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Leszke

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[54] **CONSTANT CURRENT SOURCE FOR THE OPERATION OF MULTIPLE COIL SYSTEMS**

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[73] Assignee: **Dr.-Ing. Rudolf Hell GmbH**

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[30] **Foreign Application Priority Data**

Feb. 5, 1972 Germany .... P 22 05 468.8

[52] **U.S. Cl.** .... **323/4,** 323/6, 323/9, 310/13 C, 310/31 TV

[51] **Int. Cl.** **G05f 1/56,** G05f 1/62

[58] **Field of Search** .... 315/13 C, 27 TD, 315/31 R, 31 TV; 321/20; 323/4, 6, 9, 38, 39, 45, 82

[56] **References Cited**

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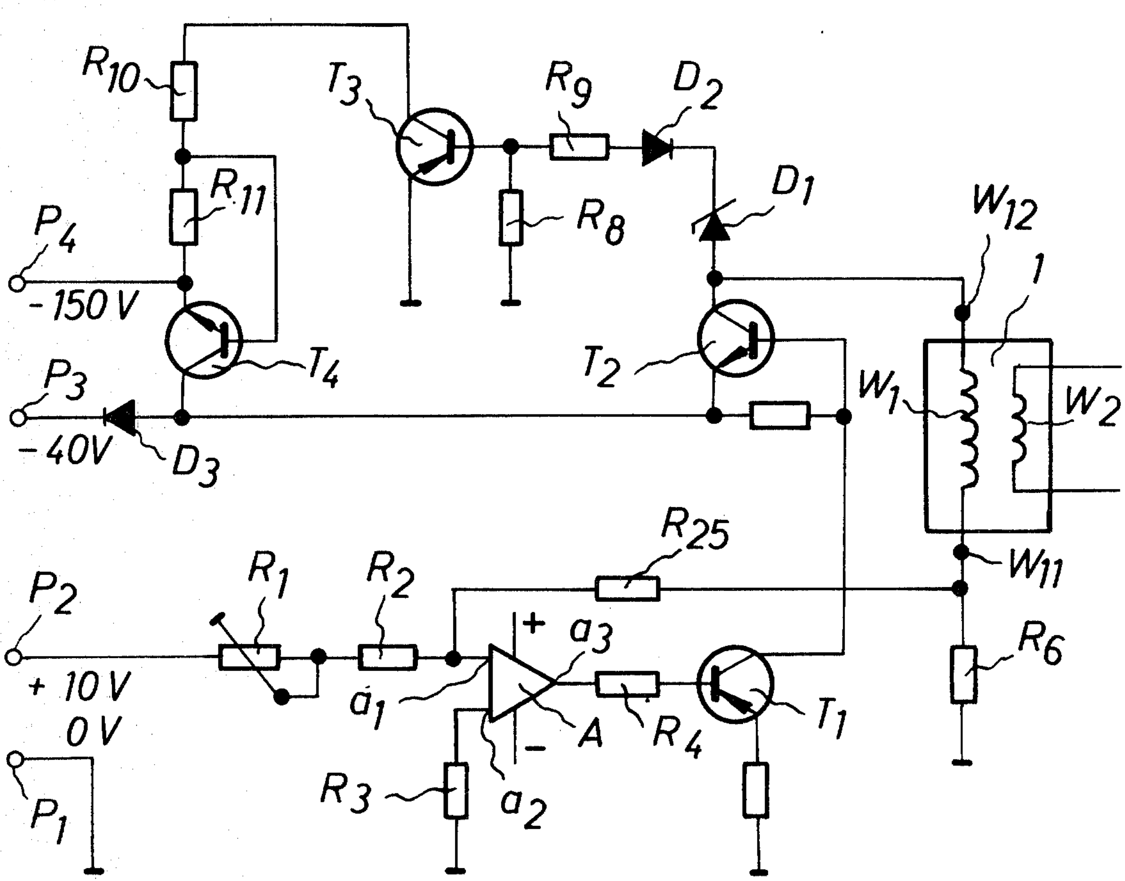
Attorney—Carlton Hill et al.

