

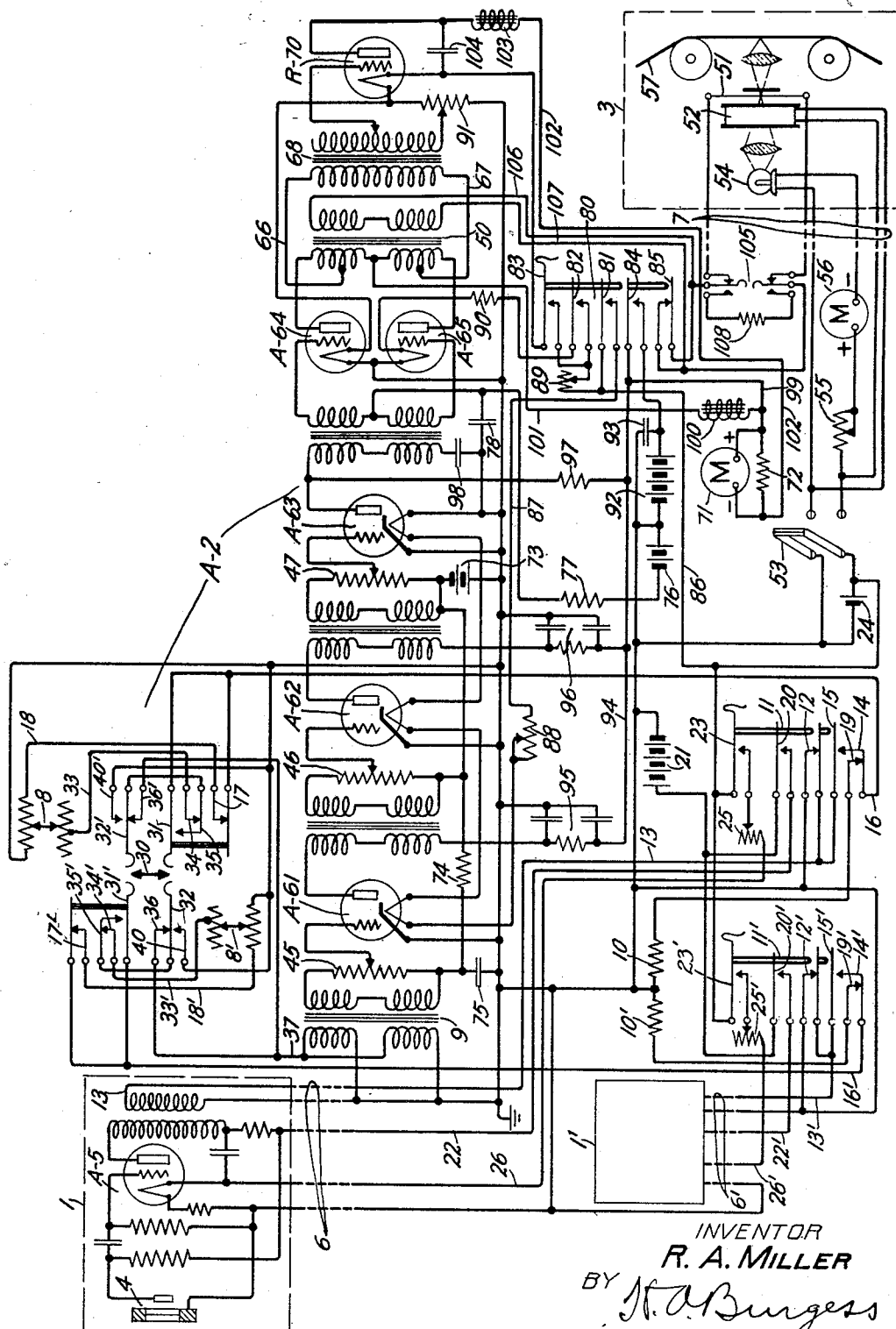
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R. A. MILLER

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AMPLIFYING SYSTEM

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INVENTOR
R. A. MILLER
BY *H. A. Burgess*
ATTORNEY

UNITED STATES PATENT OFFICE

ROBERT A. MILLER, OF PLAINFIELD, NEW JERSEY, ASSIGNOR TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

AMPLIFYING SYSTEM

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This invention relates to wave transmission systems, as for example, electrical wave transmitting and amplifying systems for use in recording sound on films.

