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(54) A DIRECT VOLTAGE TRANSFORMER

(71) We, MESSERSCHMITT-BÖLKOW-BLOHM Gesellschaft mit beschränkter Haftung, of 8000 München, German Federal Republic a Company organised and existing under the laws of the German Federal Republic, do hereby declare the invention, for which we pray that a Patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

This invention relates to a direct voltage transformer with a push-pull oscillator arranged in a bridge and with symmetrical circuit connected opposed junctions of the bridge, each half of the symmetrical circuit having a capacitor forming one arm of the bridge and a transistor switching stage forming the other arm of the bridge, the control section of each switching stage having parallel inductive feed back to the other opposed junctions of the bridge, the said junctions of the bridge having a transformer circuit with a rectifier at the output thereof.

Direct voltage transformers of this kind have relatively low losses at input voltages up to 300 V. At higher voltages, however, it is important to provide, during load change from one transistor switching stage of the push-pull oscillator to the other for the non-conducting transistor switching stage to be completely cut-off before current flow through the other conducting transistor switching stage commences. Even small overlaps in the transistor switching stages causes a short circuit current to flow through both stages and at high voltages this will be proportionally high and will cause destruction of the transistors. An increase in the time between the closing and opening of the transistor switching stages, however, causes a corresponding loss of power.

This invention seeks to provide a direct voltage transformer for higher input voltages which operates with comparatively good effeciency.

According to this invention there is provided a direct voltage transformer with a push-pull oscillator arranged in a bridge circuit and with a circuit symmetrical circuit between opposed circuit junctions of the bridge forming the input each half of the symmetrical circuit having a capacitor forming one arm of the bridge and a transistor switching stage forming the other parallel arm of the bridge, a control section of each switching stage having inductive feedback to the other opposed junctions of the bridge which are connected through a transformer circuit including a rectifier means forming an output thereof, a choke with a centre tapped winding being connected between the two transistor switching stages with the centre tap forming one of the said other junctions of the bridge which centre tap forms a connection to the transformer.

A choke arranged in this manner forms a low-loss A.C. load and ensures that during the critical load change between the transistor switching stages a voltage is induced which acts as a blocking voltage on the other transistor switching stage. Thus a short circuit current can be prevented from flowing from one transistor switching stage to the other.

Each end of the choke winding may be connected through a respective free-running diode with that input in the arm of the bridge which is opposite thereto, so that conduction of the transistor switching stages is not impeded by the chokes.

Preferably the transistor switching stages are each provided with a Darlington coupled stage and the base of the first transistor of the Darlington stage may be connected through a diode, reverse connected in relation to the base-emitter, path to the base of the second transistor of the Darlington stage.

The two base-emitter paths of a Darlington stage then receive a negative signal on being swithed off. The switching-off is thus particularly rapid. As the blocking voltage is subdivided between the two transistors of the Darlington stage, the total may be higher than when only one transistor is used for the switching stage. The higher blocking voltage reduces the switching time further.

The control sections of the transistor switching stages may each have a delay element serving to produce a negative base bias voltage whereby the leading edge of the swtiching pulses of the transistor switching stage becomes steeper. The time taken for the critical load change is thus shortened.

The direct voltage transformer of the invention may be made particularly reliable and short-circuit proof if the input to the bridge has a current limiting device means.

An embodiment of a direct voltage transformer according to the invention is shown by way of example in the circuit diagram of the accompanying drawing. The direct voltage transformer shown has a push-pull oscillator arranged in a bridge circuit. The four arms of the bridge have capacitors C_1 and C_2, and transistor switching stages S_1, S_2, respectively. The control sections of the transistor switching stages S_1 and S_2 are fed back inductively through a control transformer SÜ and a main transformer HÜ, to the opposed bridge points BD. The secondary winding of the main transformer HÜ feeds both the control transformer SÜ and a rectifier G, from which the transformed direct voltage, smoothed by capacitors EC_1 and EC_2, is taken. The direct voltage to be transformed is applied to the opposed points +E and −E of the bridge, which are across the capacitors C_1 and C_2 and the transistor switching stage S_1 and S_2. The input diodes D_1 and D_2 serve to define the polarity and the fedback respectively. An input current limiting device SB is provided.

The transistor switching stages S_1 and S_2 are interconnected through a choke Dr with a centre tap thereof forming the bridge diagonal BD. The transistor switching stages S_1, S_2, and the choke Dr are connected in series, so that the choke Dr, in the event of a flow of current in one arm of the bridge, induces a counter-voltage which acts as a blocking voltage on the transistor switching stage of the other arm of the bridge. The diodes D_3 and D_4 connected with opposite polarity in parallel with the collector-emitter paths of the transistor switching stages S_1 and S_2 respectively, and the Zener diodes Z_1, Z_2, and Z_3, Z_4 connected with opposed polarity in series and in pairs and across the base-emitter paths of the transistor switching stages, serve to limit the blocking voltage.

