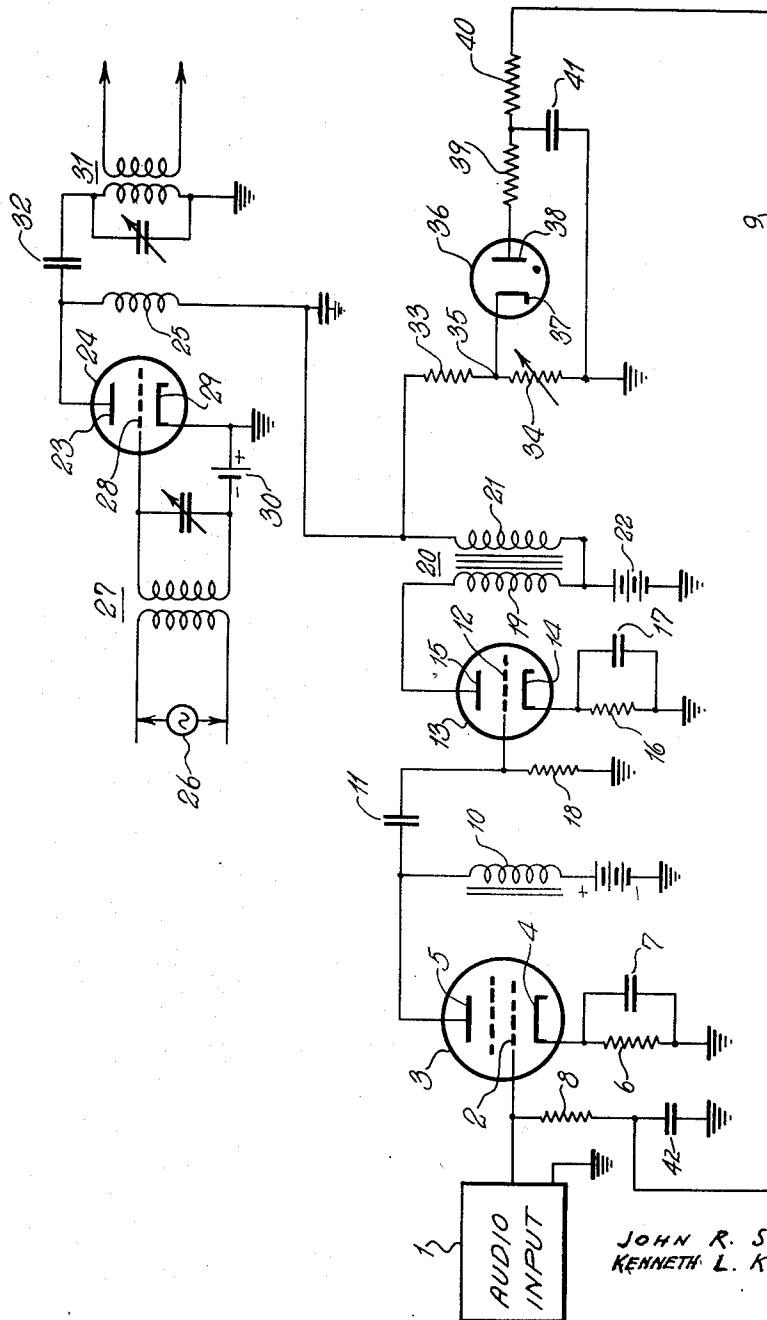


Dec. 12, 1950

J. R. SHERWOOD ET AL
MODULATION PROTECTIVE ARRANGEMENT

2,534,073

Filed April 20, 1949



JOHN R. SHERWOOD
KENNETH L. KLIPPEL
INVENTORS.

BY

John J. Ryan
ATTORNEY

UNITED STATES PATENT OFFICE

2,534,073

MODULATION PROTECTIVE ARRANGEMENT

John R. Sherwood, Cedar Rapids, and Kenneth L. Klippel, Iowa City, Iowa, assignors to Collins Radio Company, Cedar Rapids, Iowa, a corporation of Iowa

Application April 20, 1949, Serial No. 88,644

4 Claims. (Cl. 332—38)

1

This invention relates to wave modulation systems and more especially to protective arrangements for carrier modulation circuits.