5 An object of the invention is efficient control of transmission in such systems.

Another object is reduction of crosstalk or other noise or distortion.

In one specific aspect the invention is a
10 sound recording system comprising two condenser transmitters, individual preliminary vacuum tube amplifiers fed by the transmitters, a main vacuum tube amplifier fed from the preliminary amplifiers and a recording camera with a light-valve string fed from the main amplifier, the main amplifier being connected to the preliminary amplifiers by shielded cables perhaps a hundred feet long and to the camera by a cable perhaps also a hundred feet long, so that the transmitters and the camera may be remote from the main amplifier. The main amplifier includes two transmission volume control potentiometers individual to the two
25 preliminary amplifiers, for feeding the outputs of the preliminary amplifiers to the input transformer of the main amplifier. To avoid deleteriously affecting the impedance relations in the system, these mixing potentiometers are of the constant impedance type disclosed in D. F. Whiting Patent No. 1,778,779, October 21, 1930. However, they are connected in parallel to each other at their output sides, with respect to the primary winding of the input transformer of the main amplifier. The main amplifier also includes two substitute impedances individual to the two preliminary amplifiers, for simulating the impedances which the preliminary amplifiers present to the main amplifier, when the preliminary amplifiers are disconnected from the main amplifier as described hereinafter. The main amplifier also includes two keys or switches individual to the two transmitting channels comprising the transmitters, the transmitter amplifiers and the mixing potentiometers, for controlling these channels and for controlling the polarization of the transmitters, and for controlling the supply of current to the filament

and plate circuits of the vacuum tubes of the preliminary amplifiers. Each key, when in its normal position (i. e., its off position), short-circuits the output end of the circuit connecting its preliminary or transmitter amplifier to its mixing potentiometer in the main amplifier, opens the path between the short circuit and the main amplifier, and connects one of the substitute impedances, mentioned above, across the input side of its mixing potentiometer in the main amplifier as a substitute for the operating output impedance of the transmitter amplifier. The short circuit and the opening of the transmitter channel prevent the channel from transmitting waves to the mixing potentiometer that would constitute crosstalk, interference or noise currents as regards signals transmitted to the main amplifier through the other transmitter channel. When the key is operated to its "on" position it first closes circuits for polarizing its transmitter and supplying its transmitter amplifier with filament heating current and steady plate current, thereafter opens the short circuit mentioned above, and finally closes the gap which it had made in the transmitter channel and opens the circuit of the simulating resistance. To avoid deleterious effects which the flow of charging current for the transmitter or the starting or stopping of the flow of steady space current for the amplifier tends to produce on the film record, the short circuit is maintained until the steady space current for the transmitter amplifier has been established and when the key is operated to its off position, the short circuit is made again before the circuits for energizing the transmitter and the transmitter amplifier are opened.

When either transmitter channel is to be used without the other, a selecting key or switch in the main amplifier disconnects the other transmitter channel from the main amplifier and short circuits the output end of that other transmitter channel to reduce interference and crosstalk and to prevent that other channel from unnecessarily shunting away from the input transformer of the main amplifier the transmission sent

from the transmitter channel to be used. This key, moreover, before effecting this disconnection and short circuiting, eliminates the mixing potentiometer of the transmitter channel that is to be used from that channel, to avoid unnecessary attenuation or transmission loss in the channel. Any attenuation changes or volume control desired then can be obtained by means of potentiometers fed by the input transformer and the vacuum tubes of the main amplifier. The elimination of the potentiometer from its transmitter channel decreases the impedance which its transmitter channel presents to the input transformer of the main amplifier, (and thereby tends to compensate for increase of impedance presented to the input winding of the input transformer of the main amplifier which tends to result from the disconnection of the other transmitter channel from the main amplifier), so that the impedance from which the input transformer of the main amplifier works is maintained of the same order of magnitude whether one transmitter amplifier, only, is connected to the main amplifier, or both transmitter amplifiers are connected to the main amplifier.

The energization of the vacuum tubes in the main amplifier is controlled by a single key in that amplifier, which in its normal (i. e. off) position opens the filament and *dc* plate circuits of those tubes and short circuits the path from the main amplifier to the light-valve string, but which in moving to its operative (i. e., on) position removes the short circuit after closing those plate and filament circuits, and which in returning to its off position establishes the short circuit before opening the plate and filament circuits. This short circuiting of the light-valve string prevents the establishing or the decay of the *dc* plate currents from causing disturbing currents in the light-valve string.

