Voltage Stabilizers Ragulable Down to Zero, and Provided with Balanced Rectification

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The invention is a diode rectifying circuit, yielding at its positive and negative outputs a feed current of the same swing in relation ot its earth point, but having different loadability.

The main field of application of the invention being the supply of auxiliary power to voltage stabilizers regulable down to zero, thus the characteristics of the rectifying circuit embodied by the invention will be dealt with from this respect. The series pass-through type voltage stabilizers regulable down to zero can be divided into two basic sections: a valve transistor, responsible for passing-through output, and located in either a parallel circuit or in a Darlington circuit, as necessitated by the output and stability required, and a control and error signal amplifier unit, regulating the former. Also the control and error signal amplifier unit can be of any design and any degree of sophistication in compliance with the requirements made with the stabilizer. However, in order to be able to regulate output voltage down to zero, the stabilizer of any design must be supplied with zero voltage, or even below that potential level.

This requirement cannot be met by rectification producing mono-potential, since regulation down to zero is prevented by the residual voltages dropping over the film-type diodes of transistors in the control circuit, as well as by the minimal zener voltage that can be still produced by the zener diode serving as a stabilizing element. For meeting this requirement, the only method available is to make use of an external auxiliary voltage of opposed polarity, thus producing a differential voltage lower than zero out of the two potentials, and from then on using that voltage as the reference point of the control circuit.

Several methods of rectification are known for producing auxiliary voltage of opposed polarity. According to the classical design illustrated on Fig. 1, auxiliary voltage is produced by a separate secondary coil of the supply transformer. This method entails the disadvantage of necessitating the use of a special transformer, as a result of which setting up of the circuit is both cumbersome and expensive. This drawback has been eliminated by a produce of RCA /marked WP-703 A, and dealt with on Page 462, Rádiótechnika, 1976/, which takes auxiliary voltage of opposed polarity off an existing full-wave rectifier circuit by means of a single diode /Fig.2/

Although really simple and cheap, the method still has a definite drawback, following from the half--wave rectification adopted: auxiliary voltage need be filtrated by means of either a high-capacity electrolytic capacitor or several zener diodes in cascade connection.

The rectification method of the invention is suitable for eliminating the above-mentioned drawback. As apparent from Fig. 3, the invention actually is the combination of two full-wave rectifier circuits. This set-up has been rendered feasible by the fact that the existing full-wave rectifying circuit only made use of the positive half periods of the secondary voltage supplied by the supply transformer, leaving the negative halves vacant. The rectifying process of the invention makes use of the vacant negative half periods to a certain extent, by means of a pair of full-wave rectifying diodes installed in the circuit subsequently. The method, which could be termed as "cross-breed rectification", is free from all drawbacks of the rectification processes mentioned so far. No special transformer is required, setting-up is easy, and since the potential supplied is rectified by the full-wave process, no high--capacity electrolytic capacitor or cascade-connected zener diodes are necessary for filtration either. The

advantage gained over the symmetrical rectifying circuit is that two high-capacity diodes can be spared. It is apparent, therefore, that by making use of the symmetrical rectification of different output embodied in the invention, production costs of supply units regulable down to zero output voltage can be cut to a significant extent.

The simplest practical application of the method is illustrated on Fig. 4. The device is made up of a pair of Darlington pass through transistors and a single-transistor regulating and error signal amplifier unit. Regulation down to zero is facilitated by zener diodes Z1 and Z2 coupled opposite each other. Since in order to achieve complete regulation down to zero the regulating circuit requires a negative potential beyond zero, thus it is principal requirement that in the differential circuit the rated voltage of diode Z2, supplied with auxiliary voltage, be by at least several tenths of voltage higher than that of diode Z1. In principle, any pair of diodes featuring different voltage rating are suitable for the purpose, but practical experiences have shown that the zeners falling between 5 V and 8 V ensure the highest stabilizing effect, having the lowest differential resistance. Zero and final levels of output voltage can be accurately adjusted by means of resistors R1 and R2. By

means of zener bias resistor R3, a high input stability can be established, by making use of the negative currents generated by the differential voltage ratios. This is feasible because output voltage fails to drop with input voltage parallel with the gradual decrease of zener current intensity of diode Z2, but increases with it. For a given output load, the negative current intensity at which the rise of output voltage just counterbalances the input voltage associated with the given load current can be adjusted by means of zener bias resistor R3. In the present case, input stability was obtained as 150 to 250 V, relating to mains voltage, at U_{out} = 5 V, and under maximum load. Measured also at 5 V, output stability of the circuit was 8×10^{-2}, whereas output resistance amounted to 0.03 - 0.04 Ohm. In order to improve temperature stability of the device, it is advisable to grout zener diodes Z1 and Z2 with artificial resin Penelon after soldering. It is essential that on switching-off, output voltage be cut off along with input voltage, since as a result of the imbalance occurring in differential voltage retios output voltage tends to jump to top limit value while the filter electrolytic capacitors are discharged.

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Claims of Patent

1./ Symmetrical rectification of different outputs, characterized by a pair of high-capacity diodes /1/ - /2/, and a pair of low-capacity diodes /3/ - /4/ built upon the former.

2./ Symmetrical rectification of different outputs, as claimed under Para 1, for supplying auxiliary voltage to voltage stabilizers regulable down to zero, and characterized by a pair of power supply diodes /1/ - /2/ with full-wave rectification, as well as by a pair of auxiliary power supply diodes /3/ - /4/ receiving the same voltage and also featuring full-wave rectification.

3./ Practical application of symmetrical rectification of different outputs as claimed under Para.2, and as illustrated on Fig. 4, characterized by a differential circuit made up of two low-capacity zener diodes /5/ - /6/ and an auxiliary voltage filter /7/ - /8/ of a minimal rating.

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A b s t r a c t

Diode Rectification of Different Outputs
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The invention is a diode rectifying circuit supplying at its positive and negative outputs a power of the same swing in relation ot its earth point, but of different loadability.

By putting the invention into practice, the production costs of voltage regulators regulable down to zero can be significantly reduced, since the auxiliary voltage produced by the rectifying circuit of the invention only requires a minimum of filtration and stabilization.