

[54] **PULSE TRANSFORMER FOR CONTROLLED RECTIFIER**

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[51] Int. Cl. **H02m 1/18**

[58] Field of Search..... **336/69, 70, 84; 321/11, 27; 307/252 Q**

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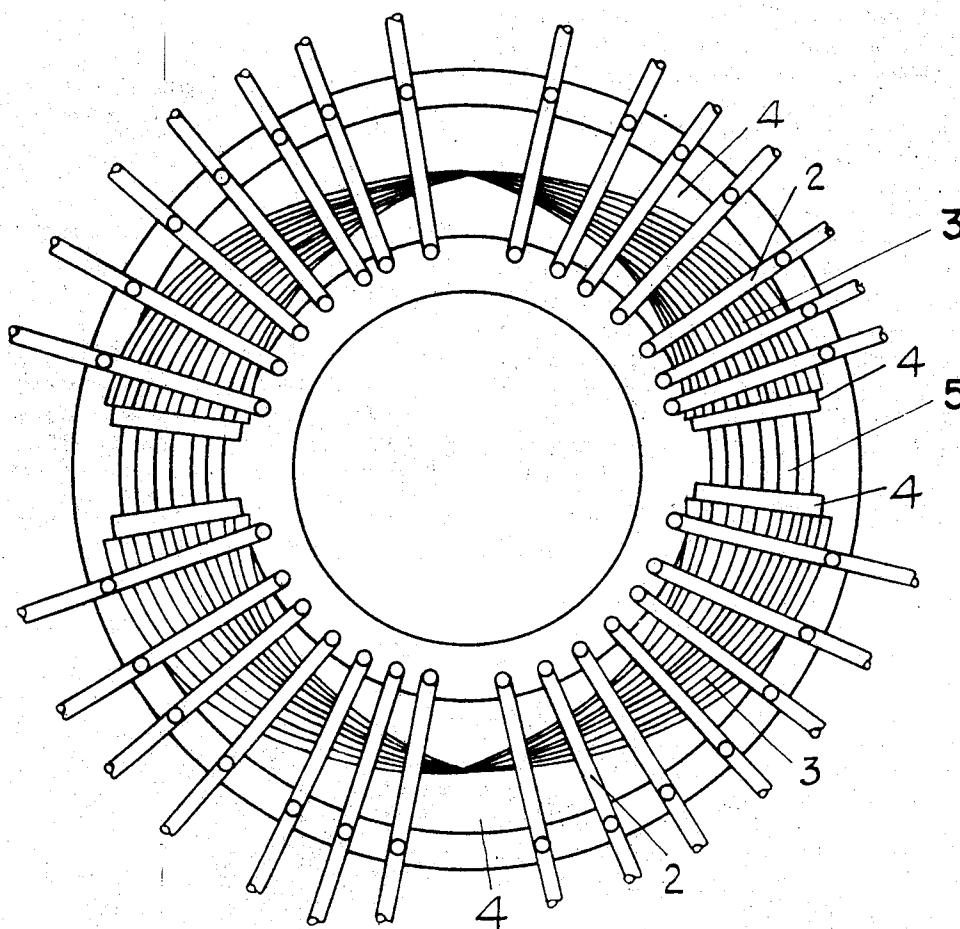
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[57] **ABSTRACT**

A transformer structure for producing pulses for igniting a chain of controlled rectifier units such as thyristors includes a primary winding consisting of one or more turns on which a number of toroidally configured iron cores are threaded. Each core is provided with at least two groups of secondary windings in which voltages are induced as a result of the alternating current which passes through the primary winding, and these voltages are applied to the control electrodes of the thyristors for igniting them. A system of screens is used to screen the secondary windings from the core. A screen first located adjacent the secondary windings has a width which is variable over the circumference of the core and does not completely screen the secondary windings from the core whereas a second screen located adjacent the core, i.e., between the core and the first screen completely surrounds the core and is of constant width. The first screen is electrically connected to one end of one group of secondary windings remote from the junction of two adjacent groups of secondary windings, and to which junction the second screen is connected.