Other objects, aspects and features of the invention will be apparent from the following description and claims.

The single figure of the drawing is a circuit diagram of a sound recording system having the features mentioned above.

The system comprises two transmitter units 1 and 1', a main amplifier A—2 and a recording camera 3. The unit 1 comprises a condenser transmitter 4 and an individual preliminary amplifier A—5 fed by the transmitter and feeding the main amplifier. The unit 1' also comprises a condenser transmitter and an individual preliminary amplifier fed by the transmitter and feeding the main amplifier; but the unit 1' is not shown in detail since it may be like the unit 1. Shielded cables 6 and 6' of a considerable length, for example 100 feet, connect the units 1 and 1' respectively to the main am-

plifier; and a cable 7 which may also be 100 feet long, for example, connects the main amplifier to the camera. Thus, the units 1 and 1' and the camera may be remote from the main amplifier.

The main amplifier includes two transmission volume control potentiometers 8 and 8' individual to the two preliminary amplifiers, for feeding the outputs of the preliminary amplifiers to the input transformer 9 of the main amplifier. To avoid deleteriously affecting impedance relations in the system, these mixing potentiometers are of the constant impedance type disclosed in the Whit- ing application mentioned above. However, they are connected in parallel to each other at their output sides, with respect to the primary winding of the input transformer of the main amplifier. The main amplifier also includes two substitute resistances 10 and 10' individual to the two preliminary amplifiers, for simulating the impedances which the preliminary amplifiers present to the main amplifier, when the preliminary amplifiers are disconnected from the main amplifier as described hereinafter. The main amplifier also includes two keys or switches 11 and 11' individual to the two transmitting channels comprising the transmitters, the transmitter amplifiers and the mixing potentiometers, for controlling these channels and for controlling the polarization of the transmitters, and for controlling the supply of current to the filament and plate circuits of the vacuum tubes of the preliminary amplifiers. Each key, when in its normal position as shown (i. e., its off position); has a contact, 12 or 12' as the case may be, connect a conductor 13 or 13' to ground, to thereby short circuit the output end of the circuit connecting its preliminary or transmitter amplifier to the main amplifier, and has a spring, 14 or 14' disconnect at spring 15 or 15' the conductor 13 or 13' from a conductor 16 or 16' leading through a contact 17 or 17' of a key 30 to the high potential input lead 18 or 18' of potentiometer 8 or 8', to thereby open at 15 or 15' the path between the short circuit at 12 or 12' and the potentiometer 8 or 8', and has a contact, 19 or 19', to connect contact 14 or 14' to the high potential end of the resistance 10 or 10' to thereby connect the resistance 10 or 10' across the input side of the potentiometer 8 or 8' as a substitute for the operating output impedance of the transmitter amplifier. In the case of each transmitter channel, the short circuit and the opening of the transmitter channel prevent the channel from transmitting waves to the mixing potentiometer that would constitute crosstalk, interference or noise currents as regards signals transmitted to the main amplifier through the other transmitter channel. When the key 11 or 11'

is operated to its "on" position it first closes a contact 20 or 20' for connecting the positive pole of battery 21 to conductor 22 or 22' for supplying plate current to its transmitter amplifier and polarizing its transmitter, and closes a contact 23 or 23' for connecting the positive pole of battery 24 through rheostat 25 or 25' and conductor 26 or 26' for supplying the transmitter amplifier with filament heating current, thereafter opens at 12 or 12' the short circuit mentioned above, and finally closes the gap which it has made at 14, 15 or 14', 15' in the transmitter channel and opens at 19 or 19' the circuit of the simulating resistance. To avoid deleterious effects which the flow of charging current for the transmitter or the starting or stopping of the flow of steady space current for the amplifier tends to produce on the film record, the short circuit is maintained at 12 or 12' until the steady space current for the transmitter amplifier has been established at 20 or 20' and when the key 11 or 11' is operated to its off position the short circuit is made again at 12 or 12' before the circuits for energizing the transmitter and the transmitter amplifier are opened at 20 or 20'.

The on positions of the keys 11 and 11' are locking positions.

