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CIRCUIT SUPPLYING IMPULSES OF REGULATED PEAK AMPLITUDE

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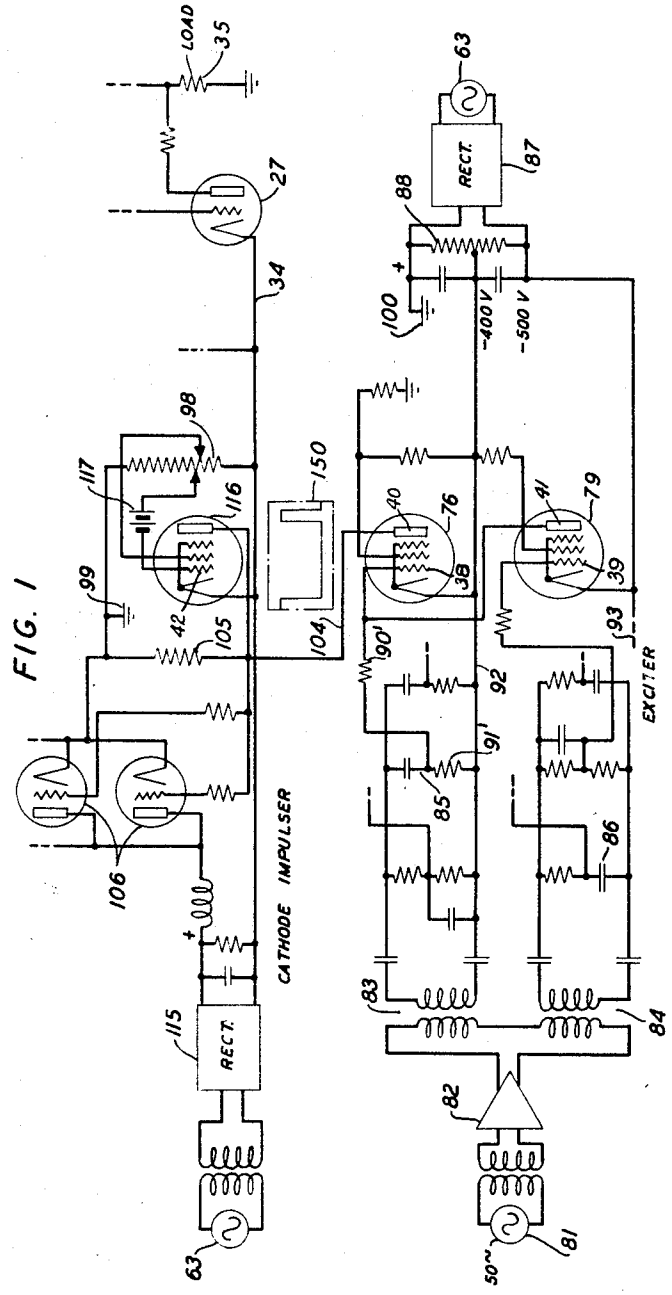

FIG. 1

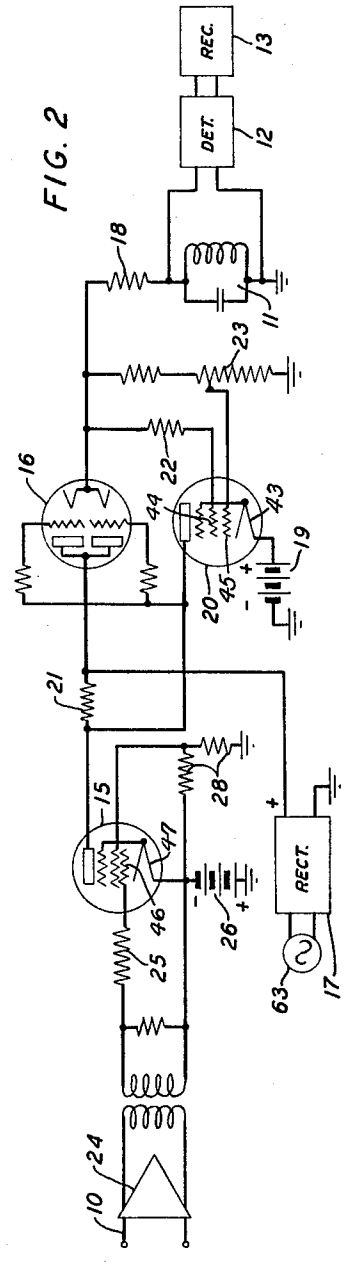

FIG. 2

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CIRCUIT SUPPLYING IMPULSES OF REGULATED PEAK AMPLITUDE

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The present invention relates to electrical wave control and particularly to means for limiting the maximum amplitude of an output wave or for producing impulses having a limited maximum amplitude. This application is in part a continuation of Lundstrom-Schimpf application Ser. No. 456,322, filed Aug. 27, 1942, for Secret Transmission of Intelligence, the part of the subject-matter that is common to this and the prior application and that is claimed herein being the sole invention of the present applicant.