9 Claims, 9 Drawing Figures



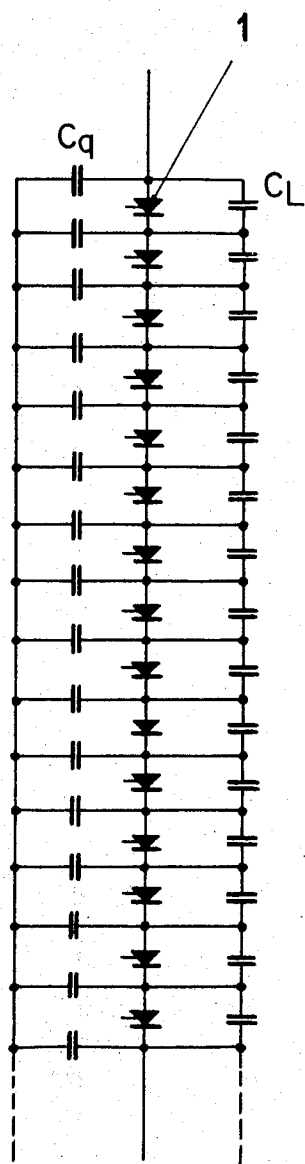


Fig. 1

Fig. 2A

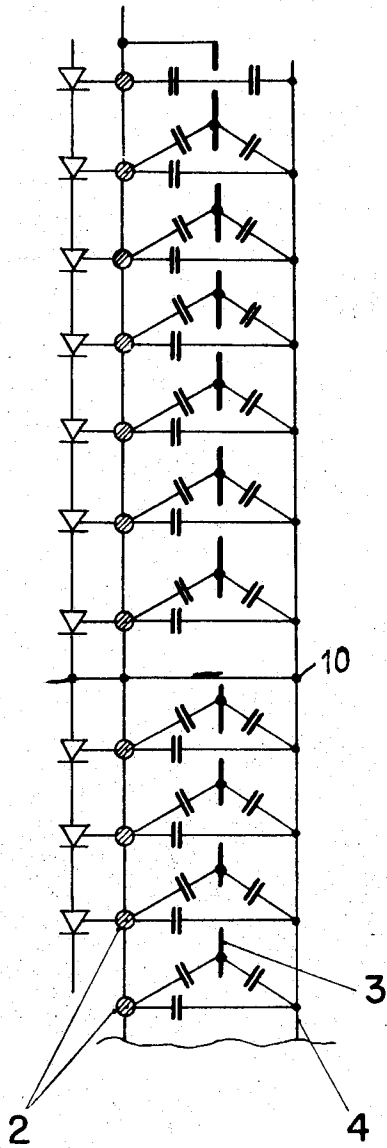