[57] **ABSTRACT**

A constant current source for the operation of multiple coil systems, utilizing a static winding and one or more dynamic windings effective at a common air gap, including a constant operational voltage source, a corrective element between the operation voltage source and static winding, and a current control system operative to control the correcting element, in which a corresponding higher operational voltage is applied to the static winding in the presence of subtractive voltages induced in the static winding as a result of the dynamic winding, with the corresponding higher operational voltage being derived from an independent voltage source or from the charge on one or more capacitors, arranged for charging to the lower operational voltage and adapted to be connected in series to provide a multiple of such voltage.

11 Claims, 3 Drawing Figures



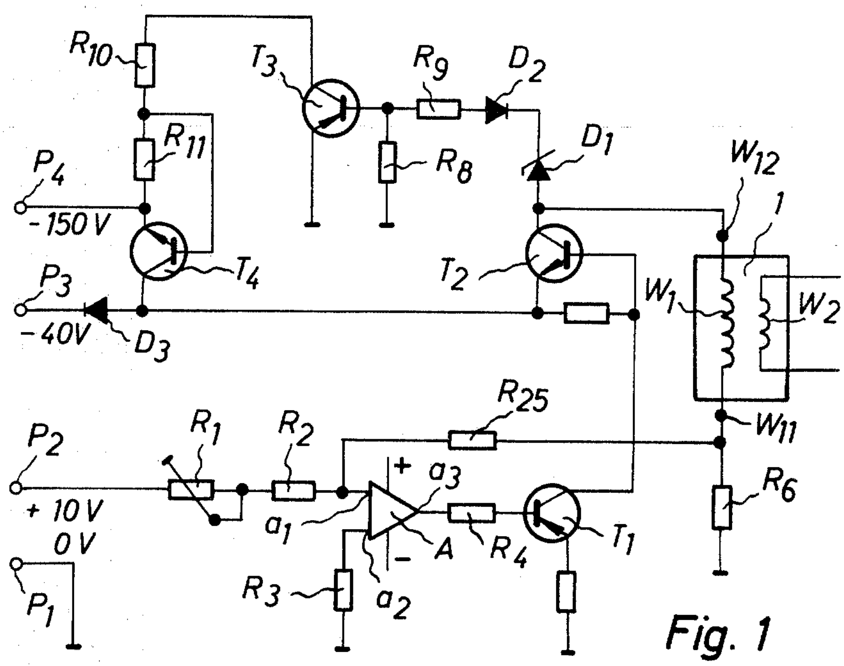

R10
T3
R9
D2
R11
R8
D1
P4
W12
-150 V
1
T4
T2
P3
W1
W2
-40V
D3
R25
W11
P2