When either transmitter channel is to be used without the other, a selecting key or switch 30 in the main amplifier is operated from its normal position, in which it is shown, down or up as indicated by the arrow heads in the drawing. It is operated down, i. e., springs 31 and 32 are moved down, when transmitter unit 1 is to be used without transmitter unit 1', or in other words when use of transmitter unit 1' is to be dispensed with for the time being; and it is operated up, i. e., springs 31' and 32' are moved up, when transmitter unit 1' is to be used without transmitter unit 1. Both the down position and the up position preferably are locking positions.

When keys 11 and 11' are in their on positions, key 30 in its normal position operatively connects both transmitter units 1 and 1' to feed their potentiometers 8 and 8' through contacts 17 and 17' as indicated above; and operatively connects the output of potentiometer 8 to the input transformer 9 of the main amplifier by connecting the high potential output lead 33 of potentiometer 8 through contacts 34 and 35 in series with contacts 32' and 36' to the high potential input lead 37 of the transformer 9; and operatively connects the potentiometer 8' to the transformer 9 by connecting the high potential output lead 33' of potentiometer 8' through contacts 34' and 35' in series with contacts 32 and 36 to the high potential input lead 37 of the transformer 9. Then if key 30 be moved from its normal

position to its down position, it first closes contact 31 to contact 35, and next opens contact 17 and separates contacts 34 and 35, and thereafter transfers contact 32 from contact 36 to grounded contact 40. The first operation connects the high potential output lead 13 of transmitter unit 1 to the high potential input lead 37 of transformer 9, the connection extending from conductor 13 through contacts 15 and 14 of key 11, conductor 16, contacts 31 and 35 of key 30, and contacts 32' and 36' of key 30, to conductor 37. The second operation opens the high potential input lead of potentiometer 8 at contact 17 and opens the high potential output lead of potentiometer 8 at contacts 34 and 35. Thus, the first and second operation have eliminated the potentiometer 8 from its transmitter channel and operatively connected the transmitter unit 1 to the main amplifier directly instead of through the potentiometer 8. The third operation transfers the high potential output lead 33' of potentiometer 8' from the high potential input lead 37 of transformer 9 to ground, the new connection from the conductor 33' extending still through contacts 34' and 35' but thence through contacts 32 and 40 to ground. Thus, this third operation has disconnected the transmitter channel including transmitter unit 1' and potentiometer 8' from the main amplifier and short circuited the output end of that channel, which reduces interference and crosstalk and prevents that channel from unnecessarily shunting away from the input transformer 9 of the main amplifier the transmission sent from the transmitter unit 1. The elimination of the potentiometer 8 from its channel, as accomplished by the first and second operations, avoids unnecessary attenuation or transmission loss in the channel. Any attenuation changes or volume control desired then, (i. e., when transmitter unit 1' is not being used), can be obtained by means of potentiometers 45, 46, 47 of the main amplifier. The elimination of the potentiometer 8 from its transmitter channel decreases the impedance which its transmitter channel presents to the input transformer 9 of the main amplifier, (and thereby tends to compensate for increase of impedance presented to the primary winding of transformer 9 which tends to result from the disconnection of the other transmitter channel from the main amplifier), so that the impedance from which transmitter 9 works will remain of the same order of magnitude whether that transmitter amplifier, only, is connected to the main amplifier, or both transmitter amplifiers are connected to the main amplifier. The secondary-to-primary impedance of each of the output transformers of the preliminary amplifiers may be, for example, 50 ohms, which is also, then, the magnitude of each

of the substitute impedances 10 and 10'. Then the resistance values of the various portions of the potentiometers 8 and 8' may be, for example, the same as the specific values given by way of illustration in the Whiting application referred to above, the primary-to-secondary impedance of the transformer 9 in the transmission frequency range ordinarily being considerably higher than the impedance from which this transformer works.

Restoring the key 30 to its normal position restores the circuits to the condition in which they were before key 30 was operated to its down position, that is, to the condition in which both transmitter units feed the main amplifier through their mixing potentiometers. In the restoration the order of operation of the contacts of key 30 is the inverse of the order in which they operated when the key was moved from its normal position to its down position.

The operation of key 30, when it is thrown from its normal position to its up position, to disable the transmitter channel comprising transmitter unit 1 and potentiometer 8 and condition the system for use of only the other transmitter channel, is similar to the above described operation that occurs when the key is thrown from its normal position to its down position, and will be apparent without further description.