Fig. 2B

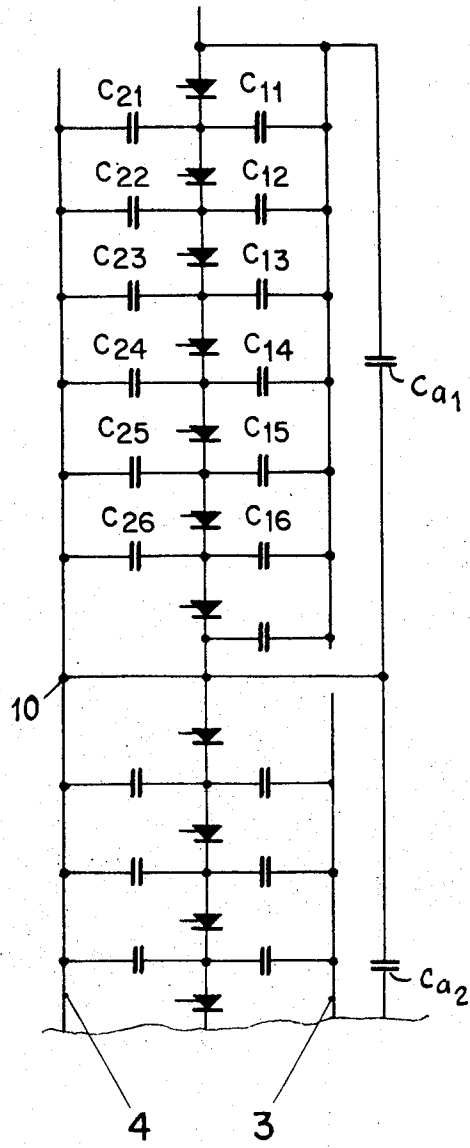


Fig. 3

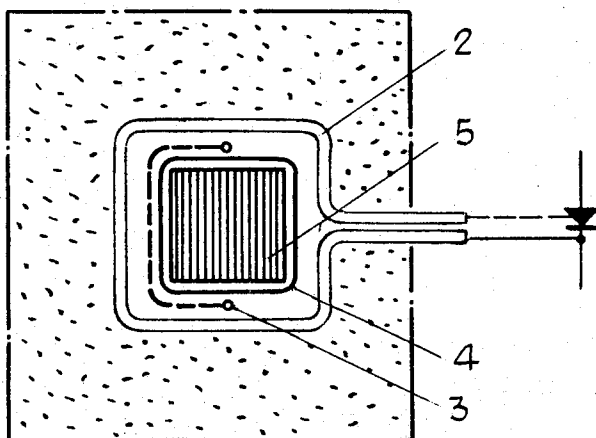
