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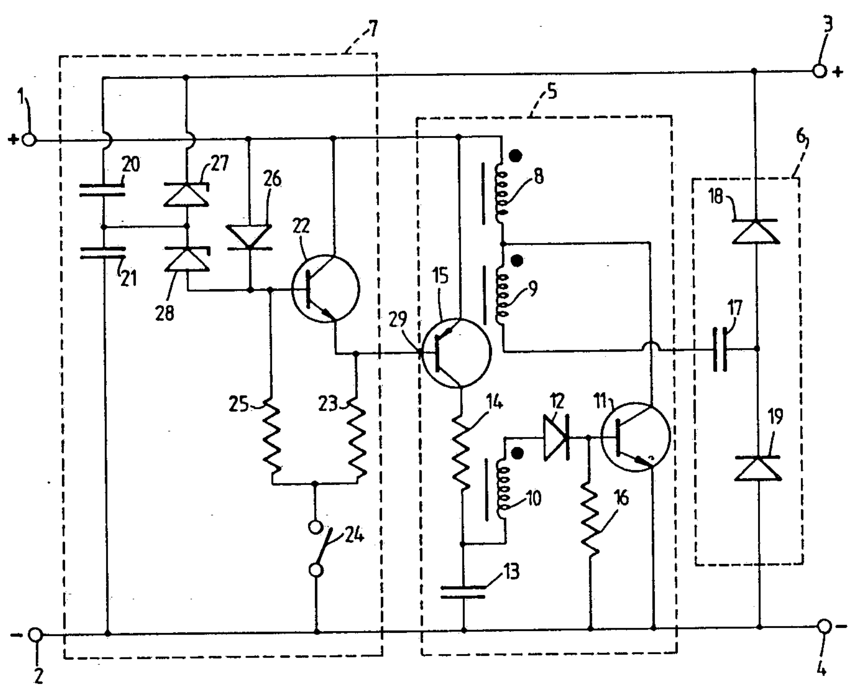
(54) D.C.-D.C. converter

(57) In order that a d.c.-d.c. converter should draw very little current in the stand-by condition the converter oscillator (5) is of the blocking oscillator type and energises an inductance (8,9) during its unblocked periods, this inductance in turn supplying output terminals (3,4) via a rectifier circuit (6). A coupling circuit (7) couples the output of the rectifier circuit to a blocking period control input (29) of the oscillator circuit in such a sense as to stabilise the output voltage, by controlling the delay rate of the voltage across the time constant capacitor (13).



The drawing originally filed was informal and the print here reproduced is taken from a later filed formal copy.

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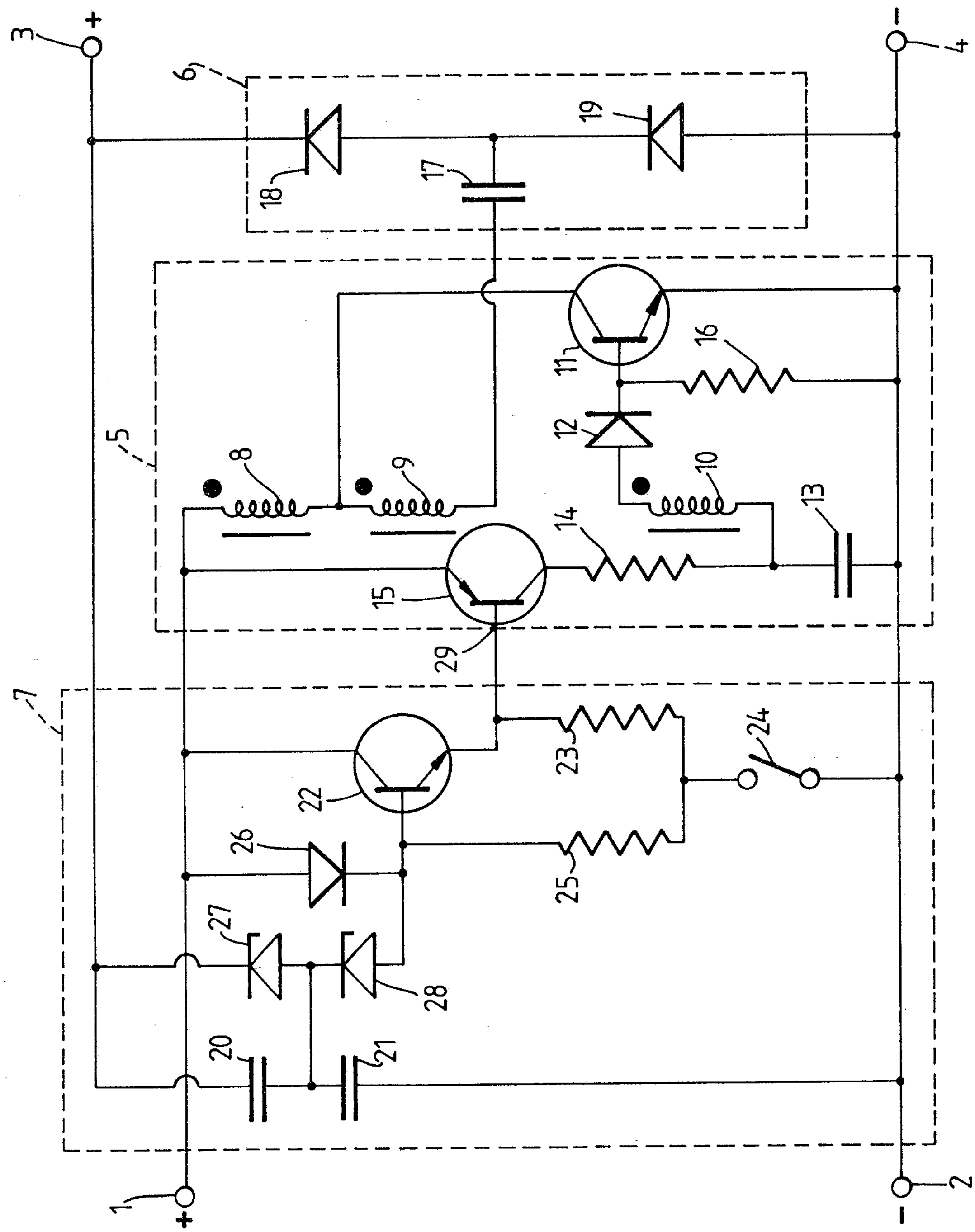

