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FACSIMILE OVERLOAD CONTROL WITH
NONLINEAR RESISTANCE IN OUTPUT
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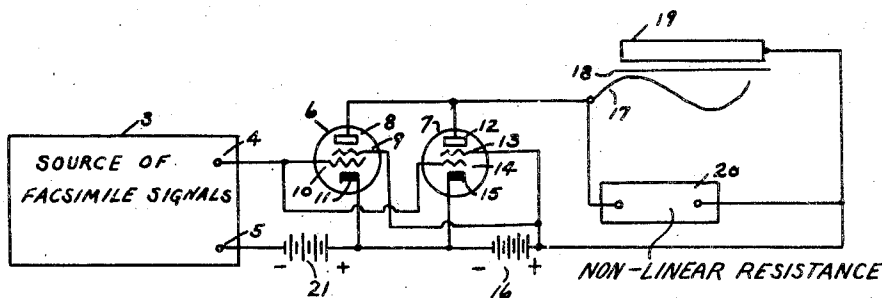


FIG 1

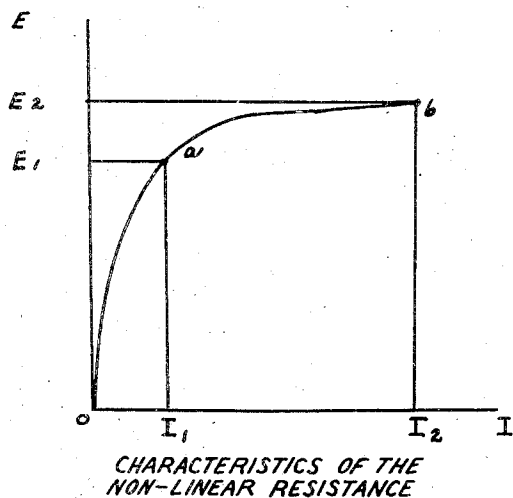


FIG 2

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FACSIMILE OVERLOAD CONTROL WITH
NONLINEAR RESISTANCE IN OUTPUTRichard C. Curtis, Short Hills, N. J., assignor to
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1 Claim. (Cl. 346—33)

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The present invention concerns facsimile system and, in particular, electrolytic facsimile recording devices.

One object of the present invention is to prevent overload in an electrolytic facsimile recording scanner.

Another object of the present invention is to prevent overload or burning of the recording sheet in an electrolytic facsimile recording scanner due to static or other transient signals in the system.

Still another object of the present invention is to provide protection for the driving circuit whenever the recording electrode is removed from the recording sheet in an electrolytic or similar facsimile recording device.

A still further object of the present invention is to render less critical the setting of the gain controls and other means for determining the recording current in an electrolytic or similar facsimile recording system. An additional object of the present invention is to prevent excessive current through the recording sheet which might decompose or even set fire to it under conditions which might otherwise yield unduly high recording current.

In the art of facsimile as a present practice a copy sheet is scanned point by point and line by line and density variations are transformed into electrical signals. These electrical signals are amplified and transmitted directly or by means of modulated signals transmitted to remote receiving points. At a receiving point the facsimile signals are utilized to control the recording current passing through or otherwise controlling recording devices which produce density variations in a recording sheet corresponding to the density variations of the original copy. In most facsimile systems the darkest marks produced in the receiving device correspond to the maximum recording current. In a system employing electrolytic recording sheet the maximum density is secured by a recording current which is close to the maximum amount of current which the sheet will pass without disintegration. In the past it has been necessary to closely control the recording current so that maximum density may be secured but at the same time current which may cause disintegration or burning of the recording sheet may be avoided. The boundary between the current required to produce maximum density of the recorded mark and the current which will produce disintegration of the recording sheet or actually cause it to burn may be very slight.

In addition to the need for the protection of the

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recording sheet, there is also a great need for the protection of the output tube or tube's circuit. In practise, one method is to employ a constant current tube as the output control tube for the recording current. A constant current tube is useful to maintain a source of high fidelity recording current on the recording electrodes, regardless of the variations in resistance or conductivity in the recording sheet and the recording circuit. One of the characteristics of a constant current tube is that variations in the plate load circuit over a considerable range have little or no effect on the plate-cathode current flow. This result is usually produced by maintaining a screen grid in the tube at a high positive voltage. When used in recording circuits of the type described herein, it is usual to have the recording electrode, and the recording sheet, in the plate load circuit during a major portion of the time. But, because of the need for the phasing and synchronizing of the recorder with the transmitter, the electrodes must be switched out of the plate load circuit during a small portion of a recording cycle. During this period the plate of the constant current tube is swinging free and the screen grid will draw all the current, unless an auxiliary load is used to maintain adequate plate voltage.

It has been found according to the present invention that if a non-linear circuit element is shunted across the recording circuit having the characteristics of a relatively high impedance for voltages up to a certain point and a suddenly lower impedance for voltages above this point that the maximum recording current may be passed through the recording sheet but that current beyond this point may be suddenly controlled so that overloading or burning of the sheet may be avoided. Also this non-linear element will act as an automatic volume control rendering gain settings in the system less critical. Normal signals will be substantially unaffected while abnormal signals will be compressed and kept from overloading the recording sheet.