The main amplifier comprises four vacuum tube stages connected in tandem between the input transformer 9 and the output transformer 50. The secondary winding of the transformer 50 feeds the light-valve string 51 of the camera. A field winding 52 for the string is energized from battery 24 through a switch 53. The light controlled by the valve is produced by a lamp 54 which is energized from battery 24 through the switch 53, a rheostat 55 and an ammeter 56. The light which the light valve string allows to pass through the valve produces the desired sound record on the moving photographic film 57.

The first three stages of the main amplifier comprise the heater type (homopotential cathode type) tubes A—61, A—62 and A—63 respectively. The fourth stage comprises tubes A—64 and A—65 in push-pull relation.

Conductors 66 and 67 tapped from the primary winding of transformer 50 feed an input transformer 68 of a volume indicator comprising a rectifier tube R—70 and a transmission volume indicating meter 71 connected across a resistance 72 in the plate circuit of the tube. The volume indicator may be, for example, of the general type disclosed in Nelson Patent 1,523,827, Jan. 20, 1925.

The heater elements of tubes A—61,

A—62 and A—63, and the filamentary cathodes of tubes A—64 and A—65 are grounded. A battery 73 having its positive pole grounded supplies negative biasing potentials for the grids of tubes A—61, A—62 and A—63, the potential for tube A—61 having fluctuations removed by a network consisting of a resistance 74 and a condenser 75. A battery 76 having its positive pole grounded supplies to the grid of tubes A—64 and A—65 negative grid biasing potential from which fluctuations are removed by a network consisting of a resistance 77 and a condenser 78.

The energization of the plate and filament circuits of the tubes in the main amplifier is controlled by a single key 80 shown in its normal or off position. When operated to its on position, it first closes, at contacts 81, 82 and 83, three filament heating circuits traced below, and next closes a contact 84 in the circuits traced below for supplying space current for the tubes, and thereafter opens at contact 85 a normally closed short circuit across the path traced below which connects the transformer 50 and the light valve string. When key 80 is returned to its off position it re-establishes the short circuit before opening the plate and filament circuits. As indicated above, this short circuiting of the light valve string prevents the establishing or the decay of the *dc* plate currents of tubes A—61, A—62, A—63, A—64 and A—65 from causing disturbing currents in the light-valve strings and consequent distortion in the sound record produced on the film 57.

The filament heating circuit for tubes A—61, A—62 and A—63 extends from the positive pole of battery 24 through conductor 86, contact 81 of key 80, conductor 87, rheostat 88, the filament of tube A—61, the filament of tube A—62, another filament of tube A—63, to ground. The filament heating circuit for tube A—65 extends from the positive pole of the battery 24 through the conductor 86, a rheostat 89, contact 82 of key 80, a resistance 90, and the filament of tube A—65, to ground. The filament heating circuit for tubes A—64 and R—70 extends from the positive pole of the battery 24 through the conductor 86, the rheostat 89, contact 83 of key 80, the filament of tube R—70, and the filament of tube A—64, to ground, a 200 ohm resistance 91 being shunted across the latter filament to provide grid biasing potential for tube R—70.

The plate circuits of the tubes of the main amplifier are energized from a battery 92 which has its negative pole grounded and which has a by-pass condenser 93 connected across it. The *dc* plate circuits for all of the tubes of the main amplifier

extend from the positive pole of battery 92 through contact 84 of switch 80. Thence the circuit for tube A—61 extends through conductors 94, the resistance arm of a resistance-capacity network 95 for removing current fluctuations, and the primary winding of the plate circuit transformer for tube A—61 to the plate of the tube. The circuit for tube A—62 extends from the contact 84 through the conductor 94, the resistance arm of a resistance-capacity network 96 similar to network 95, and the primary winding of the plate circuit transformer for tube A—62 to the plate of that tube. The circuit for tube A—63 extends from the contact 84 through the conductor 94 and a resistance 97 to the plate of the tube. A blocking condenser 98 prevents *dc* from passing through the primary winding of the plate circuit transformer for the tube. The circuit for tubes A—64 and A—65 extends from contact 84 through conductor 99, choke coil 100, conductor 101, and thence through the two halves of the primary winding of transformer 50 to the plates of the tubes. The circuit for tube R—70 extends from contact 84 through the conductor 99, resistance 72 (and meter 71 in parallel therewith), conductor 102, and choke coil 103 to the plate of the tube. A condenser 104 connected between the plate and the filament of the tube assists in the rectifying action of the circuit of the tube.