In conventional audio frequency modulating systems for radio carriers and the like, it is customary to employ a relatively expensive audio-frequency modulation transformer whose input winding is energized by the audio-frequency signals, and the voltage across the secondary winding determines the modulation of the carrier. It has been found that if, for any reason, the load across the secondary of the modulation transformer is disconnected or open-circuited, excessive voltages are built up which may damage the transformer and its associated equipment.

Accordingly, one of the principal objects of this invention is to provide a modulation arrangement for carrier systems wherein the danger of damage to the modulation equipment and especially to the modulation transformer is substantially eliminated.

A feature of the invention relates to a protective circuit arrangement for carrier modulators, wherein the use of electromechanical relays as protective control elements, is avoided.

Another feature relates to a modulation transformer having a special voltage dividing network connected across its secondary winding and including as one of the elements a gas discharge tube, for applying a cutoff negative bias to the grid of the voltage amplifier input tube when the voltage across the secondary of the modulation transformer tends to rise above a predetermined safe value.

A further feature relates to the novel organization, arrangement and relative interconnection of parts which cooperate to provide a simplified and efficient protective arrangement for carrier modulators, and which can be easily adjusted to correspond with the maximum per cent of modulation desired in the carrier.

Other features and advantages not particularly enumerated, will be apparent after a consideration of the following detailed descriptions and the appended claims.

In the single figure of the drawing, the numeral 1 represents any well-known source of audio-frequency input signals, such as voice frequency signals, which are applied to the control grid 2 of a speech amplifier tube 3. This tube may have the usual electron-emitting cathode 4, control grid 2, and plate or anode 5, and preferably an additional grid, such as a shield grid. The control grid 2 can be biased with respect to the cathode 4 in the conventional way by the cath-

2

ode bias resistor 6 and its by-pass condenser 7. This bias is chosen so as normally to cause the tube 3 to operate on the linear part of its characteristic curve for the various input signals from source 1. However, as will be described hereinbelow, under certain conditions the grid 2 is arranged to have a negative cutoff bias applied to it through resistor 8 and over conductor 9. The output of speech amplifier tube 3 can be coupled through any well-known audio-frequency coupling circuit, such for example as the audio-frequency choke coil 10 and coupling condenser 11, to the control grid 12 of a power amplifier tube 13, which may comprise the usual electron-emitting cathode 14, control grid 12 and plate or anode 15. The grid 12 is appropriately biased negatively with respect to the cathode 14 by the conventional cathode bias resistor 16 and its by-pass condenser 17. A suitable grid leak 18 provides a direct current return path from the grid 12 to the cathode 14. The amplified output of tube 13 is applied to the primary winding 19 of a modulation transformer 20. The secondary winding 21 of this transformer is connected in circuit with the usual direct current plate power supply, represented schematically by the battery 22, and also in circuit with the plate 23 of a grid-controlled modulator tube 24 through a radio frequency choke coil 25.

The high frequency or carrier source 26 is coupled through a tuned input circuit 27 across the control grid 28 and cathode 29 of modulator tube 23, the grid 28 being appropriately negatively biased with respect to cathode 29 by a suitable voltage represented schematically by battery 30. The tuned output or tank circuit 31 is coupled to the plate 23 through a suitable coupling condenser 32 in the well-known manner. The tube 24 therefore acts as a plate modulator in that its plate voltage is controlled by the voltage across the secondary winding 21 of the modulation transformer which in turn is a function of the audio-frequency modulating signals. It will be understood, of course, that the invention is not limited to a modulator of the plate modulation type, and any other well-known type of modulation such as grid modulation, constant current modulation and the like, may be employed. The circuit can be adjusted in the well-known manner so that for 100% modulation of the carrier, the peak voltage across the loaded winding 21 is at a known predetermined maximum value. Any voltage in excess of this would cause damage to the said transformer 20. Such an undesirable increase will occur, for

example, if the modulator tube load across the secondary winding 21 is removed or open-circuited.

In order to overcome this disadvantage, two resistors 33 and 34 are bridged across winding 21 with the resistor 34 preferably being adjustable. Connected between the junction point 35 of these two resistors and the conductor 9 is a voltage regulator tube 36, preferably, although not necessarily, of the gaseous discharge type, such for example as a type VR90 voltage regulator tube. The cathode 37 of this tube is connected to the point 35, and the plate or anode 38 is connected through filter resistors 39, 40, to conductor 9. Suitable filter condensers 41 and 42 are connected between the resistors 39, 40, and ground.

