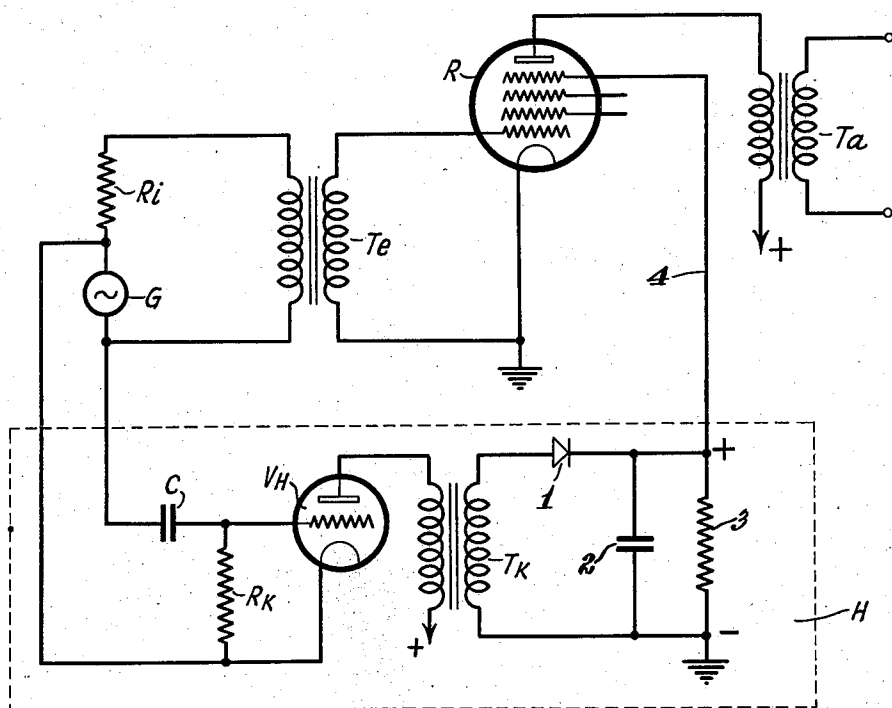


June 20, 1939.

H. BARTELS ET AL
DYNAMIC EXPANSION CIRCUIT

2,162,875

Filed Nov. 27, 1936



INVENTORS
HANS BARTELS AND
GÜNTHER ULBRICHT
BY *H. S. Sauer*
ATTORNEY

UNITED STATES PATENT OFFICE

2,162,875

DYNAMIC EXPANSION CIRCUIT

Hans Bartels and Günther Ulbricht, Berlin, Germany, assignors to Telefunken Gesellschaft für Drahtlose Telegraphie m. b. H., Berlin, Germany, a corporation of Germany

Application November 27, 1936, Serial No. 113,021
In Germany December 2, 1935

2 Claims. (Cl. 179—171)

The present invention relates to circuit arrangements for automatic control of the transmission ratio in amplifier stations in accordance with frequency.

5 In the volume control of audio-frequency arrangements for the transmission of music (such as modulating arrangements, talking film reproducing arrangements or record plate reproducers) in order to compensate for the frequency response characteristic of the ear, volume control means are often used, in which the frequency response characteristic of the amplifier arrangement depends on the control means, i. e., on the volume of the reproduction. The dependence of the frequency on the control arrangement is so chosen that it corresponds to the curve of the sensitivity of the ear. As a result thereof the natural impression of the reproduction will be retained also in case of greatly different reproduction levels, which, otherwise, would give the impression of predominance of the low-or high-frequencies.

It was found from experience that, also, where the transmission ratio is automatically controlled, such frequency dependent control in accordance with the curve of the sensitivity of the ear offers an advantage. If namely at recording i. e., when compressing the intensity range, the control is so carried out that the large amplitudes are not influenced, or but slightly influenced, as regards intensity, while the small amplitudes are however increased, it appears at reproduction as if the low frequencies were given preference. If, for instance, a bass violin and a violin are played with the same volume in the above described control the bass violin appears to be much louder than the violin. The entire sound picture is thus falsified.

In cables for transmission of wide frequency bands it is already known to use devices for maintaining the level in conjunction with distortion reducers for the purpose of preventing certain frequency ranges, more particularly the high frequencies, from being transmitted with more efficiency. This is accomplished in that in the control circuit of the level-maintaining device a distortion reducing means is inserted which is, therefore, no longer dependent upon the natural speech, but is controlled by the speech already controlled in amplitude in accordance with the frequency. In this way, the output level is maintained constant without appearance of undesirable preference of the high frequencies.