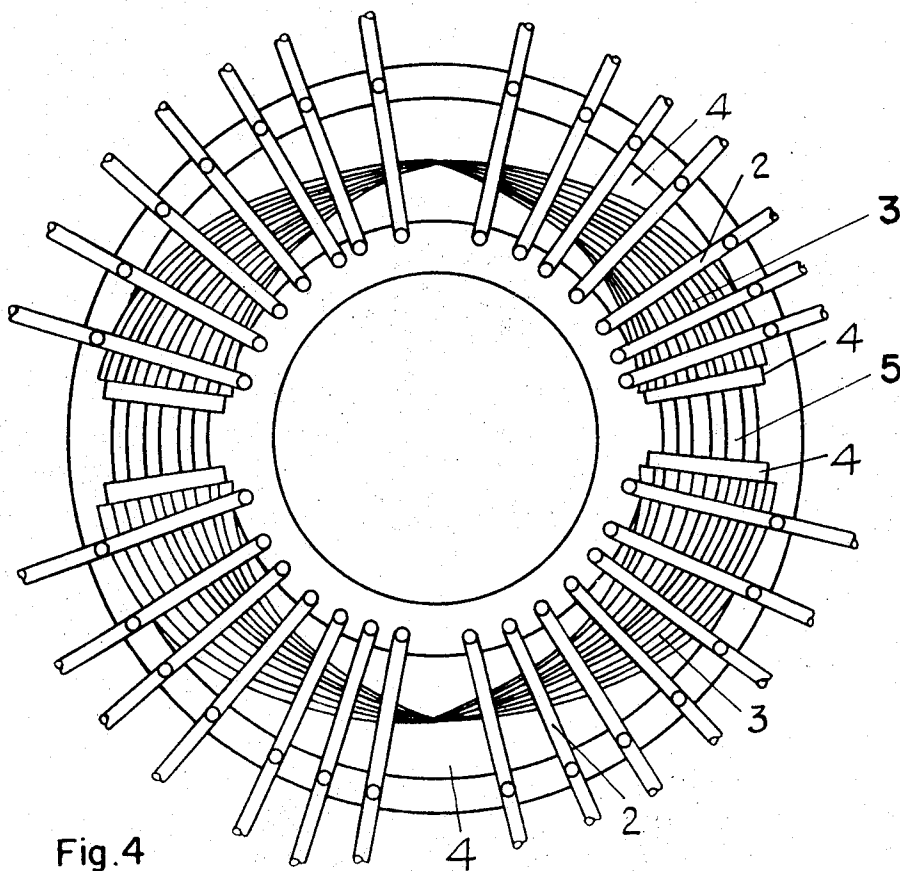
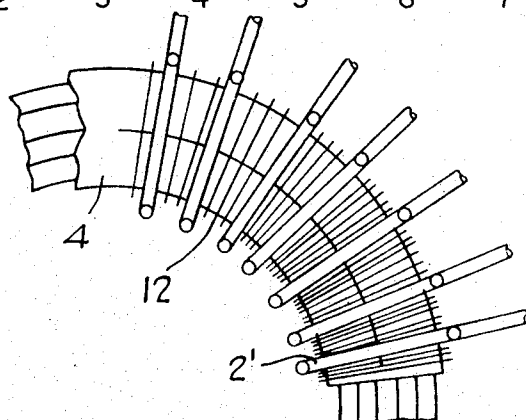
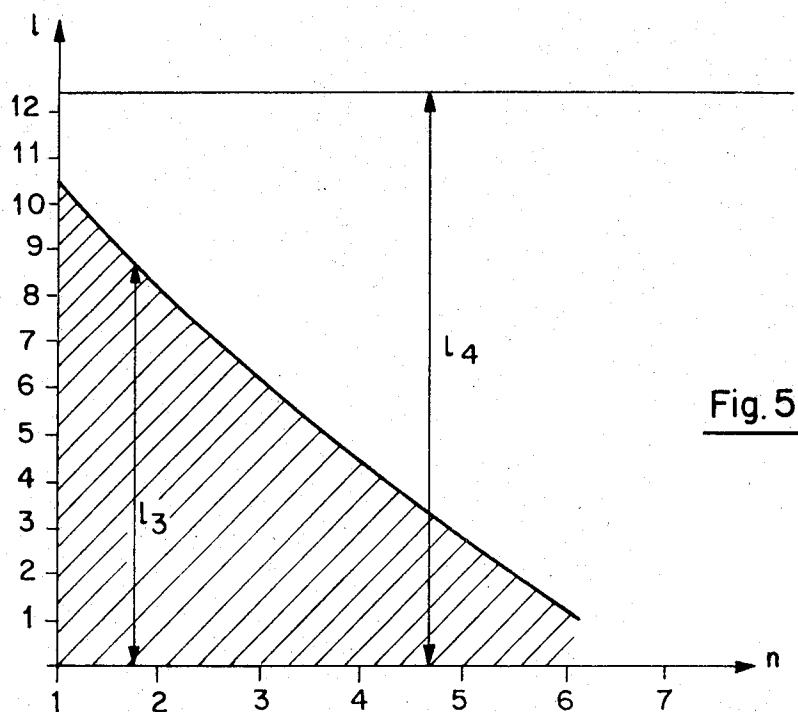