For the push-pull operation the two secondary windings of the control transformer SU, which act on the control sections of the transistor switching stages S_1 and S_2, are wound in opposite directions. A parallel connected resistance and capacitor form RC elements, RC_1 and RC_2, each connected in series with one of the secondary windings of the control transfomer SU, these serve to generate a negative base bias voltage and to cause a reduction in the switching times of the transistor switching stages. The transistor switching stages S_1 and S_2 comprise a Darlington stage pair of transistors T_1, T_2, and T_3, T_4, respectively with associated resistors R_1, R_2, R_3, and R_7, R_8, and R_4, R_5, R_6, R_{10}, respectively, serving to match and fix the working point. The Darlington stages have a high amplification factor, so that owing to the high feedback the oscillator is started easily when the input voltage is switched on. The Zener diodes Z_5 and Z_6 cause both transistor switching stages S_1 and S_2 to be slightly conductive when the input voltage is switched on. The flow of current which then commences is sufficient to start the oscillation. A starting means is not therefore necessary. To accelerate the switching off process in the Darlington stages the bases of the transistors T_1 and T_2, and T_3 and T_4, are interconnected through a voltage divider comprising resistors R_{11}, R_{12}, and R_{13}, R_{14}, and a fast switching diode D_7 and D_8 respectively. This ensures that both base-emitter paths of the Darlington stage will receive a negative signal when the stage is switched off, the time required for the switching off process thus being reduced.

An RC element RC_3 in the transformer circuit serves mainly to compensate the phase shift caused by inductance.

The arrangement and function of the current limiting devices interposed in the arm of the bridge of the direct voltage transformer are as follows:

The Darlington stage transistors T_5 and T_6 are conductive under normal operating circumstances, so that the greater part of the input current flows through the Darlington stage and the reistor R_{15}. When the input current of the direct voltage transformer has reached a certain level, the voltage drop in the reistor R_{15} switches the transistor T_7 to the conductive state. In through the collector-emitter paths of the transistor T_7 current is taken from the base of the Darlington stage, to an increasing extent with the increase in the voltage drop in the resistor R_{15}, as a result of which the flow of current and the said voltage drop in the resistor R_{15} are reduced. This produces a closed regulating circuit which ensures a constant input current to the direct voltage transformer. The level of the input current can be selected by resistor R_{15}. If the voltage drop in the Darlington stage exceeds a certain value, for example due to a further reduction in the load resistance at the output or owing to an increase in the voltage at the input of the direct voltage transformer, then due to the voltage divider R_{16}, R_{17} in parallel with the Darlington stage end and the diode D_9 the voltage at the base of the transistor T_7 will increase after a period determined by capacitor EC_3, and the transistor will thus draw more current from the base of the Darlington stage T_5, T_6 to cause a further voltage drop through the Darlington stage. The current limiting device then blocks completely, except for a small working current, and does not re-conduct until the withdrawal of current has been completely reduced or the supply of current is temporarily switched off.

WHAT WE CLAIM IS:-

1. A direct voltage transformer with a push-pull oscillator arranged in a bridge and with a symmetrical circuit between opposed juntions of the bridge forming the input, each half of the symmetrical circuit having a capacitor forming one arm of the bridge and a transistor switching stage forming the other parallel arm of the bridge, a control section of each switching stage having inductive feed-back to the other opposed junctions of the bridge which are connected through a transformer circuit including rectifier means forming an output thereof, a choke with a centre tapped winding being connected between the two transistor switching stages with the centre tap forming one of the said other opposed junctions of the bridge which centre tap forms a connection to the transformer.

2. A direct voltage transformer in accordance with Claim 1, wherein each end of the winding of the choke is connected through a respective free-running diode with the input in the arm of the bridge which is opposite thereto.

3. A direct voltage transformer in accordance with Claim 1 or 2, wherein the transistor switching stages each have a Darlington connected stage.

4. A direct voltage transformer in accordance with Claim 3, wherein the base of a first transistor of a Darlington stage is connected through a diode in opposition to the base-emitter path with the base of the second transistor forming the Darlington stage.

5. A direct voltage transformer in accordance with any one of the preceding Claims, wherein the control sections of the transistor switching stages each have a delay element which generates a negative base bias voltage.

6. A direct voltage transformer in accordance with any one of the preceding Claims 1 to 5, wherein the input to the bridge has a current limiting means.

7. A direct voltage transformer constructed and arranged to function substantially as herein described with reference to and as shown in the accompanying drawings.

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1583206 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*