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SPECIFICATION

D.C.-D.C. converter

This invention relates to a d.c.-d.c. converter circuit arrangement comprising a blocking oscillator circuit an output signal of which controls, in operation, a switching element connected in series with an inductance across a pair of d.c. input terminals, which inductance is coupled to a d.c. output terminal via a rectifier circuit, said oscillator circuit being provided with frequency control means for controlling the decay rate, during each blocking period, of the blocking voltage set up across the oscillator blocking capacitance when the oscillator circuit is unblocked, and hence the duration of each blocking period, in dependence upon the value of a control signal supplied in operation to a control input of said control means.

Blocking oscillator circuits are well-known and are discussed in many publications, for example in the book "Electronic Circuits and Tubes" by the Cruft Electronics Staff (McGraw Hill, 1947) pages 804-809. Although their actual circuit configurations can take several different forms a common feature is that cumulative action caused by positive feedback around the oscillator circuit active element(s) when the oscillator circuit is unblocked results in the generation of a voltage change on a capacitance included in the oscillator circuit. When the cumulative action eventually ceases due to the positive feedback factor falling to below unity the circuit becomes blocked; cumulative action cannot recur until the voltage on the capacitor decays sufficiently towards its original value to cause or allow this to happen. Obviously the rate at which the blocking voltage decays determines the length of each period during which the cumulative action is blocked, and hence the oscillator output frequency, and it is known, for example in the context of time-base oscillators in early television receivers, to control the decay rate and hence the oscillator frequency by means of a control signal (derived in the case of the television receivers from the difference between the oscillator frequency and synchronising pulses). When such a blocking oscillator is used as a television receiver time-base oscillator the periods when the oscillator is blocked correspond to the scan periods of the receiver cathode-ray tube, and the periods when the oscillator is unblocked correspond to the retrace or fly-back periods.

It is common practice in television receivers to derive the high (EHT) voltage required by the cathode-ray tube by rectification of a voltage which appears across a winding of the line time-base output transfomer during each line fly-back period, the transformer being supplied via a switching element which is open during each flyback period and closed otherwise. If this is the case and a blocking oscillator is employed as the line time-base oscillator the open periods of the switching element correspond to the unblocked periods of the oscillator.

It is sometimes a desirable property of a d.c.-d.c. converter circuit arrangement that the current consumed thereby is very low in the absence of significant current being drawn from the converter output. This will be the case, for example, when the converter is driven by means of a battery and supplies a load such as a photographic flash bulb, Geiger Müller tube or electric fence which only draws current intermittently. It is an object of the invention to provide an arrangement which can have this property.