In one aspect the invention comprises a circuit including a regulator for fixing the peak or maximum value of output current together with a control circuit for causing the regulator to cut the output voltage down to some lower value, specifically zero, at set times.

In a related aspect the invention comprises a limiter for use in a frequency modulation or similar system in which the regulator fixes the maximum swing in one direction and the frequency-modulated wave determines the times at which the output is momentarily reduced to zero.

The nature and objects of the invention together with its various features will be made clear in the following detailed description together with the accompanying drawings in which:

FIG. 1 is taken in its entirety from the parent application and is a schematic circuit diagram of an impulser together with an exciter therefor according to this invention; and

FIG. 2 is a schematic circuit diagram of a frequency modulation detector circuit including a limiter in accordance with this invention.

The circuit of FIG. 1 illustrates the invention as used for the purpose of furnishing an interrupted plate voltage to the gas-filled tube **27** in which a negative voltage of 150 volts is applied to the cathode of tube **27**, relative to ground to allow the tube to ionize under grid control for a fixed interval, such as 18 milliseconds, and this voltage is reduced to zero for a short interval, such as 2 milliseconds, to cause the tube to become deionized. The requirement is assumed to be that the —150 volts applied to the cathode has a regulated constant value at all times when it is not interrupted. In the parent disclosure the tube **27** is one of the tubes of a stepper circuit and the useful output is taken from across the load resistance **35**.

The circuit as disclosed in FIG. 1 comprises the cathode impulser shown in the upper portion of the figure and the exciter shown in the lower part of the figure. The timing of the action of the circuit is under the control of a source **81** of 50-cycle waves of constant frequency. This current is amplified at **82** and applied to a pair of tubes **76** and **79** through transformers **83** and **84**.

Considering first the two tubes **76** and **79**, a negative half-cycle of the 50-cycle input wave swings the grids **38** and **39** of these tubes beyond cut-off. At some point in the cycle the grids are driven in the positive direction a sufficient amount to transmit current, and the current rises quickly to full value. Due to phase shifting circuits **85** and **86** the 50-cycle wave on the grid **38** of tube **76** leads that applied to the grid **39** of tube **79** by 2 milliseconds. Tube **76** first transmits current through a path which can be traced from its plate **40** over lead **104**, resistor **105** to ground at **99**, to ground at **100**, upper part

of potentiometer resistance **88** in the output of rectifier **87** and —400-volt cathode lead **92**. (Source **63** is an alternating curent power source such as a lighting circuit.) This current from tube **76** flowing through resistor **105** throws the grids of tube **106** negative beyond cut-off and shuts off the flow of current from rectifier **115** to the output potentiometer **98** whereby both the cathode and the anode of the tube **27** are brought to ground potential and tube **27**, if previously ionized becomes deionized.

At a time 2 milliseconds later tube **79** sends current from its plate **41** through resistors **90'**, **91'**, lead **92**, lower part of resistor **88** to —500-volt cathode lead **93**. The current flow through resistors **90'** and **91'** cuts off the tube **76** by blocking its grid **38** and this tube remains blocked until the grid again swings toward positive under control of the 50-cycle wave from source **81**, when the process repeats itself.

In order to be able to supply a closely regulated peak voltage to the cathode of the tube **27** the cathode impulser includes a voltage regulator. The output of rectifier **115** is filtered and the resulting direct current is put through series tubes **106** and potentiometer resistance **98**, the tubes **106** being inserted in the positive lead to ground **99**. (A plurality of tubes **106** are used in parallel in order to provide sufficient power capacity where a number of steppers, similar to **27**, are to be energized.) Pentode tube **116** is connected across the line with its cathode connected to the negative side and its plate connected through resistor **105** to the positive side. Its control grid **42** is connected in series with battery **117** to a point in resistor **98** so that a suitable fractional part of the output voltage can be applied to the control grid. The regulation is based on the assumption that the voltage of battery **117** remains sufficiently constant. This battery may have some convenient voltage, such as 90 volts. Just enough opposing voltage is tapped off from resistor **98** to bring the control grid of tube **116** to some suitable control point on the tube characteristic. This establishes a normal value of current through resistor **105** which fixes the normal regulating voltage on the grids of tubes **106**. Variations in voltage across resistor **98** swing the grid **42** of tube **116** above or below its normal value; these variations are amplified and applied to the grid of tubes **106** in such sense as to oppose the assumed variations in output voltage by varying the drop of the potential across tubes **106**. In this way the circuit regulates itself to a constant output voltage of 150 volts. This is applied over conductor **34** as previously described between ground and the cathodes of all of the steppers that are connected to lead **34**. When the voltage of the grids of tubes **106** is thrown negative by current received over lead **104**, the tubes **106** change their function from regulating to blocking for the 2-millisecond assumed interval. The diagram within the rectangle **150** indicates graphically the pulsating character of the voltage in lead **104**.

