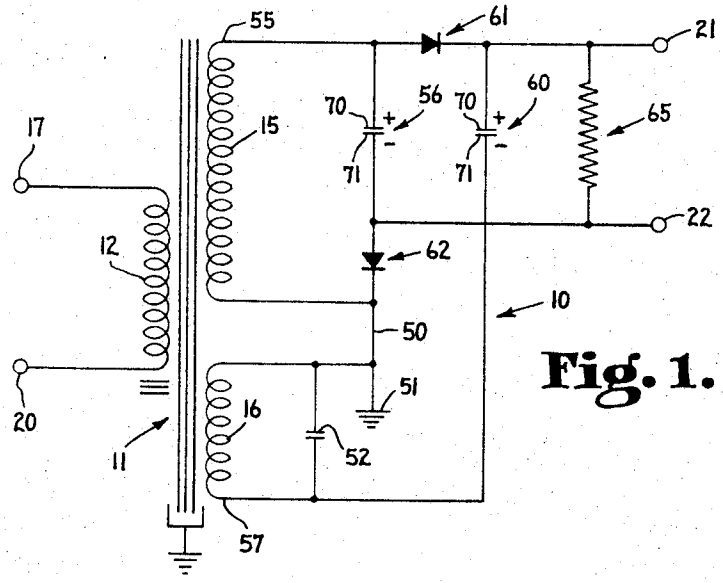

Fig. 1.

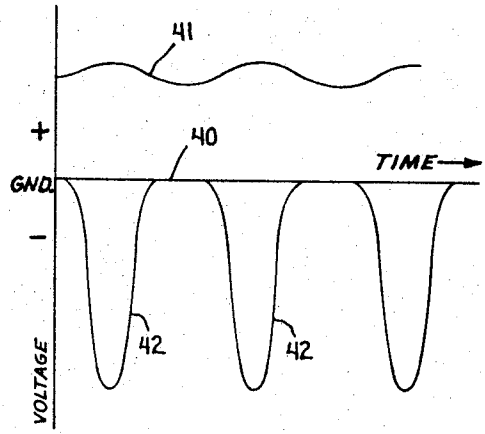

Fig. 2.

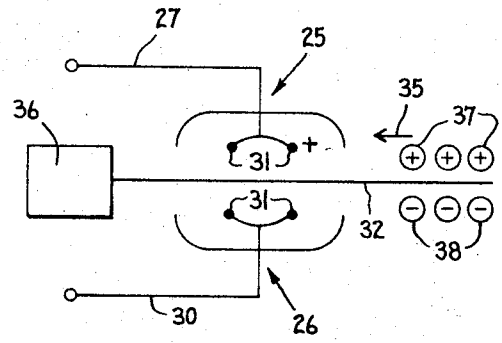

Fig. 3.

INVENTOR.
ROBERT R. HOFFMAN

BY Woodard, Weikart, Emhardt & Naughton
Attorneys

United States Patent Office 3,414,769 Patented Dec. 3, 1968

3,414,769

POWER SUPPLY WITH SIMULTANEOUSLY PEAKING POSITIVE AND NEGATIVE OUTPUT VOLTAGES

Robert R. Hoffman, Huntington, Ind., assignor to Wabash Magnetics, Inc., Huntington, Ind., a corporation of Indiana

Filed Feb. 14, 1966, Ser. No. 527,134
6 Claims. (Cl. 317—2)

ABSTRACT OF THE DISCLOSURE

A power supply which produces between one output terminal and ground a comparatively steady positive direct current potential, and produces between another output terminal and ground a periodically peaking negative direct current potential, the positive and negative potentials reaching their respective peak values simultaneously.

Such a power supply may be used as a part of corona producing means for use in an electrostatic copier.

The present invention relates to an electrostatic copier and to a power supply particularly adapted for use in such a copier.

Presently available electrostatic copying mechanism incorporate a corona providing arrangement which includes a pair of terminals located on opposite sides of the paper web. The blank paper is drawn into the mechanism between the terminals between which is established a potential on the order of 12,000 volts. The resulting corona produces an electrostatic charge on the opposite sides of the paper. The paper is made in such a way that a light image striking the paper produces an inability to separate the charges. The paper may then be dusted with an epoxy powder which goes only to the charged areas. Heat treating is then used to melt the epoxy image to permanently adhere it in position.