A key 105 shown in its normal position controls the circuit from transformer 50 through the light-valve string. This circuit is from the upper terminal of the secondary winding of the transformer through conductor 106, upper right hand contact of key 105, the light-valve string 51, lower right hand contact of key 105, and conductor 107 to the lower end of the transformer winding. As indicated above, the contact 85 of key 80 normally connects conductors 106 and 107 to short circuit the light valve string, but this contact opens the short circuit whenever the main amplifier is in use.

By operation of key 105 to its alternate position, a six ohm resistance 108 for simulating the impedance of the light-valve string can be substituted for the light valve string as the load on the secondary winding of transformer 50. The substitution tests the circuit continuity of the string, since the reading of the volume indicator meter 71 depends upon the load on the amplifier tubes A—64 and A—65 and should not change when the substitution is made, provided the string is in proper condition.

The primary winding of transformer 50 serves as an autotransformer for matching the primary-to-secondary impedance of the input transformer 68 of the volume indicator circuit to the impedance from which it works.

What is claimed is:

1. The method of operating a wave transmission system having two sources of waves connected to feed a wave transmission channel, which comprises disconnecting one of said two sources and short-circuiting it and so changing the impedance of said other source as to tend to maintain constant the impedance from which said channel works.

2. The method of operating a wave transmission system including two wave transmitting channels, a wave receiving channel fed by said transmitting channels, and transmission volume adjusting means in one of said transmitting channels, which comprises eliminating the volume adjusting means from the one transmitting channel and disconnecting the other of the two transmitting channels from the receiving channel.

3. In combination, two wave transmitting channels, a wave receiving channel fed by said transmitting channels in parallel, transmission volume adjusting means in each of said two transmitting channels, and switching means operable selectively to eliminate the volume adjusting means from either of said two transmitting channels, at will, and disconnect the other of said two transmitting channels from said receiving channel.

4. A main amplifier for amplifying waves from a wave transmitting channel which includes a telephone transmitter remote from said main amplifier, a preliminary amplifier fed by and located at the transmitter and a wave transmission path connecting the preliminary amplifier to said main amplifier, said main amplifier comprising impedance for simulating the operating impedance with which the preliminary amplifier faces said main amplifier, and switching means operable to first close contacts for connection in energizing circuits of the transmitter and the preliminary amplifier, thereafter open contacts for connection across the end of the wave transmission path at the main amplifier, subsequently close contacts for connection in series in that wave transmission path, and finally open contacts for connection in series between said first mentioned impedance and said main amplifier.

5. A wave transmission system comprising two transmitting channels, a main vacuum tube amplifier fed from said transmitter amplifiers, and a sound recording camera having a light-valve string fed from said main amplifier, each of said transmitting channels comprising a condenser transmitter and a preliminary vacuum tube amplifier for amplifying waves from the transmitter, and said main amplifier comprising impedances for respectively simulating the operating impedances with which said pre-

liminary amplifiers face said main amplifier, two switching means individual to said two transmitting channels for first connecting the simulating impedance for the channel across the channel near the main amplifier, thereafter opening the channel at a point between the preliminary amplifier and the simulating impedance, subsequently short circuiting the channel at a point between the preliminary amplifier and the first mentioned point, and finally deenergizing the transmitters and the preliminary amplifiers, two potentiometers individual to said two transmitting channels, switching means operable to sequentially eliminate either of said potentiometers from circuit and open the output circuit of the other, and switching means operable to sequentially short circuit said light-valve string and deenergize said main amplifier.

6. The method of operating a vacuum tube amplifier which comprises establishing and stopping the flow of steady plate current for the amplifier and maintaining the output side of the amplifier short circuited over a period beginning before the steady plate current has been reduced and terminating after the steady plate current has been established.

7. A system comprising a light-valve having a light-valve string, a vacuum tube for feeding said light-valve string, and switching means operable to sequentially short circuit said light-valve string and deenergize said vacuum tube.

In witness whereof I hereunto subscribe my name this 25th day of March, 1930.

ROBERT A. MILLER.

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