Referring to FIG. 2, input circuit **10** is for the reception of frequency modulated waves which after amplitude limiting are to be applied to the slope circuit **11** for detection at **12** and reception of the modulating signal at **13**. The circuits between **10** and **11** are concerned with the problem of amplification and amplitude limiting.

With tube **15** out of its socket, regulator tube **16** supplies a constant voltage from rectifier **17** to the resistance **18** and slope circuit **11** in series. The path for this current is from the positive pole of rectifier **17**, plate-to-cathode space of tube **16** and through resistance **18** and slope circuit **11** to ground. This regulation assumes a constant voltage in battery **19** which has its positive pole connected to the cathode **43** of control tube **20**. The space current through tube **20** flows in a path from ground through rectifier **17**, resistance **21**, plate-to-cathode space

of tube **20**, battery **19** to ground, the voltage developed by rectifier **17** being in excess of the opposing voltage of battery **19** by suitable margin. The current through resistor **21** determines the bias voltage on the grids of tube **16** since the grids of tube **16** are connected to one end of this resistance and the plates are connected to the other end, and this bias has a normal value such as to give the desired impedance to the regulator tube **16** to supply the proper output voltage and permit the desired range of regulation. Tube **20** has its screen grid **44** connected through resistor **22** to the output side (cathode) of tube **16** to supply positive bias voltage and its control grid **45** connected to an adjustable tap on resistance **23** connected between the positive output terminal of tube **16** and ground.

Any variation in output voltage relative to the steady voltage of battery **19** causes a variation in the cathode-control grid potential of tube **20**, which in turn varies the bias on the grids of regulator tube **16** by varying the current flow through resistor **21**, in such direction as to oppose the assumed variation in output. The action is similar to that of tubes **106** and **116** of FIG. 1, the battery **19** serving the same purpose as battery **117**, with the result that the output voltage variations are reduced to negligibly low value.

Assuming tube **15** to be in its socket and a frequency modulated wave to be impressed on its input control grid **46**, current flows from rectifier **17** through resistor **21** and the plate-to-cathode space of tube **15** when this tube is in conducting condition, and through battery **26** to ground, and the positive halves of this wave cause tube **15** to send enough current through resistor **21** to throw the bias on the grids of tube **16** beyond cut-off with the result that the current through the tube **16** and hence in the slope circuit is interrupted. Tube **15** is cut off by the impressed high frequency voltage during a large part of each negative half wave and during these times the tubes **16** and **20** operate as previously described to hold the output voltage into the slope circuit at constant value. In this way a square-topped output wave is sent into the slope circuit the fundamental frequency of which is the same at all instants as that of the incoming frequency modulated wave and this output wave has constant peak amplitude.

The tube **15** should be operated over its entire characteristic in each cycle of the impressed wave and this may require amplification of the input wave, indicated as provided at **24**. Amplitude modulation or variation that may be present in the incoming frequency modulated wave is suppressed by the fact that the input waves of smallest amplitude swing the grid **46** of tube **15** far enough in the positive direction to completely interrupt current in tube **16** and far enough in the negative direction to reduce the space current in tube **15** to zero. Input waves of greater amplitude cannot produce any greater amplitude of output current.

It may be desirable in some cases to operate tube **15** as an overloaded amplifier with positive half-wave amplitude limitation and for this purpose a large resistance **25** is shown in series with the grid **46**. Battery **26** is used to bias the cathode **47** of tube **15** sufficiently negative so that tube **16** is cut off when tube **15** conducts. Its function is the same as the —400-volt supply used on the exciter tube **76**. However, due to the characteristics of tube **16**, only 150 volts need be used in this case, for the drop in tube **15** is sufficiently low to allow its plate to go sufficiently negative with respect to ground to supply the necessary negative bias to the grids of tube **16** to cut off current through tube **16**.

In both of the FIG. 1 and FIG. 2 circuits as shown the output current is caused to fall to zero during the periods of interruption of the regulated supply when tubes **106** or **16** are biased beyond cut-off. If it is desired that the output voltage fall to some low value different from zero this may be done in the manner disclosed in the parent application by providing in parallel with the output a second regulated supply of relatively low constant voltage which is not interrupted. When the main supply is interrupted this second supply remains effective in the output circuit to give the desired low voltage. Such second or auxiliary supply may be connected in parallel with resistor **98**, for example. Such an arrangement is shown in FIG. 4 of the parent application in connection with the grid impulser of that figure.

