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(54) **On-load tap changing transformer.**

(57) An on-load tap changing trnsformer having a preselecting switch which connects taps No.1, No.2, No.3, ... No.N to corresponding fixed contacts No.1, No.2, No.3, ... No.N during a standard connecting operation of a movable contact and connects additional taps No.N+1, No.N+2, No.N+3, ... No.N+M to corresponding fixed contacts during an additional connecting operation of a movable contact.

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FIG. 4A

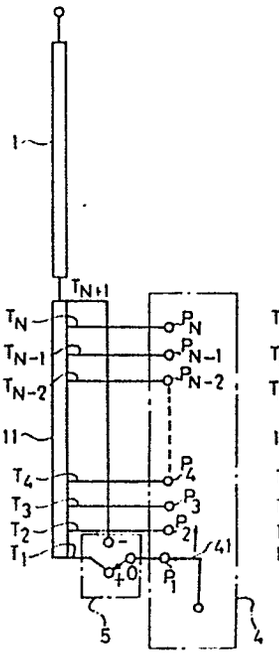

FIG. 4B

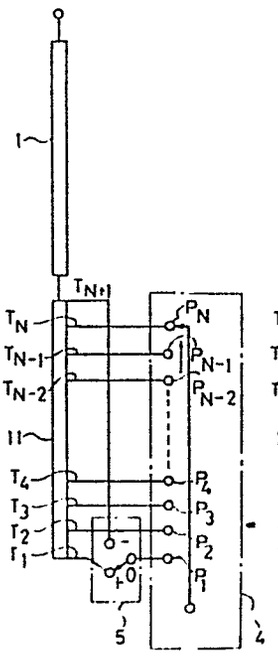

FIG. 4C

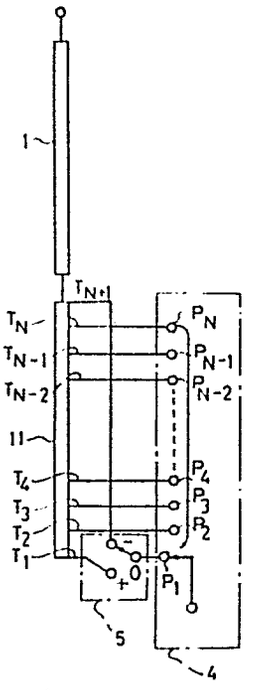

FIG. 4D

Tap position		1	2	3	--------	N-1	N	N+1
Position of fixed contact		1	2	3	--------	N-1	N	N+1
Pre-selecting switch	from 1 to N+1	+						−
	from N+1 to 1	+					−	

TITLE OF THE INVENTION

On-load tap changing transformer

FIELD OF THE INVENTION AND RELATED ART STATEMENT

1. FIELD OF THE INVENTION

This invention relates to an on-load tap changing transformer, and more particularly to an improvement in its tap changing.

2. DESCRIPTION OF THE RELATED ART

FIG.1A shows on-load tap changing transformer of the prior art. Reference numeral 1 denotes a main winding of transformer, reference numeral 2 denotes a tap winding, reference marks T_1, T_2, T_3 ,... T_N denote taps provided on the tap winding 2, and reference numeral 4 denotes a tap selector (or a selector switch) having fixed contacts P_1, P_2, P_3 ,... P_N each connected to the corresponding taps T_1 to T_N. In case that the numeral 4 is a tap selector, a diverter switch is used together, as commonly well-known. It's denotation is however intentionally omitted in the FIG. to avoid complicating explanation. Unless otherwise mentioned, the tap selector and the selector switch are hereinafter generically called "tap selector".

The tap selector 4 has fixed contacts P_1 to P_N arranged, for example, in uniform intervals on a circumference of a circle and has a movable contact 41 movable on the circumference of the circle. The tap selector 4 is an ordinary rotary type tap selector. As

shown in FIG.1B, by rotating the movable contact 41, one of the fixed contacts P_1 to P_N is selected in such an order as contacts P_1, P_2, P_3 .... P_N. By further rotating the movable contact 41, one of the fixed contacts P_1 to P_N is again selected in the order of contacts P_1 , P_2 , P_3 ... P_N. By a reverse rotation of the movable contact 41, one of the fixed contacts P_N to P_1 is selected in such order as contacts P_N, P_{N-1}, P_{N-2} .... P_1. In this conventional on-load tap changing transformer, N tap positions are produced.

