United States Patent

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Austria
A 10699/68

[54] **DYNAMIC RANGE COMPRESSOR**
11 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** **323/19,**
179/1 VC, 323/48, 323/62, 330/145, 333/14
[51] **Int. Cl.** **H04b 1/64,**
G05f 5/00
[50] **Field of Search** 333/14;
328/168; 323/22 T, 66, 19, 48, 60, 62; 330/145;
179/1 VC, 1 VL

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ABSTRACT: A dynamic range compressor includes a resistance controllable as a function of the level of an input signal, or a resistance network, including semiconductor elements, controllable as a function of the input level, and further includes a differential transformer having two opposing windings of substantially equal numbers of turns, and having a third winding coupled to the two windings. The signal to be compressed is fed directly to one of the two windings and is fed to the other of the two windings through the resistance or resistance network which is controlled as a function of the level.

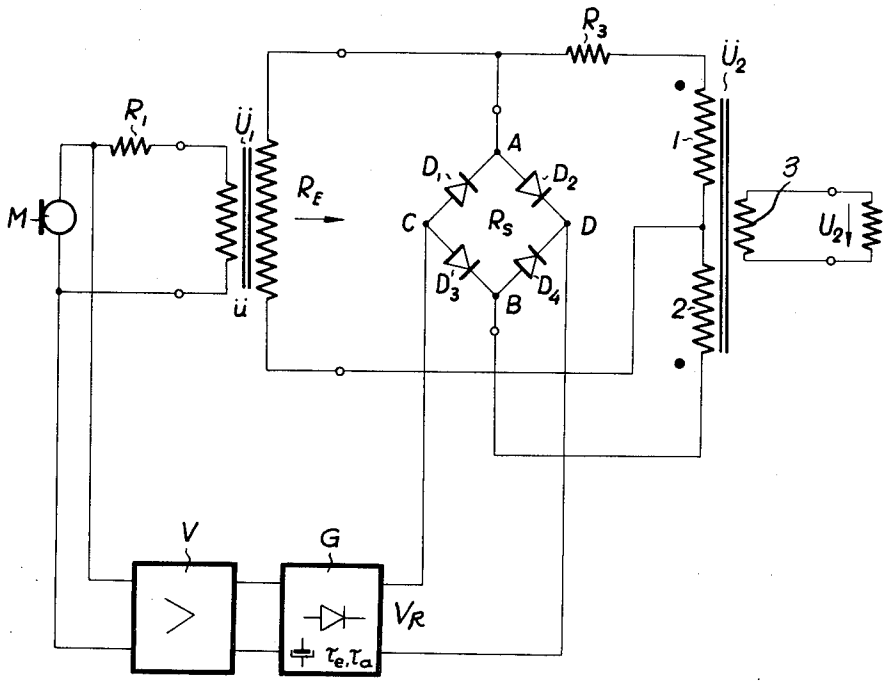


FIG. 1

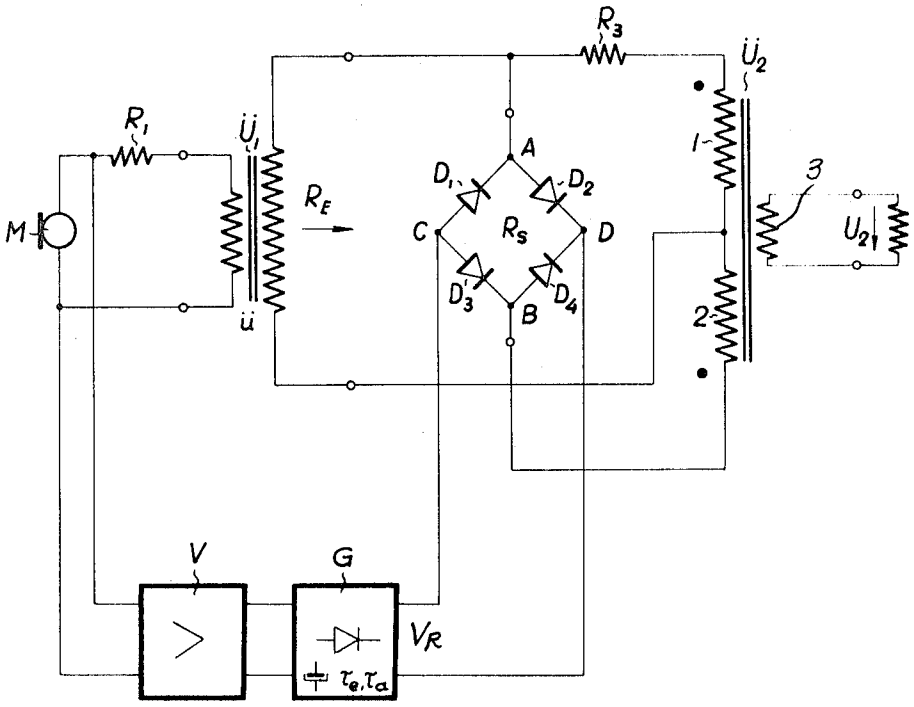
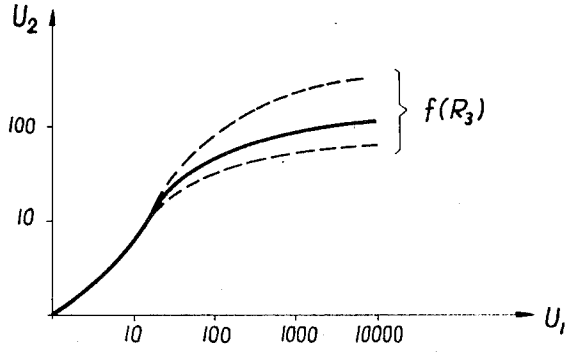