According to the invention a d.c.-d.c. converter circuit arrangement as defined in the first paragraph is characterised in that said output signal is arranged to control said switching element to be closed while the oscillator circuit is unblocked and to be open while the oscillator circuit is blocked, and in that a feedback circuit is provided from an output of said rectifier circuit to said control input for supplying a control signal which depends on the value of the output voltage of the rectifier circuit to said control input to thereby stabilise the value of said output voltage.

It has now been recognised that controlling the switching element to be closed while the oscillator circuit is unblocked and to be open while the oscillator circuit is blocked, and deriving a control signal for the decay rate of the blocking voltage from an output of the rectifier circuit enables a converter circuit arrangement having the said property to be obtained in a very simple manner. There is in principle no upper limit to the durations of the periods during which the oscillator circuit is blocked and hence during which the switching element is open, and it can be arranged that the current consumed by the arrangement during these periods is very low indeed. This is especially the case if the switching element is included in the positive feedback loop of the oscillator circuit; the positive feedback loop may, for example, contain a single amplifier stage an active element of which is constituted by said switching element. This can also result in an arrangement which is very economical in respect of components, especially if the inductance is constituted by a winding of a transformer which is included in the positive feedback loop.

An embodiment of the invention will now be described, by way of example, with reference to the accompanying diagrammatic drawing, the single Figure of which is the circuit diagram of the embodiment.

In the drawing a d;c.-d.c. converter circuit arrangement, for example for powering a Geiger Müller tube (not shown) has a pair of d.c. input terminals 1 and 2 and a pair of output terminals 3 and 4. The arrangement comprises a blocking oscillator circuit 5, a rectifier circuit 6 and a feedback circuit 7. The blocking oscillator circuit comprises a transistor active element or switching element 11 around which is provided a positive feedback loop comprising a primary winding 8 of a transformer, a feedback winding 10 of said transformer, and a diode 12. The transformer, whose windings have the polarities shown, also has a secondary winding 9. Winding 8 and the collector-emitter path of transistor 11 are connected in series across the input terminals 1 and 2. One end of winding 10 is connected to the base of transistor 11 via the diode 12 and the other end of winding 10 is connected to terminal 2 via an oscillator blocking capacitance 13. The common point of winding 10 and capacitance 13 is connected to terminal 1 via the series arrangement of a resistor 14 and the collector-emitter path of a transistor 15. A resistor 16 is connected between the base of transistor 11 and terminal 2. Diode 12 and this resistor are provided simply to protect the transistor 11 reverse emitter-base characteristics. The operation of oscillator 5 is conventional. When transistor 11 is conductive cumulative action due to positive feedback around the loop 11,8,10,12 results in the build-up of a negative potential on the upper electrode of capacitor 13. When the cumulative action eventually ceases due to the gain around the feedback loop falling below unity and transistor 11 turns off, this situation is maintained until capacitor 13 has discharged/charged through resistor 14 and transistor 15 sufficiently such that the potential thereon forward-biasses transistor 11 once again, at which point another cumulative action occurs. The time taken for the requisite discharging/charging to occur is obviously determined by the current flowing in transistor 15. The base of transistor 15 thus constitutes an input for a control signal for controlling the decay rate, during each blocking period, of the blocking voltage set up across capacitor 13 when the circuit is unblocked, and hence the duration of each blocking period.

One end of winding 9 is connected to the common point of winding 8 and the collector of transistor 11, and the other end of winding 9 is connected via a capacitor 17 to the anode of a diode 18 and the cathode of a diode 19. Diodes 18 and 19 are connected in series between the output terminals 3 and 4 and constitute, together with capacitor 17, the rectifier circuit 8. When transistor 11 is conductive the left-hand electrode of capacitor 17 is driven negative by the voltage across the series-connected windings 8 and 9 while its right-hand electrode is maintained at the potential of terminal 4 by diode 19. When subsequently the left-hand electrode of capacitor 17 is driven positive by the series-connected windings 8 and 9 due to turn-off of transistor 11 and the energy then stored in the transformer this positive potential, added to the potential already present across capacitor 17, is fed to output terminal 3 by diode 18. The potential across terminals 3 and 4 is smoothed by the series arrangement of a capacitor 20 and a capacitor 21 which also forms part of the feedback circuit 7.

The base 29 of transistor 15, i.e. the frequency control input of the oscillator circuit 5, is fed from the output of the coupling circuit 7, more particularly from the emitter of a transistor 22 which is connected to terminals 2 and 4 via a resistor 23 and a switch 24. The base of transistor 22 is also connected to the terminals 2 and 4 via a resistor 25 and the switch 24, and also to terminal 1 via a diode 26. Output terminal 3 is connected to the base of transistor 22 via the series combination of two zener diodes 27 and 28 the common point of which is connected to the common point of the capacitors 20 and 21.