The terminals of the corona providing arrangement normally include a plurality of parallel wires which are intended to be positioned in parallel relation to the paper. It is, however, difficult or impossible for all practical purposes to construct the copier with the terminal wires exactly and precisely parallel to the path of the paper. For this reason there is a good likelihood of arcing occurring between the terminals which can result in burning of the paper and which is difficult to extinguish. Consequently one object of the present invention is to provide, in an electrostatic copier, means for extinguishing arcing.

A further object of the invention is to provide an improved electrostatic copier.

Still another object of the invention is to provide an improved power supply.

Presently available electrostatic copying mechanism tend to accumulate lint on the corona providing terminal wires. Therefore, a further object of the present invention is to provide means for automatically removing this lint from the wires of the terminals.

Still a further object of this invention is to provide a power supply which is efficient yet is inexpensive in providing a pulsating DC voltage.

Another object of the invention is to provide an improved power supply for an electrostatic copier.

Related objects and advantages will become apparent as the description proceeds.

One embodiment of the present invention might include an electrostatic copier comprising a corona providing arrangement including a pair of terminals, means for moving a web initially at ground potential between the terminals to be acted upon by the charge on said terminals, a power supply connected electrically across said terminals, said power supply being capable of producing a DC voltage between the terminals with the potential on said terminals peaking simultaneously oppositely relative to ground.

The full nature of the invention will be understood from the accompanying drawings and the following description and claims.

FIG. 1 is an electrical schematic drawing of the power supply of the present invention.

FIG. 2 is a graph showing the output of the power supply of FIG. 1 when the power supply is provided with a sign wave input.

FIG. 3 is a schematic section or side view of an electrostatic copier embodying the present invention.

For the purposes of promoting an understanding of the principles of the invention, reference will now be made to the embodiment illustrated in the drawing and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended, such alterations and further modifications in the illustrated device, and such further applications of the principles of the invention as illustrated therein being contemplated as would normally occur to one skilled in the art to which the invention relates.

Referring now more particularly to the drawings, there is illustrated a power supply **10** which includes a transformer **11** having a primary winding **12** and first and second secondary windings **15** and **16**. The power supply is provided with input terminals **17** and **20** and with output terminals **21** and **22**.

Referring to FIG. 3, in the electrostatic copier of the present invention, the terminals **21** and **22** are connected respectively to the terminals **25** and **26** which include leading wires **27** and **30** and a plurality of parallel wires **31** shown in end view in FIG. 3. The parallel wires **31** extend parallel to the paper web **32** on opposite sides thereof across the web and in perpendicular relation to the direction of movement **35** of the paper web. The paper **32** is drawn through the electrostatic copier by means of a suitable power mechanism **36**. When the electrostatic copier is in operation, the terminals **25** and **26** constitute a corona providing arrangement which provides a layer of positive charges **37** on the upper surface of the paper and a layer of negative charges **38** on the lower side of the paper.

Referring to FIG. 2, the output of the power supply and the voltage carried on the terminals **25** and **26** is shown. The line **40** represents ground potential with positive voltage being shown upwardly from the line **40** and negative voltage being shown downwardly from the line **40**. The function or line **41** represents the potential on the terminal **25** while the negative peaks **42** represent the potential on the terminal **26**. The horizontal scale in FIG. 2 represents time. The number of peaks **42** or the number of undulations in the wave or function **41** are equal to the frequency of the AC input across the input terminals **17** and **20** of the transformer **11**.

Referring again to FIG. 1, the center tap **50** of the two secondary windings **15** and **16** is connected to ground **51** with the windings **15** and **16** in series aiding relationship. A capacitor **52** is connected across the secondary **16** so as to form a tuned tank circuit which is tuned to the frequency expected at the input **17** and **20**. The purpose of the capacitor **52** is to cause the secondary **16** to draw substantial volt amperes so that to the primary the transformer appears to be a highly efficient load. The purpose of the tank circuit including the winding **16** and the capacitor **52** is also to saturate the secondary magnetic circuit with magnetic flux. It has been found that such a secondary electrical resonant circuit as is provided by the inductance **16** and the capacitor **52** causes a stabilization

of the output across the terminals **21** and **22**. Thus, even though the input voltage increases or decreases over a relatively long period of time, the output voltage will be maintained relatively stable.