In one embodiment used by applicant the resistor **21** had a value of 0.25 megohm, resistance **25** was 1.0 megohm, the grounded part of resistance **28** was 20,000 ohms and the part connected to the cathode of tube **15** was 10,000 ohms, resistance **22** was 20,000 ohms, resistance **23** was 43,000 ohms, with the slider movable over the upper end portion comprising 10,000 ohms, and the resistor shown immediately above resistance **23** in the figure was 5,000 ohms.

What is claimed is:

1. A circuit for supplying an interrupted voltage of constant peak amplitude comprising a source of voltage, a voltage regulator comprising a grid controlled space discharge tube having its cathode-anode space path in series with said source and a resistor, means to supply as a bias voltage to the grid of said tube a voltage obtained from the drop of potential across a portion of said resistor in such sense and proportion as to tend to maintain constant the voltage across said resistor, means to derive a voltage for utilization from the drop of potential across said resistor and means to interrupt the current flow in said resistor comprising means to impress on the grid of said tube a sufficiently high negative voltage to cause interruption of the space current flow through said tube.

2. In combination, a source of voltage, a load circuit supplied from said source, a grid controlled space discharge tube having its space path connected in series between said source and said load circuit, means responsive to voltage variations between said tube and said load for controlling the grid potential of said tube in such direction and to such extent as to tend to maintain constant the voltage applied across said load circuit, and means for applying temporarily a large enough negative voltage to the grid of said tube to cause interruption of the supply of voltage from said source to said load.

3. A circuit combination according to claim **2**, in which said last means comprises a switching tube having a space path and having an output circuit including said space path and a high resistance in series, means including said high resistance in circuit with the grid of said first-mentioned tube whereby the flow of current in said output circuit through said high resistance applies a potential to said grid, and circuit means to establish and interrupt current flow through said output circuit including said high resistance.

4. In a circuit for supplying impulses of current to a load, a source of alternating current, a source of direct current, a grid controlled discharge tube having a space path connected in series between said source of direct current and said load, voltage regulator means operating on the grid of said tube to maintain the voltage applied to said load substantially constant, a switching tube having an input circuit coupled to said source of alternating current and an output circuit coupled to said grid for applying to said grid in response to current flow through said switching tube a large enough negative voltage to interrupt the current flow through said first tube.

5. In a receiving circuit for frequency modulated waves, a slope circuit, a source of direct current voltage, a regulator tube having its space path connected in series with said source and said slope circuit and having a grid, means for applying voltage regulating potentials to said grid to tend to maintain constant the voltage applied across said slope circuit, a grid controlled switching tube, means to impress a frequency modulated wave on

the grid of said switching tube of sufficient amplitude to interrupt the space current of said switching tube in each alternation of the frequency modulated wave, and means coupling the output of said switching tube to the grid of said regulator tube for causing the output current of the switching tube to apply voltages to the grid of said regulator tube of sufficiently high amplitude to cause interruption of the current from said source to said slope circuit.

6. In a receiving circuit for frequency modulated waves, a slope circuit, an initial tube having a grid, cathode and anode, a second tube having a grid, cathode and anode, means to supply the frequency modulated waves to the grid of the initial tube, a common source of anode current for both tubes, a high resistance between said common source and the anode of said initial tube, a conductive connection between the anode of the initial tube and grid of the second tube and means to supply interrupted current from the anode-cathode circuit of said second tube to said slope circuit, said frequency modulated waves interrupting space current in said initial tube in their negative swing, said initial tube causing plate current interruption in said second tube during positive swings of said frequency modulated waves.

7. In a receiving circuit for frequency modulated waves, a discriminator, means including a regulator tube for supplying current to said discriminator, said tube including a grid-cathode circuit, means to regulate the maximum

value of current transmitted through said regulator tube to a constant value, a control tube having a grid, and an output circuit, means to apply received frequency modulated waves to said control tube grid, means to produce such large voltage swings in the grid potential of said control tube in response to said received frequency modulated waves as to cause said control tube to conduct current in response to all positive values, and to zero value, of applied frequency modulated waves, said last means causing interruption of current flow through said control tube in response to all negative values of applied frequency modulated waves of minimum signal amplitude and greater amplitudes, and means including a resistance common to the output circuit of said control tube and the grid-cathode circuit of said regulator tube, said resistance in response to current flow through said control tube causing interruption of current through said regulator tube.

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