R1
R2
a3
R6
+ 10 V
0 V
a1
A
R4
T1
R3
a2
P1

Fig. 1

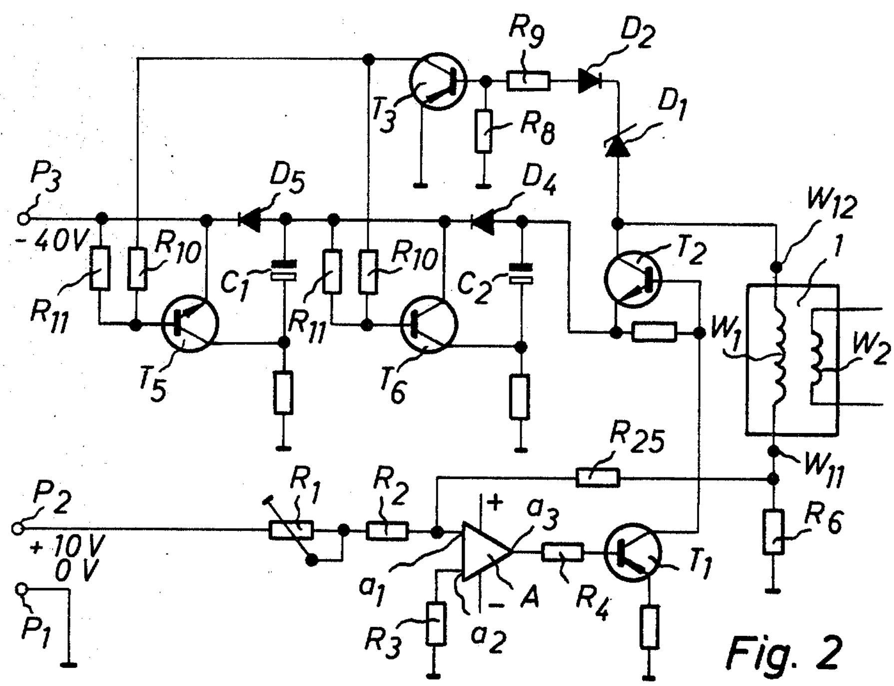

R9
D2
D1
T3
R8
P3
D5
D4
W12
-40V
R10
R10
T2
1
C1
C2
R11
R11
W1
W2
T5
T6
R25
W11
R1
R2
P2
a3
R6
+ 10 V
0 V
a1
A
R4
T1
P1
R3
a2

Fig. 2

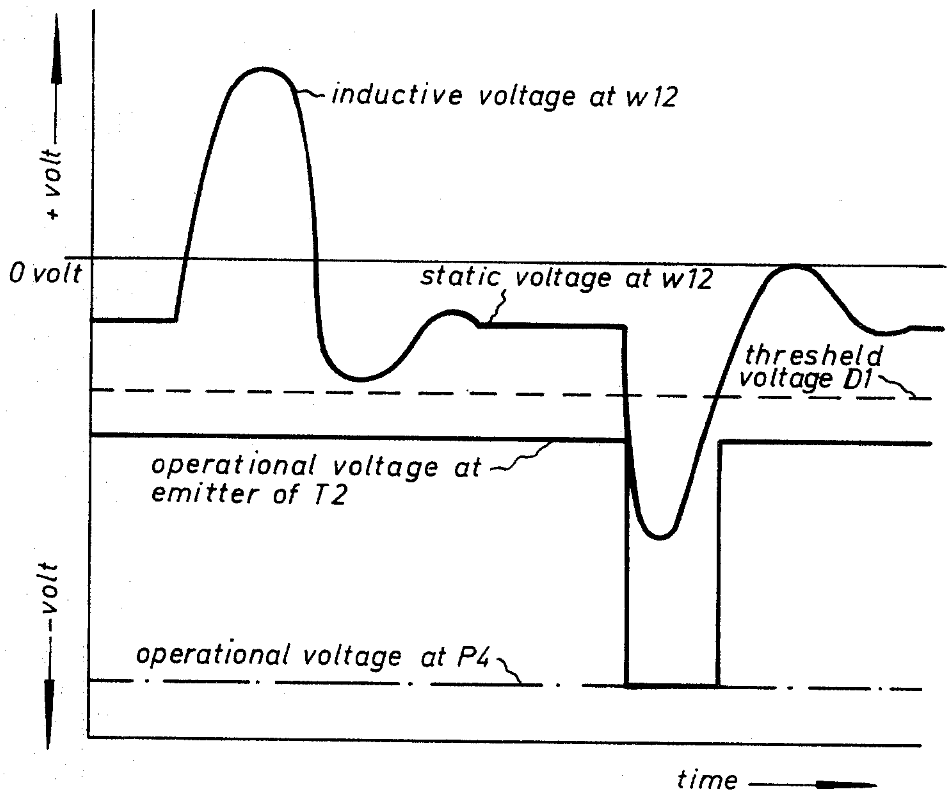

+ volt
0 volt
inductive voltage at w12
static voltage at w12
thresheld voltage D1
operational voltage at emitter of T2
- volt
operational voltage at P4
time

Fig. 3

CONSTANT CURRENT SOURCE FOR THE OPERATION OF MULTIPLE COIL SYSTEMS

BACKGROUND OF THE INVENTION

The invention is directed to a constant current source for the operation of multiple coil systems employing a static and one or more dynamic windings which are effective at a common air gap, in which the constant current source includes a constant operational voltage source, a correcting element operatively disposed between the operational voltage source and the static winding, and with a current control system for effecting control of the correcting element.