In accordance with the invention, the desired control depending on frequency and in accord-

ance with the sensitivity curve of the ear, is obtained with simple means in that the frequency response of the auxiliary circuit is adapted to the sensitivity curve of the ear. This can be accomplished by means of a frequency-dependent coupling, or by inserting frequency dependent elements in the transmission path of the auxiliary circuit (auxiliary amplifier). The auxiliary circuit furnishes the direct displacement potential required for the control, and which is a measure for the mean level of the impulses of the tone frequency. In the presence of sufficiently high alternating potentials, which is the case for instance where impulses are returned from the output circuit to be used for the control of one of the preliminary tubes (backward control), a special amplifier is not required. In these arrangements the frequency-dependent element is arranged between the tap point of the alternating potential and the rectifier producing the direct control potential.

The aforementioned circuit appears on the surface to operate theoretically correct only where individual frequencies are transmitted. In the transmission of several frequencies, in fact, the frequency response of the individual frequencies can no longer be influenced separately, since the direct potential depends simultaneously on all frequencies. However, tests have proven that where several frequencies are simultaneously transmitted, the new arrangement permits of a satisfactory control dependent on frequency and conforming to the sensitivity curve of the ear.

In the drawing is shown a low frequency amplifier employing a gain control circuit utilizing the invention.

The circuit arrangement in the drawing shows an audio-frequency amplifier R, whose input electrodes are coupled across the secondary of the audio input transformer T_e. The symbol G denotes a generator, or source, of audio-frequency currents, and the source G is connected across the primary winding of the audio input transformer. The symbol R_i denotes the inner resistance of G. The amplified audio output of the tube is impressed upon the audio output transformer T_a. The volume range of the output of amplifier R is expanded by using the network H including tube V_H, and the output of the latter is impressed upon a rectifier I by means of the transformer T_k. The resistor 3 is connected in series with the secondary winding of transformer T_k and rectifier I, the positive side of the resistor 3 being connected to the grid of tube R adjacent the output plate, while the opposite terminal of

resistor 9 is at ground potential. A condenser 2 is connected in shunt with resistor 3 and acts to by-pass audio pulsations. The condenser C is so chosen that at low frequencies (such as 100 cycles) it is lower in resistance than the sum of R_L and R_K (R_K being the coupling resistance of the auxiliary circuit H). The constants of condenser C and resistor R_K are chosen so that the expansion circuit will have a frequency response characteristic corresponding to the frequency-sensitivity characteristic of the human ear. It is well known that the frequency-sensitivity characteristic of the human ear is such that the ear is relatively more sensitive to low frequency sounds as the general level of intensity is increased. Of course, as the signal input from source G increases in amplitude, the gain of tube R will be increased because of the increasing voltage drop across resistor 3, but the gain of tube R will be relatively less for low frequencies than for high frequencies.

What is claimed is:

1. In combination with a source of audio-frequency currents, a tube provided with input electrodes, an output electrode, and a gain control electrode disposed adjacent the output electrode, an expansion circuit comprising a rectifier having an input circuit connected to said source, a resistor in circuit with said rectifier for developing a direct current voltage which increases with an increase in amplitude of current from said

source, means for applying said direct current voltage to said gain control electrode in a sense to increase the tube gain, and said rectifier input circuit including a network whose constants are chosen to impart a frequency-response characteristic to the expansion circuit which varies with intensity inversely to the variation of the frequency-sensitivity curve of the ear.

2. In combination with a source of audio-frequency currents, a tube provided with input electrodes, an output electrode, and a gain control electrode disposed adjacent the output electrode, an expansion circuit comprising a rectifier having an input circuit connected to said source, a resistor in circuit with said rectifier for developing a direct current voltage which increases with an increase in amplitude of current from said source, means for applying said direct current voltage to said gain control electrode in a sense to increase the tube gain, and said rectifier input circuit including a network whose constants are chosen to impart a frequency-response characteristic to the expansion circuit which varies with intensity inversely to the variation of the frequency-sensitivity curve of the ear, and said rectifier input circuit additionally including an amplifier disposed between said network and said rectifier.

HANS BARTELS.
GÜNTHER ULBRICHT. 30