Fig. 4





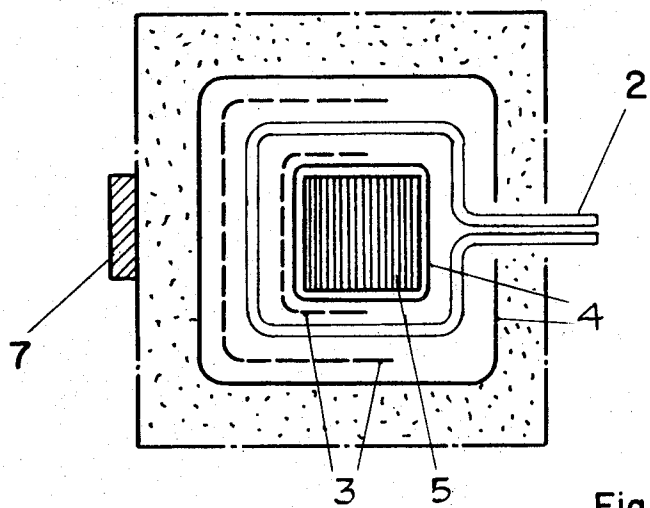


Fig. 7

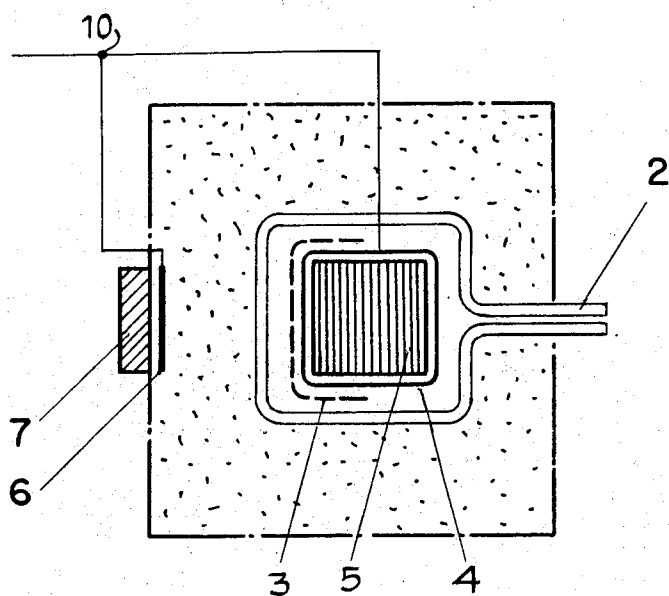


Fig. 8

PULSE TRANSFORMER FOR CONTROLLED RECTIFIER

The invention relates to a pulse transformer for a controlled rectifier containing, for example, a chain of thyristors, the transformer having a toroid core and at least two groups of secondary windings which function as control windings on the core.

It has been proposed to arrange screens in the windings on the toroid cores of a control pulse transformer. However, this does not eliminate the stray capacitance between the control windings and cores, this stray capacitance adversely affecting the voltage distribution along a thyristor chain.

In accordance with the present invention a pulse transformer for a controlled rectifier has a toroid core on which are wound at least two groups of secondary windings which function as control windings, the secondary windings being screened from the core by at least two screens, the first of which is connected to one end of one winding group remote from the junction of two adjacent groups of secondary windings while the second screen has a terminal connected to the junction; the ratio of capacitance C_{1n} between the first screen and each winding $n = 1, 2, 3, \dots, m$ of one group of secondary windings to the capacitance C_{2n} between the second screen and the same winding n satisfying the condition: $C_{1n} = C_{2n} \cdot m - n/n$, where n is to be counted from said one end of the group of windings in the direction towards the junction between the two groups of secondary windings.

The invention will now be described in more detail, by way of examples, with reference to the accompanying largely diagrammatic drawings, in which:

FIG. 1 is the known capacitive substitution circuit diagram of a pulse transformer connected to a thyristor chain;

FIG. 2A is an equivalent capacitive circuit diagram of a pulse transformer provided with double screening;

FIG. 2B is the substitution circuit diagram of the transformer, according to FIG. 2A, referred to the thyristor chain controlled thereby;

FIG. 3 is a section through the wound toroid core of a pulse transformer; provided with a multiple screen arrangement in accordance with the invention;

FIG. 4 is a view in plan which shows a construction of a pulse transformer having multiple screens arranged between the core and secondary coils according to a first embodiment of the invention;

FIG. 5 shows graphically the dimensions of a screening element relative to the number of turns on a wound toroid core;

FIG. 6 is a partial plan view of the transformer core illustrating a modified embodiment for the screen component 3 of the FIG. 4 embodiment;

FIG. 7 shows a section through a further embodiment of a wound toroid core of a pulse transformer provided with multiple screens according to the invention; and,

FIG. 8 shows a section through another embodiment of wound toroid core of a pulse transformer provided with multiple screens according to the invention.