FIG. 2



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FIG. 3a

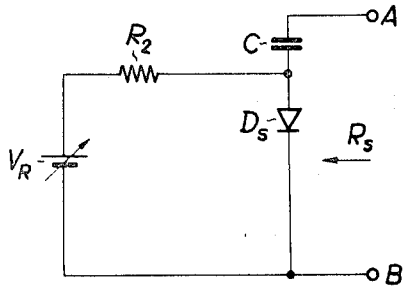


FIG. 3b

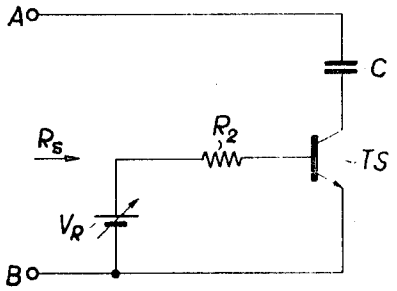
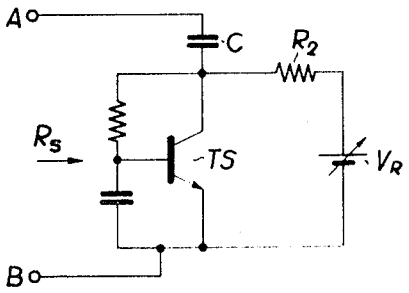


FIG. 3c



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DYNAMIC RANGE COMPRESSOR

BACKGROUND OF THE INVENTION

The dynamic range of original sound events, for instance, in the case of concerts, is up to 80 db. and more. It is well known that such a large range cannot be accommodated fully in disc recordings, radio transmissions, tape recordings, etc., but that this natural range must be narrowed down correspondingly. A remaining compressed dynamic range of 50 db. is still considered as very good.

For high-quality studio recording, this narrowing down or compressing is usually effected by the sound engineer, that is, manually, but it is nevertheless the practice in many situations in studio engineering to employ range compressors. In any event, range compressors are a very useful implements of transmission technology in electroacoustic installations generally, and are particularly valuable for a tape-recording amateur, as they relieve the amateur of the continuous monitoring of the level meter and make it possible for the amateur to concentrate on the sound event itself that is to be recorded.

Known compressor circuits range from bridge arrangements, with small carbon and metal filament lamps, to extensive control circuits, for instance, including control valves with forward and feedback control. With the exception of circuits using control valves, the known arrangements all work according to the principle of the level-dependent voltage divider, the control voltage, in high-quality arrangements, usually being applied to the diagonal of a bridge. This bridge consists of four controlled resistance elements, for example, diodes, transistors, etc. The variable resistance appears across the other diagonal of the bridge. Photoresistors also have been used as controlled resistances, and are illuminated by a light source whose brightness is dependent on the signal voltage.

However, most of the known circuits are too expensive for an amateur. The industry has endeavored to meet the amateur's needs, and has recently brought on the market magnetic tape recorders which are already equipped with a built-in dynamic range compressor. Now, these dynamic range controls are actually needed in only a few cases such as if a sound event, whose dynamic range is very large or not predictable, is to be recorded directly on the tape. If the tape or disc recording of radio transmissions is involved, a dynamic range compressor is no longer required because of the already reduced dynamic range of the transmission, and may possibly even be detrimental. It would therefore appear to make more sense to locate the dynamic range compressor in the microphone, rather than in the sound channel. This results in the requirement that such a control device must be inexpensive and have a small power drain.

To realize this concept, there are two distinct paths. The low frequency signal either can be taken from the tape equipment, rectified, and the obtained voltage used as the control voltage, or the necessary control voltage can be tapped directly from the microphone, using a separate amplifier. As, in both cases, only very small power levels are available, it is necessary to provide the compressor with a sensitivity which is as high as possible.