FIG.2A shows other prior art on-load tap changing transformer. Reference numeral 5 denotes an ordinary pre-selecting switch. The pre-selecting switch 5 is used as polarity switch. As shown in FIG.2B, by rotating the movable contact 41, one of the fixed contacts P_1 to P_N is selected in such order as contacts P_1, P_2, P_3 .... P_N. By further rotating the movable contact 41, the pre-selecting switch 5 is changed to a tap designated by (-) in FIG.2A. By further rotating the movable contact 41, one of the fixed contacts P_1 to P_N is again selected in the order of contacts P_1, P_2, P_3.... P_N. By a reverse rotation of the movable contact 41, one of the fixed contacts P_N to P_1 is selected in such order as contacts P_N, P_{N-1}, P_{N-2} .... P_1. In this conventional on-load tap changing transformer, 2N-1 tap positions are produced.

FIG.3A shows still other prior art on-load tap

changing transformer. Reference numeral 3 denotes a coarse tap winding. The pre-selecting switch 5 is used as coars step switch. As shown in FIG.3B, by rotating the movable contact 41, one of the fixed contacts P_1 to P_N is selected in such order as contacts P_1, P_2, P_3 .... P_N. By further rotating the movable contact 41, the pre-selecting switch 5 is changed to a tap designated by (-). By further rotating the movable contact 41, one of the fixed contacts P_1 to P_N is again selected in the order of contacts P_1, P_2, P_3 .... P_N. By a reverse rotation of the movable contact 41, one of the fixed contacts P_N to P_1 is selected in such order as contacts P_N, P_{N-1}, P_{N-2} .... P_1. In this prior art on-load tap changing transformer, 2N-1 tap positions are produced.

In the prior art on-load tap changing transformers, only N of tap positions can be provided in case no polarity switch nor coarse step switch (hereinafter called linear changing) is used. And, when more tap positions are necessary, the polarity switch or the coarse step switch must be provided. But, the polarity switch or the coarse step switch cannot be used by limitation due to impedance of transformer. Therefore, in such case, even when only 1 tap position is desired to be provided as additional one, a newly designed on-load tap changing transformer having N+1 contacts must be made and used.

OBJECT AND SUMMARY OF THE INVENTION

It is an object of the invention to provide an improved on-load tap changing transformer having N+M taps using N of contacts without using the polarity switch or the coarse step switch.

An on-load tap changing transformer comprises:

N fixed contacts No. 1, No. 2, No. 3 ... No. N provided,

a movable contact which contacts the fixed contacts,

a tap winding having N taps No. 1, No. 2, No. 3 ... No. N connected to corresponding fixed contacts and M additional taps,

wherein the improvement is that

a pre-selecting switch which connects the taps No. 1 to No. N to corresponding fixed contacts No. 1 to No. N during a standard connecting operation of the movable contact and connects the additional taps No. N+1, No. N+2, No. N+3, ... No. N+M to corresponding fixed contacts during an additional connecting operation of the movable contact is provided.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG.1A shows a connection of a prior art on-load tap changing transformer.

FIG.1B is a diagram for showing connecting condition of the on-load tap changing transformer of

FIG.1A.

FIG.2A shows a connection of another prior art on-load tap changing transformer.

FIG.2B is a diagram for showing connecting condition of the on-load tap changing transformer of FIG.2A.

FIG.3A shows a connection of still other prior art on-load tap changing transformer.

FIG.3B is a diagram for showing connecting condition of the on-load tap changing transformer of FIG.3A.

FIG.4A shows a preferred embodiment of an on-load tap changing transformer embodying the present invention in selecting a tap position No. 1.

FIG.4B shows the preferred embodiment of the on-load tap changing transformer embodying the present invention in selecting a tap position No. N.

FIG.4C shows the preferred embodiment of the on-load tap changing transformer embodying the present invention in selecting a tap position No. N+1.

FIG.4D is a diagram for showing connecting condition of the on-load tap changing transformer of FIG.4A, 4B and 4C.

FIG.5A shows another embodiment of the on-load tap changing transformer embodying the present invention.

FIG.5B is a diagram for showing connecting

condition of the on-load tap changing transformer of FIG.5A.

FIG.6A shows still other embodiment of the on-load tap changing transformer embodying the present invention.

FIG.6B is a diagram for showing connecting condition of the on-load tap changing transformer of FIG.6A.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The constitution of a preferred embodiment of an on-load tap changing transformer embodying a present invention is described in detail with reference to FIGs.4A, 4B and 4C. Reference numeral 1 denotes a main winding of transformer, reference numeral 11 denotes a tap winding having taps T_1, T_2, T_3 ... T_N, T_{N+1}, standard taps T_1, T_2, T_3 ... T_N and reference numeral 4 denotes a tap selector (or a selector switch) having fixed contacts P_1, P_2, P_3 ... P_N each connected to the corresponding taps T_1 to T_N, and reference numeral 5 denotes a pre-selecting switch. One of fixed contacting points of the pre-selecting switch (point designated by (-) in FIG.4A) is connected to the tap T_{N+1}, another fixed contact point of the pre-selecting switch (point designated by (+) in FIG.4A) is connected to the tap T_1, and a movable contacting point O is connected to the fixed contact P_1.