Connected between the upper end **55** of the secondary **15** and the output terminal **22** is a capacitor **56**. Connected between the lower end **57** of the secondary **16** and the output terminal **21** is a further capacitor **60**. A first diode **61** is connected between the upper end **55** of the secondary **15** and the output terminal **21**, said diode **61** being oriented for low resistance to the flow of positive current from the end **55** of the secondary to the output terminal **21**. The diode **62** is connected between ground **51** and the output terminal **22** with the diode **62** being oriented for low resistance to flow of positive current from the output terminal **22** to ground. A resistance **65** is connected between the output terminals **21** and **22** and functions to bleed off the capacitors of the circuit when the power supply is not being used.

In operation the capacitor **56** is charged to the peak voltage appearing across the secondary winding **15**, while the capacitor **60** is charged to the total peak voltage appearing across the secondary windings **15** and **16** which, as mentioned, are in series aiding relationship. As indicated in the drawing, the polarity of the charge appearing on the capacitor **56** and **60** is positive on the plates **70** and negative on the plates **71**. The charge on the capacitors **56** and **60** is supplied through uni-directional current through the diodes **62** and **61**.

The output voltage between terminal **21** and ground at **51** is the algebraic summation of the voltage appearing across the capacitor **60** and the secondary winding **16**. Since the magnitude of the voltage appearing across the capacitor **60** is greater than the magnitude of voltage appearing across the secondary winding **16**, the output wave form **41** in FIG. 2 appears as a positive undulating DC voltage with the undulations or pulsations being obtained from the changing voltage of the secondary winding **16**.

The output between the terminal **22** and ground at **51** is the voltage appearing across the diode **62**. This voltage is the algebraic summation of the voltage across the capacitor **56** and the voltage across the secondary winding **15** of the transformer. When these two voltages are series aiding, the amplitude is nearly twice the peak voltage appearing across the transformer secondary winding **15**. When these two voltages are in the opposite direction, however (when the secondary winding **15** changes its direction of voltage polarity) there is no voltage drop across the diode **62** and consequently the output **22** reaches ground potential. Thus, the output voltage at **22** appears as the peaks **42** with the intermediate ground potential between each of the peaks. Of course, the peaks **42** occur at the same frequency as the primary source voltage.

One important feature of the present invention is the fact that the positive peaks in the wave form **41** occur simultaneously with the negative peaks in the wave form **42**. Consequently, the output voltage between the terminals **25** and **26** of the corona producing device is a direct current voltage but also incorporates a repeated maximum electrical stress occurring when the wave form **41** reaches its most positive values and the wave form **42** reaches its most negative values.

The present invention provides means for extinguishing arcing. This is automatically provided by the changing potential **42**. Thus, if an arc is established between the terminals at the time of peaking of the wave forms **41** and **42**, the arc is immediately extinguished by the dropping back of the opposite potential on both of the terminals. The greatly varying potential on both of the terminals also causes the lint collected upon the terminals to be burned off and removed from the terminals, thus preventing the lint from interfering with the creation of the proper corona. The power supply of the present invention produces a continuously moving and varying number of negative discharge points on the negative terminal **26** (on the wires **31**).

It has also been found that the power supply of the present invention in combination with the copier produces a more even distribution of positive and negative charges across the surface of the paper **32**. If the usual and conventional constant DC charge provided across the terminals is used with terminal wires **31** which are not precisely parallel to the surface of the paper, the charge tends to be deposited from the points of the wires **31** which are closest to the paper. Thus the paper is not evenly charged across its surface and the copier will not reproduce properly. The power supply of the present invention, however, eliminates this problem because an even discharge of positive and negative charges is applied to the paper even though some portions of the wires **31** are closer to the paper than other portions thereof.