Usually a static focusing winding and a dynamic winding are utilized for the focusing of the electron beam of a cathode-ray tube, to vary the field in the peripheral areas relatively remote from the center of the tube face. As a result of the utilization of a common air gap for both windings, voltages are unavoidably induced in the static winding in the present of current changes in the dynamic winding.

As the number of turns in the static winding is usually much greater than that of the dynamic winding, the voltages induced in the static winding may be greater than the operational voltage applied to the control circuit.

In order to maintain the current in the static winding constant irrespective of the above conditions it has heretofore been the practice to select an operational voltage of such magnitude that it is greater than any opposing induced voltage peaks which may occur. While it is possible to operate with such high operational voltage, this solution has the disadvantage that a loss of power will result at the correcting element operatively connected between the operational voltage source and the static winding, which loss is proportional to the difference between the operational voltage and the voltage at the two winding terminals of the static winding. Consequently, the power converted into undesired heat will materially increase with an increase in the operational voltage, with the ratio becoming even more unfavorable in the situation where the high induced voltage occurs relatively infrequently.

It is therefore the problem of the present invention to provide an improved system of the type referred to, in which an increased operational voltage is applied only when required for the balance of induced voltage peaks, with a lower operational voltage being applied in the absence of such peaks.

BRIEF SUMMARY OF THE INVENTION

The problem is solved in the present invention by the utilization of a threshold-value sensing system which is connected to the static winding and to a threshold-value switch whereby the latter will operatively connect the static winding, over the correcting element, with a higher operational voltage in the presence of subtractive voltages induced in the static winding resulting from the presence of the dynamic winding.

It is possible to employ as the higher operational voltage a separate, independent higher operational voltage supply, or one or more capacitors which are charged by the normal low operational voltage and whose charge voltage can be operatively connected in series with the operational voltage over a cooperable switch when the threshold-value switch is actuated by the presence of an induced voltage peak.

In the event a simple capacitor circuit is insufficient to provide a suitable high voltage, one or more additional capacitors circuits of the same type may be provided, preferably each utilizing a transistor as the switching means for such capacitor.

In a preferred form of the invention, a transistor may be employed as the threshold-value switch and a Zener diode as the sensing means for actuating such transistor.

The invention proceeds from the recognition that current changes in a winding of a multiple-coil system do not immediately cause a corresponding voltage at the terminals of a second magnetically coupled winding, but, due to the inductivity and capacitance of the winding, results following a delay, whereby the second winding behaves as a parallel oscillator circuit which may even overshoot in the opposite direction, assuming a small loss resistance. The relatively slow increase of the induced coil voltage permits the switching over from the normal lower operational voltage to a higher operational voltage for a required short period of time when a predetermined threshold-value is reached at the static winding. Following the expiration of the induced voltage half-wave, the threshhold-value switch will immediately deactivate to return the application of the normal low operational voltage to the static winding. This operation can be repeated as often as desired and presents the advantage that the increased operational voltage is applied when only actually required, whereby the loss at the correcting element of the current control system is increased only very slightly above the value existing under purely static operations.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings wherein like characters indicate like or corresponding elements;

FIG. 1 is a schematic circuit diagram of a system according to the invention employing a separate independent higher voltage source;

FIG. 2 is a schematic circuit diagram, similar to FIG. 1 illustrating a further embodiment of the invention in which two capacitors and respective controlling transistors are utilized as a higher voltage source; and

FIG. 3 is a graphic representation of various voltages involved in the operation of the system.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the arrangement of FIG. 1 illustrating an example of a system, embodying the invention, for the current supply of a combined static-dynamic focussing system, indicated generally by the numeral 1, which comprises a static winding w_1 containing a relatively large number of turns, and a dynamic winding w_2 containing a substantially smaller number of turns, with the respective windings being disposed at a common air gap, not illustrated.