In FIG.4A, the pre-selecting switch 5 selects

the point designated by (+), and the tap selector 4 selects the fixed contact P_1. As shown in FIG.4D, by rotating the movable contact 41, one of the fixed contacts P_1 to P_N is selected in such order as contacts P_1, P_2, P_3 .... P_N (hereinafter referred to as standard connecting operation). The state of selecting the contact P_N is shown in FIG.4B.

By further rotating the movable contact 41, the pre-selecting switch 5 is selected to the point designated by (-) (hereinafter referred to as additional connecting operation). Then the fixed contact P_1 is selected, as shown in FIG.4C. Thus, the fixed contact P_1 is connected to the tap T_{N+1}.

In this embodiment, the N+1 tap positions can be selected in case that N fixed contacts are provided in a row of taps for the standard operation.

FIG.5A shows another embodiment of the on-load tap changing transformer embodying the present invention. In FIG.5A, the tap winding 12 has the taps T_1, T_2, T_3 ... T_{N+2}, standard taps T_1, T_2, T_3 ... T_N and additional taps T_{N+1} and T_{N+2}. Reference numeral 5 denotes a pre-selecting switch having a switch 5a and a switch 5b. In FIG.5A, the switches 5a and 5b select the point designated by (+), and the tap selector 4 selects the fixed contact P_1. As shown in FIG.5B, by rotating the movable contact 41, one of the fixed contacts P_1 to P_N is selected in

order as contacts P_1, P_2, P_3 .... P_N (standard connecting operation).

By further rotating the movable contact 41, both the switches 5a and 5b are selected to the point designated by (-). Then the fixed contact P_1 is selected. Thus, the fixed contact P_1 is connected to the tap T_{N+1}.

By further rotating the movable contact 41, the fixed contact P_2 is selected. Thus, the fixed contact P_2 is connected to the tap T_{N+2}.

In this embodiment, the N+2 tap positions can be selected in case that N fixed contacts are provided.

Although in the above embodiments the movable contact is successively contacted in such order as contacts P_1, P_2, P_3 .... P_N, P_1, P_2 ...., in other modified embodiments the movable contacts may be successively contacted in such order as contacts P_1, P_2, P_3 .... P_N, P_{N-1}, P_{N-2} .... , as shown in FIG.6A. In FIG.6A, one of fixed contacting points of the switch 5a (point designated by (-)) is connected to the tap T_{N+1}, and another fixed contacting point of the switch 5a (point designated by (+)) is connected to the tap T_{N-1}. One of fixed contacting points of the switch 5b (point designated by (-)) is connected to the tap T_{N+2}, and another fixed contacting point of the switch 5a (point designated by (+)) is connected to the tap T_{N-2}. As shown in FIG.6B, by rotating the movable contact 41, one of the fixed contacts

P_1 to P_N is selected in such order as contacts P_1, P_2, P_3 .... P_N (the standard connecting operation).

By further rotating the movable contact 41, both the switches 5a and 5b are selected to the point designated by (-). Then the fixed contact P_{N-1} is selected. Thus, the fixed contact P_{N-1} is connected to the tap T_{N+1}.

By further rotating the movable contact 41, the fixed contact P_{N-2} is selected. Thus, the fixed contact P_{N-2} is connected to the tap T_{N+2}.

In other modified embodiments, the tap changer having fixed contacts P_1 to P_N arranged in a line and endlessly and successively changing the fixed contacts may be used.

As has been described in detail for various embodiments, in the present invention by using only N contacts and without necessity of using the polarity switch or the coarse step switch, N+M tap positions can be obtained.

Although the invention has been described in its preferred form with a certain degree of particularity, it is understood that the present disclosure of the preferred form has been changed in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and the scope of the invention as hereinafter claimed.

Claims

1. An on-load tap changing transformer comprising: N fixed contacts No. 1, No. 2, No. 3 ...No. N (P_1-P_N), a movable contact (41) which contacts said fixed contacts (P_1-P_N), a tap winding (2) having N standard taps No. 1, No. 2, No. 3 ... No. N (T_1-T_N) connected to corresponding fixed contacts (P_1-P_N) and M additional taps (T_{N+1}-T_{N+M}) wherein the improvement is that a pre-selecting switch (5) which connects the taps No. 1 to No. N (T_1-T_N) to corresponding fixed contacts No. 1 to No. N (P_1-P_N) during a standard connecting operation of the movable contact (41) and connects the additional taps No. N+1 (T_{N+1}-T_{N+M}), No. N+2, No. N+3 ... No. N+M to corresponding fixed contacts during a additional connecting operation of the movable contact is provided.