A pulse transformer is used to control a chain of serially connected thyristors 1 of a controlled thyristor rectifier as shown in FIG. 1. The transformer usually comprises a primary winding turn or turns on which a number of wound toroid cores with windings are threaded. Each toroid core is provided with a number of second-

ary windings, for example 28, each of which is used to control a thyristor. Each secondary winding has a capacitance relative to the toroid core, the core being at a mean voltage value.

The corresponding capacitance substitution circuit for such a system is shown in FIG. 1. The capacitances between the windings and the toroid core can be considered as providing parallel capacitances C_q and series capacitances C_L , and these together result in an irregular voltage distribution along the thyristor chain, such irregularity being the greater, the higher the ratio of parallel capacitance C_q to the serial capacitance C_L . The irregular voltage or rate of change of voltage du/dt along the chain should remain as small as possible and should not exceed, for example, 30 percent, even if the serial capacitance C_L of the thyristors 1 is relatively small. This can be achieved by providing each toroid core with two screens.

FIGS. 2A and 2B show such an example. FIG. 2A shows two groups of seven toroid control windings 2, sectionally indicated, the screens being shown adjacently. The first screen 3, being arranged near the control windings and being of a width which is variable over the circumference of the toroid core, does not completely screen the control windings whereas the second screen 4 being arranged at such a distance from the control windings which allows intermediate arrangement of the first screen, completely surrounds the toroid core at constant width. One part of the capacitance of the control winding is transferred to the first screen and the other part to the second screen. The first screen 3 is at the potential of the remote end of one group or chain of control windings or the respective thyristor of the chain as shown in FIG. 2A. The second screen 4 is connected by a terminal to the mid-potential junction 10 of the chain as shown. The capacitive effect of the second screen on the control windings progressively increases from the two end-thyristor windings in the direction of the mid-potential terminal of the second screen.

The capacitive substitution circuit diagram of this system referred to the thyristor chain is shown in FIG. 2B. Each control winding is associated with two capacitances, one capacitance C_{1n} ($n = 1, 2, \dots, m$) relative to the first screen and the other capacitance C_{2n} relative to the second screen. The substitution circuit diagram contains two further capacitances C_{n1} and C_{n2} , representing the influence of stray capacitances which become externally effective. These capacitances may influence the values of the capacitances C_{2n} and for this reason they are appropriately included into the calculation of these capacitances. The capacitance values for the first screen are so selected that the capacitive effect on the thyristor column is cancelled by the second screen and by the external stray capacitances. No irregular voltage distribution occurs when the capacitances are completely compensated in this way.

The effect of these capacitances is compensated by satisfying the following conditions:

$$C_{1n} = C_{2n} \cdot m - n/n$$

$$n = 1, 2, 3, \dots, m$$

$$m = n_{max}$$

FIGS. 3 and 4 show the spatial arrangement. FIG. 3 shows the toroid core 5 in section. The iron core 5 is completely surrounded by the second screen 4. The first screen 3 extends only partially around the iron

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core and the second screen 4. The control windings 2 are disposed outside the two screens. FIG. 4 shows a plan view indicating the position of the screens and the windings. It can be readily seen that the width of the first screen 3 varies from winding to winding.

FIG. 5 shows the width L of the screens plotted relative to the number of windings n for an actual embodiment. The circumference is developed onto a plane. The manner in which the width L_3 of the first screen 3 varies with the number of windings while the width L_4 of the second screen 4 remains constant can also be readily seen by reference to this illustration.

FIG. 6 illustrates a modified embodiment for the variable-width screen component 3 included in the embodiment of FIG. 4. In FIG. 6, the equivalent screen is seen to be a winding 12 which is wound around the screen 4 in such manner that the number of individual turns of the winding between adjacent secondary coils 2' of the winding group progressively increases in the direction away from the connection terminal of the screen 4 to the junction between two groups of windings.