Switch 24 constitutes an on/off switch for the arrangement and is closed when the arrangement is "on". When switch 24 is open transistor 15 has no source of forward bias and hence is cut-off. Capacitor 13 cannot discharge/charge under these circumstances and thus transistor 11 is also cut-off. Transistor 22 can also draw no current because its emitter circuit is broken. There is therefore no current drain from the input terminals 1 and 2.

When switch 24 is closed transistor 15 is forward-biassed through resistor 23 so that capacitor 13 starts to charge towards the potential of terminal 1. When it has charged sufficiently to forward-bias transistor 11, transistor 11 turns on and the aforesaid cumulative action occurs, producing a positive potential on output terminal 3. This action is repeated until the potential on terminal 3 rises sufficiently far that the Zener voltage of the combination of diodes 27 and 28 is exceeded. When this occurs transistor 22, which has been previously forward-biassed through diode 26, becomes even more forward-biassed, pulling the potential on the base of transistor 15 towards the potential on terminal 1 and hence tending to turn off transistor 15. If no current is being drawn from output terminals 3 and 4 transistor 15 turns off substantially completely, carrying just sufficient current to allow the oscillator circuit to unblock now and again to maintain the potential across output terminals 3 and 4 (which terminals are supplying the current through the zener diodes 27 and 28). If current should be drawn from terminals 3 and 4, tending to cause the potential across these terminals to fall more rapidly, the average current through transistor 15 increases, reducing the durations of the blocked periods of the oscillator and thereby stabilising the voltage across the output terminals.

In a particular construction for the arrangement shown the various components etc. had the following values or type numbers.

Transistor 11	BC337
Transistor 15	BC558
Transistor 22	BC548
Zener diodes 27,28	BZT03-C270
Diodes 12,26	BAW62
Diodes 18,19	BYD33J
Capacitors 20,21	100nF, 400v
Capacitor 13	470nF, 100v
Capacitor 17	2.2nF, 400v
Resistor 16	10K ohms
Resistor 14	2.2K ohms
Resistor 23	220K ohms
Resistor 25	10M ohms
Winding 8	14 turns
Winding 9	1000 turns
Winding 10	14 turns.

Windings 8,9 and 10 were wound on a gap-less transformer core type UU10. A smoothing capacitor (not shown) of 220 microFarads was provided across the terminals 1 and 2. The arrangement was capable of supplying approximately 550 volts across terminals 3 and 4, stabilised at currents from zero to 200 microamps. The input voltage across terminals 1 and 2 was 9 volts. The consumption of the arrangement (which was intended to supply a Geiger Müller tube) was in the range 100-250 microamps with no load.

It will be apparent to those skilled in the art that many modifications are possible to the arrangement shown without departing from the scope of the invention as defined by the claims.

CLAIMS

1. A d.c.-d.c. converter circuit arrangement comprising a blocking oscillator circuit an output signal of which controls, in operation, a switching element connected in series with an inductance across a pair of d.c. input terminals, which inductance is coupled to a d.c. output terminal via a rectifier circuit, said oscillator circuit being provided with frequency control means for controlling the decay rate, during each blocking period, of the blocking voltage set up across the oscillator blocking capacitance when the oscillator circuit is unblocked, and hence the duration of each blocking period, in dependence upon the value of a control signal supplied in operation to a control input of said control means, characterised in that said output signal is arranged to control said switching element to be closed while the oscillator circuit is unblocked and to be open while the oscillator circuit is blocked, and in that a feedback circuit is provided from an output of said rectifier circuit to said control input for supplying a control signal which depends on the value of the output voltage of the rectifier circuit to said control input to thereby stabilise the value of said output voltage.

2. An arrangement as claimed in Claim 1, wherein the switching element is included in the positive feedback loop of the oscillator circuit.

3. An arrangement as claimed in Claim 2, wherein the positive feedback loop contains a single amplifier stage an active element of which is constituted by said switching element.

4. An arrangement as claimed in Claim 2 or Claim 3, wherein said inductance is constituted by a winding of a transformer which is included in said positive feedback loop.

5. An arrangement as claimed in any preceding claim, wherein said inductance is constituted by a primary winding of a transformer a secondary winding of which is connected to said d.c. output terminal via said rectifier circuit.

6. A d.c.-d.c. converter circuit arrangement substantially as described herein with reference to the drawing.

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