SUMMARY OF THE INVENTION

This invention relates to dynamic range compressors and, more particularly, to a novel, improved and relatively inexpensive dynamic range compressor which includes either a resistance controllable as a function of the level or a resistance network controllable as a function of the level.

The objective of the invention is to provide a dynamic range compressor of high sensitivity which is simply inserted between a microphone and a tape recorder, and thus can be effective only for microphone recordings. In accordance with the invention, a dynamic range compressor includes a resistance controllable as as a function of the level, or includes a resistance network including semiconductor elements, such as diodes, transistors, etc., controllable as function of the level. The dynamic range compressor further includes a differential

transformer. This differential transformer includes two mutually opposing windings of equal or nearly equal numbers of turns, and the signal to be compressed is fed directly to one of these two windings and is fed to the other of the two windings either through a resistance controlled as a function of the level or through a resistance network controlled as a function of the level. The compressed signal is derived at a third winding of the transformer and which is coupled to the mentioned two windings.

Such a dynamic compressor is best operated with a high-impedance signal source. As microphones, however, are generally of low impedance, a step-up transformer is additionally provided on the input side of the compressor. The primary side of the step-up transformer is connected to the signal voltage source, and there is also connected, in parallel with the signal voltage source, an amplifier arrangement whose output is loaded with a rectifier arrangement. The rectified output voltage of the amplifier arrangement is fed to the level-dependent resistance or the level-dependent resistance network.

As resistances controllable as a function of the level, semiconductors, such as diodes, transistors, or the like, are especially suited. These act either as a simple, control voltage divider, in which case the differential resistance is utilized, or they can be arranged in a bridge circuit having the signal voltage supplied by the step-up transformer applied to one diagonal while the control voltage is applied to the other diagonal.

An object of the invention is to provide an improved and relatively inexpensive dynamic sound range compressor.

Another object of the invention is to provide such a dynamic sound range compressor which is simply inserted between the microphone and a tape recorder and is effective only for microphone recordings.

A further object of the invention is to provide such a dynamic sound range compressor in which the signal to be compressed is fed directly to one of two mutually opposing windings of substantially equal numbers of turns, of a differential transformer, and is fed to the other of the two windings through a resistance controlled as a function of the level or a resistance network controlled as a function of the level.

Another object of the invention is to provide such a dynamic sound range compressor in which the compressed signal voltage is derived from a third winding of the differential transformer.

A further object of the invention is to provide such a dynamic sound range compressor which is operated with a high-impedance signal source in the nature of a step-up transformer, having its primary winding provided on the input side of the compressor.

Another object of the invention is to provide such a dynamic sound range compressor in which an amplifier arrangement is connected in parallel with the signal voltage source and is loaded with a rectifier arrangement, with the rectified output voltage being supplied to the level-dependent resistance or the level-dependent resistance network.

For an understanding of the principles of the invention, reference is made to the following description of typical embodiments thereof as illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a basic schematic wiring diagram of the invention dynamic sound range compressor;

FIG. 2 is a graphical illustration of the effect of the resistance on the shape of the control characteristic; and

FIGS. 3*a*, 3*b* and 3*c* are schematic wiring diagrams illustrating further embodiments of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The basic schematic wiring diagram illustrated in FIG. 1 is directed to a dynamic range compressor which is to compress the output voltage of a low-impedance microphone M. Logically, the microphone voltage is stepped up by the transformer U_1, as thereby, in addition to the improvement of the present invention, the voltage division between the stepped-up microphone resistance and the input impedance R_E of the differential transformer U_2 is utilized.

The secondary winding of step-up transformer U_1 has one end connected to the junction point of two windings 1 and 2 of differential transformer U_2. These windings 1 and 2 have an equal, or nearly equal, number of turns and, electrically, the two windings are connected so that they oppose each other as to their effect. That is, in the third winding 3 of differential transformer U_2 there is formed the difference between the voltages induced by the respective windings 1 and 2.

If both voltages are of equal magnitude, cancellation occurs. If only one of the two windings 1 or 2 is energized, the signal voltage, in dependence on the transformation ratio of transformer U_2, will appear in full in winding 3.

Winding 1 of transformer U_2 has the signal voltage applied directly thereto through a resistor R_3. On the other hand, the signal voltage is applied to the winding 2 through a resistance controllable as a function of the level, or through a resistance network controllable as a function of the level. That is, the two voltages are connected in opposition to a larger or smaller degree through the controllable resistance R_S and in dependence on the sound level. The voltage, thus compressed, is then derived at winding 3.