One specific embodiment of the present invention might include the following values:

Capacitor **56** (4,000 volts DC rated)	microfarads__	.025
Capacitor **60** (4,000 volts DC rated)	do____	.025
Capacitor **52** (600 volts AC rated)	do____	.25
Resistor **65**	megohms__	100
Primary winding **12**	turns__	2,000
Secondary winding **15**	do____	36,000
Secondary winding **16**	do____	6,500

The above described specific values when incorporated in the circuit of FIG. 1 provide a 2,800 volt RMS AC voltage across the secondary **15** and a 600 volt RMS AC voltage across the secondary **16** when the primary **12** is provided with 115 volt AC 60 cycles current. The average voltage then provided at the terminal **21** is 4,000 volts DC while the peak voltage provided at the terminal **22** is 8,000 volts. The above figures are, of course, provided only as one illustrative exampe of the present invention.

While the invention has been illustrated and described in detail in the drawings and foregoing description, the same is to be considered as illustrative and not restrictive in character, it being understood that only the preferred embodiment has been shown and described and that all changes and modifications that come within the spirit of the invention and the scope of the claims are also desired to be protected.

The invention claimed is:

1. In an electrostatic copier, a corona providing arrangement comprising a pair of terminals, means for moving a web initially at ground potential between said terminals to be acted upon by the charge on said terminals, a power supply connected electrically across said terminals, said power supply producing between said terminals a comparatively steady positive direct current potential and a periodically peaking negative direct current potential, said positive potential and said negative potential reaching their respective peak values simultaneously.

2. The electrostatic copier of claim **1** wherein the power supply of claim **1** comprises:

input means for a source of alternating current electrical energy;

first, second and third output terminals, said first terminal for providing a reference potential, said second terminal for providing a comparatively steady positive direct current potential, and said third terminal for providing a periodically peaking negative direct current potential;

a transformer having a primary winding coupled to said input means and having first and second secondary windings connected in series aiding relationship, said first terminal being connected to a junction between said first and second windings;

a first diode, said second terminal being connected through said first diode to the end of said first wind-

ing opposite the end connected to said junction, said diode being oriented for low resistance to the flow of positive current from said opposite end to said second terminal;

a second diode, said third terminal being connected through said second diode to said first terminal, said second diode being oriented for low resistance to flow of positive current from said third terminal to ground;

and first, second and third capacitors, said first capacitor being connected between said third output terminal and said opposite end, said second capacitor being connected between said second output terminal and the end of said second winding opposite the end connected to said junction, said third capacitor being connected in shunt with said second secondary winding.

3. The power supply of claim **2** with the addition of a resistor connected across said second and third output terminals.

4. A power supply comprising:

input means for a source of alternating current electrical energy;

first, second, and third output terminals, said first terminal for providing a reference potential, said second terminal for providing a comparatively steady positive direct current potential, and said third terminal for providing a periodically peaking negative direct current potential;

a transformer having a primary winding coupled to said input means and having first and second secondary windings connected in series aiding relationship, said first terminal being connected to a junction between said first and second windings;

a first diode, said second terminal being connected through said first diode to the end of said first winding opposite the end connected to said junction, said diode being oriented for low resistance to the flow of positive current from said opposite end to said second terminal;

a second diode, said third terminal being connected through said second diode to said first terminal, said second diode being oriented for low resistance to flow of positive current from said third terminal to ground;

and first, second and third capacitors, said first capacitor being connected between said third output terminal and said opposite end, said second capacitor being connected between said second output terminal and the end of said second winding opposite the end connected to said junction, said third capacitor being connected in shunt with said second secondary winding.

5. The power supply of claim **4** additionally comprising a resistor connected across said second and third output terminals.

6. The power supply of claim **5** wherein a transformer secondary winding is inductively coupled to the transformer primary winding, and a secondary electrical resonant circuit is provided including an inductive portion and a capacitive portion, said secondary electrical resonant circuit being connected to said primary winding only by an inductive coupling between said inductive portion and said primary winding.

References Cited

UNITED STATES PATENTS

2,922,883	1/1960	Giaimo	317—262 X
2,965,481	12/1960	Gundlach	250—49.5 X
3,054,897	9/1962	Pritchard	250—49.5

JOHN F. COUCH, *Primary Examiner.*

J. A. SILVERMAN, *Assistant Examiner.*