The resistors 33 and 34 act as a voltage divider, the ratio of the two resistors 33 and 34 being adjusted so that when the peak voltage across winding 21 is below that necessary to achieve 100% modulation, or any other desired maximum per cent modulation, in the carrier, insufficient potential is impressed across cathode 37 and anode 38 to render tube 36 conductive. On the other hand, when the said peak voltage across winding 21 rises to a dangerous value, or above that necessary to achieve the desired per cent modulation of the carrier, sufficient potential is impressed across tube 36 to render it conductive. The tube 36 thereupon acts to produce a rectified negative direct current voltage on conductor 9, the ripples or audio-frequency components being filtered out by the filter combination 39, 40, 41 and 42. The rectified negative voltage on conductor 9 is applied to the control grid 2 through the resistor 8, and is of such a value as to bias the tube 3 to plate current cutoff. This in turn causes a corresponding reduction in the voltage across primary winding 19, and reduces the voltage across winding 21 to the desired safe low value.

With the foregoing arrangement, it will be seen that the excitation of grid 2 is approximately 180° out of phase with the voltages in the winding 21. Consequently the direct current negative voltage feedback circuit above described does not introduce undesirable regeneration in the system.

One of the important advantages of the system as described, is that the protective feature can be easily adapted to any reasonable level of operation or maximum percentage modulation in the carrier merely by changing the relative values of the two resistors 33 and 34.

While one particular embodiment has been described herein, it will be understood that various changes and modifications may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. A carrier modulation system, comprising a source of carrier waves, a source of modulating signals, a modulator tube, a grid-controlled amplifier tube for amplifying said modulating signals, a modulation transformer for coupling the amplified signals to said modulator tube, and means to protect said transformer against excessive voltage rise when the modulator load is removed from the secondary winding of said transformer, the last-mentioned means comprising a

voltage divider connected across said secondary winding, a rectifier tube having its anode-cathode discharge path bridged across said voltage divider and normally non-conductive except when the voltage across said secondary winding rises above a predetermined value, and circuit connections from said rectifier tube to said amplifier tube to apply a plate current cut-off bias to the grid thereof.

2. A carrier modulation system, comprising a source of carrier waves, a source of modulating signals, a grid-controlled amplifier tube for said signals, a modulation transformer for coupling the amplified signals to the modulator tube, a pair of voltage divider resistors connected across the secondary winding of said transformer, a rectifier tube connected between said voltage divider resistors and the control grid of said amplifier tube, and means to adjust the relative values of the voltage divider resistors to render said rectifier tube non-conductive except when the voltage developed across said secondary winding rises above a predetermined level, and circuit connections between said rectifier tube and the grid of said amplifier tube for applying a plate current cut-off bias to said grid when the voltage developed across said secondary winding rises above said predetermined value.

3. A modulation system, comprising a source of carrier waves, a source of modulating signals, a pre-amplifier for said modulating signals, a power amplifier for the pre-amplified signals, a modulator tube, a modulation transformer coupling the plate circuit of said power amplifier to said modulator tube, a voltage divider bridged across the secondary winding of said modulation transformer, means to adjust the ratio of the sections of said voltage divider to correspond with a predetermined maximum peak voltage across said secondary winding, a voltage regulator tube of the diode rectifier type bridged across one section of said voltage divider, and circuit connections between said rectifier tube and said pre-amplifier tube to bias said pre-amplifier tube to plate current cut-off when the modulator load is effectively removed from said secondary winding.

4. A modulation system according to claim 3, in which said voltage divider comprises a fixed resistor in series with an adjustable resistor across said secondary winding, said adjustable resistor being correlated with the desired per cent of modulation in the carrier to cause said rectifier tube to become conductive when the peak voltage developed across said secondary winding tends to increase the per cent of modulation of the carrier above said predetermined level.

JOHN R. SHERWOOD.
KENNETH L. KLIPPEL.

REFERENCES CITED

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

UNITED STATES PATENTS			
Number	Name	Date	
2,402,598	Charchian	June 25, 1946	
FOREIGN PATENTS			
Number	Country	Date	
560,906	Great Britain	Apr. 26, 1944	