A current control system is provided which insures that a constant current will steadily flow through the static winding w_1, such control system being supplied with a constant voltage over terminals P_1 and P_2, and in the example, a negative operational voltage of $-40V$ being supplied at the terminal P_3. The current of the static winding w_1 flows across the resistance R_6, over winding w_1, transistor T_2 and across the decoupling diode D_3 to the low operational voltage at terminal P_3. A current change occuring at the resistor R_6 thus causes a corresponding current change at the resistor

R_{25}. If a difference arises between the current through the resistor 25 and the current, which flows from P_2 through the resistors R_1 and R_2, a voltage change will result at the summation point a, of the amplifier A, i.e. a negative potential will be produced at the inverting input of the amplifier A.

The latter will be amplified, appearing at the outlet a_3 of the control amplifier A with positively increasing potential and will be applied to the base of the transistor T_1 over the resistor R_4. The collector current of the transistor T_1 thus will be lowered. As the transistor T_1 determines the operation of the transistor T_2, the collector current of the latter will likewise be lowered and thereby the current for the static winding w_1 will likewise be lowered. Such control loop is so designed that an equilibrium of currents will occur under normal static operation, whereby the winding current is proportional to the current through resistors R_1 and R_2. In the presence of induction voltages, induced in the static winding w_1 by the dynamic winding w_2, the voltage of the static winding w_1 will be influenced either additively or subtractively, whereby the winding terminal w_{12} becomes either more positive or more negative with respect to its normal static level. If a positive induced voltage occurs at the winding terminal w_{12} this will result in an addition to the lower operational voltage source and will be controlled without difficulty by the control amplifier A (see the positive induced amplitude at the left side of FIG. 3), by effecting an increase in the collector-emitter resistance of the transistor T_2 functioning as a correcting element. The path over a Zener diode D_1 and a diode D_2, connected in series therewith and which is oppositely poled, is blocked due to the polarity of diode D_2.

If however, a negative induced voltage occurs at the winding w_1 (as illustrated at the right side of FIG. 3) this will cause a subtraction from the lower operational voltage, possibly causing a reduction in the coil current, and in extreme cases even a reverse of the current direction. To prevent this possibility, means are provided for switching over from the lower operational voltage supply (−40V) to a higher operational voltage supply (−150V). Such switching over is initiated when the Zener voltage of the diode D_1 is reached, such voltage being conducted over diode D_2 and series resistors R_9 to the base of a transistor T_3 functioning as a threshold-value switch. The transistor T_3, following triggering thereof, will so control a transistor T_4, connected over resistor R_{10} with the collector of the transistor T_3, that the transistor T_4 will be conductive. In addition to the above components, base resistor R_8 for the transistor T_3 and base resitor R_{11} for the transistor T_4 are provided.

As the emitter of transistor T_4 is connected with terminal P_4 supplying the higher operational voltage of −150V, conduction of transistor T_4 will result in the application of this higher operational voltage to the transistor T_2 which functions as the correcting element when the transistor T_4 is rendered conductive. A misapplication of such higher operational voltage with respect to the normal operation voltage supplied to the terminal P_3 of −40V, is prevented by the suitably poled diode D_3 in the supply line.

As soon as the negative induced amplitude decays to a point below the threshold-value of the Zener diode D_1, the two transistors T_3 and T_4 will be blocked and the lower operational voltage of −40V will be supplied to the emitter of transistor T_2.

FIG. 2 illustrates a further embodiment of the invention which in many respect corresponds directly with the circuit of FIG. 1, and accordingly component elements of FIG. 2 are provided with the same reference numerals as corresponding elements illustrated in FIG. 1.

If a positive inductive voltage appears at the winding terminal w_{12} the control process will be the same as previously described with respect to the system of FIG. 1.

However, in this arrangement, the low voltage source is operatively connected to the emitter of the transistor T_2 over respective diodes D_4 and D_5. The diode D_5 is operatively shunted by a capacitor C_1 and the emitter-collector path of a transistor T_5, the collector of which, and thus one side of the capacitor C_1, being connected to common by a resistor. The base of the transistor T_5 is operatively connected over a resistor R_{10} to the collector of the transistor T_3. In like manner the diode D_4 is operatively shunted by the capacitor C_2 and emitter-collector path of the transistor T_6, R_{11} comprising the base resistor and resistor R_{10} connecting the base thereof to the collector of the transistor T_3. Thus, assuming that the transistors T_5 and T_6 are blocked, the capacitors C_1 and C_2 will be charged to the potential of the low operating voltage appearing at terminal P_3.