It has also been found that the same non-linear circuit element may be used for the above described purpose and, in addition, as an auxiliary load to maintain a safe voltage on the plate of the tube during the period when the recording electrodes are not in the plate circuit. A linear type of load may not be used for the same purpose, unless switched into and out of the circuit, but a non-linear resistor, of the proper size, may be permanently installed in the circuit, without affecting the quality of the recording. Thus the same non-linear resistor may be employed to pre-

vent burning of the recording paper during the recording portion of the cycle and to prevent the burning out of the constant current tube, during the non-recording portion of the cycle, both functions being performed without switching or otherwise changing the circuit of the resistor.

Fig. 1 shows a circuit embodying one form of the present invention.

Fig. 2 shows a curve of the voltage versus current characteristics of a suitable non-linear circuit element for practicing the present invention.

Fig. 1 shows a source of facsimile signals 3, having output terminals 4 and 5, feeding output tubes 6 and 7. The output circuit may include one or more tubes as for instance the two tubes 6 and 7 connected in parallel as shown. Tubes 6 and 7 may be any suitable output tubes but should preferably be constant current tetrodes, as shown. Tube 6 has a cathode 11 heated by conventional means not shown, control grid 10, screen grid 9 and plate 8, while tube 7 has cathode 15 heated by conventional means not shown, control grid 14, screen grid 13 and plate 12. The corresponding elements such as cathodes 11 and 15 of the two tubes 6 and 7 are connected in parallel to provide more recording current than would be provided by a single tube. The facsimile signals from source 3 are connected through bias source 21, providing cut-off in the absence of signal between cathodes 11 and 15 and control grids 10 and 14, as shown. Screen grids 9 and 13 are energized from a source of bias voltage 16 and plates 8 and 12 are connected to helical electrode 17 of the facsimile recorder while the linear electrode 18 is connected to the positive side of the bias voltage source 16. Recording is accomplished by passing current between helical electrode 17 as it is rotated and linear electrode 18 through the electrolytic recording paper 19. Since helical electrode 17 does not make a complete 360° circle, but only a turn of 315°, there is a 45° portion of the recording cycle when there is no interaction between linear electrode 18 and helical electrode 17. During this period the plate circuit would normally be open except for the presence of the resistor 20. With no plate voltage, excessive current would be drawn by grids 9 and 13, burning out the tubes. Since the plate current of tubes 6 and 7 is under the control of the facsimile signal from source 3 the current passing through the electrolytic recording paper 19 at any instant is determined by the instantaneous value of the facsimile signal and corresponding density variations will be produced in the recording sheet. The recording sheet is advanced by conventional means not shown completing the scanning operation. In order to render the setting of gain control or other conventional control means in the facsimile receiver less critical, to protect the constant current tube from being overloaded and to prevent overloading and burning of the electrolytic paper 19, a non-linear resistor 20 is connected between helical electrode 17 and linear electrode 18 as shown. In order to accomplish the purposes of the present invention this resistor 20 should have the characteristic that it has a high resistance for all voltages up to a certain point and a much lower resistance at voltages above this point. The resistor should be so chosen that the point of transition should approximate the maximum current which it is

desired to pass through the recording sheet. An example of the type of resistor or non-linear circuit element which is suitable for this purpose is a silicon-carbide combination known by the trade name of Thyrite.

Fig. 2 shows the voltage current characteristics of a suitable non-linear resistor as shown at 20 in Fig. 1. In Fig. 2 it is shown how the resistor characteristic is that of a relatively high resistance for voltages from 0 to E_1 at which point the current I_1 is passed and that of a relatively low resistance from E_1 to E_2 at which point the current of I_2 is passed. Point E_1 should coincide substantially with the maximum voltage which it is desired to place across the recording sheet. Higher voltages will be heavily shunted by the lowering resistance value of the non-linear resistor. As can be seen, during the recording period, except to prevent excessive voltages that might appear on the electrodes, the non-linear resistor does not interfere with the recording process. During the non-recording portion of the cycle, the non-linear resistor becomes the plate load and replaces the electrode load circuit so that the plate always is supplied with adequate voltage. For normal currents, it again appears only as a normal load.

While only one embodiment of the present invention has been shown and described many variations will be apparent to those skilled in the art within the spirit and scope of the invention as set forth in the appended claim.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

In a recorder adapted to record upon a recording medium exhibiting a maximum tolerable recording voltage, a source of signals, at least one constant current vacuum tube for controlling a recording current, input and output circuits to said tube, said input circuit being connected to said signal source, at least one pair of electrodes connected to said output circuit for impressing recording signals upon said recording medium located therebetween, and at least one non-linear resistor, having a relatively high resistance at voltages below said tolerable voltage and a relatively low resistance at voltages above said tolerable voltage, connected across said electrodes and the output circuit of at least one of said constant current tubes, said non-linear resistance alternately preventing the output voltage of said output circuit from exceeding said maximum tolerable recording voltage and preventing said output voltage from decreasing to a point where low output voltage may injure said constant current tubes.

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The following references are of record in the file of this patent:

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