In the basic schematic wiring diagram shown in FIG. 1, the controllable resistance R_S is formed by a bridge circuit consisting of four diodes D_1, D_2, D_3, and D_4. The bridge resistance between the two corners A and B changes in correspondence to the control voltage applied to the corners C and D, and which is derived from the output of microphone M. For this purpose, an amplifier V is connected to microphone M, and a rectifier arrangement G is connected to the output of amplifier V. Rectifier arrangement G consists essentially of a diode and a charging capacitor. The DC voltage obtained in this manner depends, as to its magnitude, on the amplitude of the AC voltage at the output of microphone M, and this DC voltage is supplied to the controlled bridge circuit.

Depending on the application, there is commonly needed short-charging time constants, approximately 10–20 msec., and long-discharge time constants, approximately 5–20 sec. These are realized by the choice of the charging capacitor, the source impedance and the discharge resistor (τ_e,τ_a).

The slope of the dynamic range compression can be varied by means of the resistor R_3. In an exact sense, two effects are superimposed. On the one hand, the signal is influenced according to the differential circuit in transformer U_2 and, on the other hand, according to the relationship between resistances R_3 and R_S.

FIG. 2 illustrates the influence of the resistance R_3, the relation between the two voltages U_1, U_2 (input and output voltages of the compressor) being shown in the diagram as a function of R_3. The effect of R_3 can be described as follows: If R_3=R_S the output voltage U_2 is zero, but R_3 is so chosen that this is the case, with certainty, far above the maximum to be transmitted. However, depending on where this point is located, the slope within the dynamic range can be varied.

In place of the diode bridge arrangement, which makes sense only where a high degree of dynamic range compression is required, and a suppression of control transients becomes more and more difficult, simple circuit arrangements using only one diode or one transistor can be used. Arrangement of this type are shown, in principle, in FIG. 3*a*, 3*b* and 3*c*.

Thus, in FIG. 3*a*, a diode D_S replaces the bridge of FIG. 1, and the AC voltage is fed to this diode through a capacitor C. Diode D_S has the control voltage $V_R$supplied thereto through resistor R_2, this control voltage being a function of the signal. The resistor R_S which depends on the applied signal voltage, appears between the two terminals A and B.

In the circuits of FIG. 3*b* and 3*c*, diode D_S is replaced by a transistor, whereby a larger resistance change can be obtained with smaller signal voltages than in the case of the diode circuit of FIG. 3*a*. In FIG. 3*b*, the control voltage V_R is applied to the base of transistor TS through resistance R_2 whereas, in FIG. 3*c*, the control voltage is applied to the emitter-collector circuit of transistor TS.

The sensitivity of a dynamic range compressor embodying the invention is relatively high, as a narrowing down of the dynamic range, in the amount of 40 db., can be obtained with a DC voltage at 0.6 v. The power required is extremely low and, physically, the invention range compressor can be accommodated in a microphone housing.

While specific embodiments of the invention have been shown and described in detail to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. A dynamic sound range compressor, comprising a signal voltage source; resistance means variable in response to control signals; control means for applying a control signal which is a function of the sound level to said resistance means; a transformer having two opposing windings and having a third winding coupled to said two windings; first circuit means applying the signal voltage from said source directly to one of said two windings; and second circuit means applying the signal voltage from said source to the other of said two windings through said resistance means; said third winding deriving the compressed signal voltage.

2. A dynamic sound range compressor as in claim 1, wherein said opposing windings have substantially equal numbers of turns.

3. A dynamic sound range compressor, as claimed in claim 1, in which said resistance means comprises a variable resistance controlled as a function of the sound level control signals.

4. A dynamic sound range compressor, as claimed in claim 1, in which said resistance means comprises a resistance network controlled as a function of the sound level control signals.

5. A dynamic sound range compressor, as claimed in claim 1, wherein said control means include an amplifier arrangement connected in parallel with said signal voltage source; a rectifier arrangement connected to the output of said amplifier arrangement; and circuit means applying the DC output voltage of said rectifier arrangement to said resistance means controllable as a function of the sound level.

6. A dynamic sound range compressor, as claimed in claim 5, in which said resistance means comprises a semiconductor element controllable by the DC output voltage of said rectifier arrangement.

7. A dynamic sound range compressor, as claimed in claim 6, in which said semiconductor element is a diode.

8. A dynamic sound range compressor, as claimed in claim 6, in which said semiconductor element is a transistor.

9. A dynamic sound range compressor, as claimed in claim 5, in which said resistance means is a resistance network controllable as a function of the sound level, said resistance network consisting of a bridge arrangement of semiconductor elements; means applying the signal from said signal voltage source through one bridge diagonal to one of said two windings; and means applying the signal-dependent control voltage from the output of said rectifier arrangement to the other bridge diagonal.

10. A dynamic sound range compressor, as claimed in claim 9, in which said semiconductor elements of said bridge arrangement are diodes.

11. A dynamic sound range compressor, as claimed in claim 9, in which said semiconductor elements of said bridge arrangement are transistors.