FIG. 7 shows a further example. In this case the windings 2 are screened on both sides by duplicated first screens 3. This arrangement is appropriate if the external capacitances of the control windings could give rise to a disturbing effect.

FIG. 8 shows an embodiment similar to that of FIG. 3. In FIG. 8, the first first screen 3 is provided radially inwards of the winding 2. A further screen 6, having the same potential as the second screen 4, is disposed radially outwards of the first screen 3 on the other side of the winding 2. The influence of the capacitances of the control windings relative to the further screen 6 is compensated by appropriately shaping of the first screen 3. Undesirable external capacitances are compensated where necessary by externally disposed shrouds 7.

The system described hereinabove improves the efficiency and reduces the cost of thyristor rectifier control. The du/dt stress caused by changing voltages on the thyristors is reduced by using the screens. This means that cheaper thyristors and smaller du/dt chokes for limiting the effect of the voltage changes along the rectifier chain can be used.

We claim:

1. In a pulse transformer arrangement for and controlling the operation of semiconductor switching elements such as thyristors, the combination comprising a toroidal core, secondary windings surrounding said core, said secondary windings being distributed circumferentially about said core and arranged in first and second groups, a chain of thyristors connected in series, said thyristors being likewise arranged in first and second groups corresponding in number to the secondary windings of said first and second groups and being connected respectively thereto, first and second

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screens located between said core and each group of secondary windings, said first screen being connected to the thyristor chain at the first thyristor of the first thyristor group so as to lie at the potential thereof and said second screen being connected to the thyristor chain at a point between the last thyristor of said first thyristor group and the first thyristor of said second thyristor group so as to lie at the potential thereof, said first and second screens having a construction such that the ratio of capacitance C_{1n} between said first screen and the number n of the secondary windings of each group of windings satisfies the condition:

$$C_{1n} = C_{2n} \cdot m - n/n$$

15 where: $n = 1, 2, 3, \dots, m$

$$m = n_{max}$$

and where n is counted from the first control winding in said first group of windings in the direction towards said junction between said first and second groups of windings.

2. A pulse transformer as defined in claim 1 wherein the dimensions of said second screen are constant.

3. A pulse transformer as defined in claim 1 wherein the dimensions of said first screen vary in a progressive manner around the toroidal core in accordance with the number of the control windings of each group.

4. A pulse transformer as defined in claim 1 wherein said first screen broadens in width around the toroidal core starting from the connection terminal of said second screen to said junction between said first and second groups of windings.

5. A pulse transformer as defined in claim 1 wherein said first screen is constructed as a winding on and distributed along said core and wherein the number of turns of said winding between adjacent secondary windings progressively increases in the direction away from the connection terminal of said second screen to said junction between said first and second groups of windings.

6. A pulse transformer as defined in claim 1 wherein said first screen consists of two parts one of which lies outside of said secondary windings and the other screen part being located between said secondary windings and said toroidal core.

7. A pulse transformer as defined in claim 1 wherein said first and second screens are disposed between said secondary windings and said toroidal core.

8. A pulse transformer as defined in claim 7 wherein said first screen is disposed adjacent said secondary windings and wherein said second screen is disposed adjacent said toroidal core.

9. A pulse transformer as defined in claim 7 and which further includes a third screen electrically connected to said second screen and which is located outside of said secondary windings.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,771,042 Dated November 6, 1973

Inventor(s) WERNER FAUST - CONRAD BERIGER - and HANS JÜRG BOSSI

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Claim 1, line 12 - (Column 4) - after "group"
the following should be inserted:

-- to the capacitance C_{2n} between said second
screen and the same group --

Claim 5, line 2 "s" before "winding" should be
-- a --

Signed and sealed this 12th day of March 1974.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

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