If a negative induced voltage now appears at the winding terminal W_{12}, the transistor T_3 will be rendered conductive in the manner previously described, and as the bases of the two transistors T_5 and T_6 are connected with the collector of the transistor T_3, such transistors likewise will conduct. As the respective capacitors C_1 and C_2 cannot discharge through the associated, oppositely poled diodes D_5 and D_4, the charges on the respective capacitors will be applied in series with the low operational voltage −40V on the emitter of the transistor T_2, and as soon as the negative induced amplitude has decayed below the threshold-value of Zener diode D_1, the transistors T_3, T_5 and T_6 will again be blocked, permitting the capacitors C_1 and C_2 to recharge.

It will be appreciated that, the in dependence upon the operating parameters involved, merely a single capacitor may be employed, or if desirable additional capacitors over the two illustrated, may be provided circuited in similar manner.

Having thus described my invention it is obvious that although minor modifications might be suggested by those versed in the art, it should be understood that I wish to embody within the scope of the patent warranted hereon all such modifications as reasonably and properly come within the scope of my contribution to the art.

I claim as my invention:

1. A constant current source for the operation of multiple coil systems employing a static winding and at least one dynamic windings, effective at a common air gap, having a constant operational voltage source, a correcting element operatively disposed between the operational voltage source and the static winding, and a current system operative to control the correcting element, comprising a threshold-value switch, threshold-value sensing means operatively connected to the static winding and to the threshold value switch, a corresponding higher operative voltage source, said threshold-value switch being operative in the presence of subtractive voltages, induced in the static winding as a

result of the presence of the dynamic winding, to connect the static winding with said higher corresponding operational voltage source over said correcting element.

2. A system according to claim **1,** wherein the higher operational voltage source is a separate independent operational voltage source.

3. A system according to claim **1,** wherein the higher operational voltage source comprises at least one capacitor circuited to be charged by the lower operational voltage, and associated switch means operatively connected to said threshold-value switch, operative, when the latter is actuated, to switch the charge voltage of said capacitor in series with the lower operational voltage source.

4. A system according to claim **3,** wherein a plurality of charged capacitors and associated switch means are provided and arranged for connection in series with said lower operational voltage, when said threshold value switch is actuated.

5. A system according to claim **3,** wherein said associated switch means comprises a transistor.

6. A system according to claim **4,** wherein said associated switch means for the respective capacitors each comprises a transistor.

7. A system according to claim **6,** wherein each of said capacitors is circuited to receive said lower operational voltage over an appropriately poled diode, the transistor comprising the switch means associated with each capacitor being operatively connected in series with such capacitor, and such capacitor and cooperable transistor shunting the associated diode, said diodes being operative, when the associated transistors are blocked, to supply the lower operational voltage to said correcting element and to the respective associated capacitors to charge the same, and, when the associated transistors are conductive, to prevent discharge of the associated capacitor other than in series with said operational voltage and said correcting element.

8. A system according to claim **7,** wherein said correcting element comprises a transistor operatively connecting said winding, over said diodes, to said lower operational voltage, said threshold-value switch comprising a transistor operatively controlled by said threshold-value sensing means, the latter comprising a Zener diode operatively connecting said winding to said threshold-value transistor.

9. A system according to claim **1,** wherein the threshold values switch comprises a transistor, and the threshold-value sensing means comprises a Zener diode.

10. A system according to claim **2,** wherein said independent higher operational voltage source is operatively connected to and controlled by said threshold-value switch, and a diode operatively connecting said correcting element to the lower operation voltage source for blocking application of said corresponding higher voltage thereto.

11. A system according to claim **10,** wherein said correcting element comprises a transistor operatively connecting said diode and said first mentioned transistor to said winding, said threshold-value switch comprising a transistor operatively controlled by said threshold-value sensing means, said threshold-value sensing means comprising a Zener diode operatively connecting said winding to said threshold value transistor.

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