2. An on-load tap changing transformer in accordance with claim 1, wherein said pre-selecting switch (5) has at least one switch having two fixed connecting points and a movable connecting point, one of said fixed connecting points being connected to corresponding one of standard taps No. 1, No. 2, No. 3 ... No. N-1 (T_1-T_{N-1}), another fixed connecting point being connected to corresponding one of additional taps No. N+1, No. N+2 ... No. N+M (T_{N+1}-T_{N+M}), and movable connecting point being connected to corresponding one of said fixed contacts No. 1, No. 2, No. 3 ... No. N-1 (P_1-P_N).

3. An on-load tap changing transformer in accordance with claim 2, wherein said one of said fixed connecting points is connected to corresponding one of standard taps No. 1, No. 2, No. 3 ... No. M

(P_1-P_M), said movable connecting point is connected to corresponding one of said fixed contacts No. 1, No. 2, No. 3 ... No. M (P_1-P_M), and said pre-selecting switch (5) is changed when selecting of said movable contact (41) is changed from the fixed contact No. N (P_N) to No. 1 (P_1) and when selecting of the movable contact is changed from the fixed contact No. N (P_N) to No. N-1 (P_{N-1}).

4. An on-load tap changing transformer in accordance with claim 2, wherein said one of said fixed connecting points is connected to corresponding one of standard taps No. N-1, No. N-2 ... No. N-M (T_{N-1}-T_{N-M}), said movable connecting point is connected to corresponding one of said fixed contacts No. N-1, No. N-2, No. N-3 ... No. N-M (P_{N-1}-P_{N-M}), and said pre-selecting switch (5) is changed when selecting of said movable contact (41) is changed from the fixed contact No. N (P_N) to No. N-1 (P_{N-1}) and when selecting of the movable contact (41) is changed from the fixed contact No. N-1 (P_{N-1}) to No. N (P_N).

FIG. 1A (Prior Art)

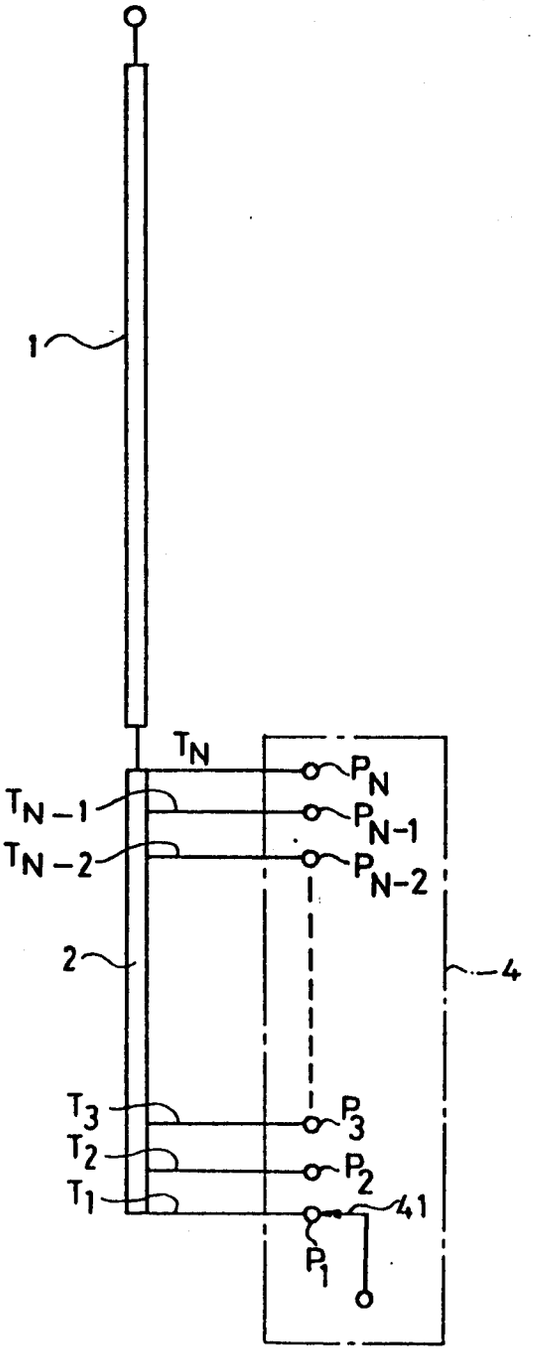

FIG. 1B (Prior Art)

Tap position	1	2	3	— — — — — — —	N-2	N-1	N
Position of fixed contact	1	2	3	— — — — — — —	N-2	N-1	N

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FIG. 2A (Prior Art)

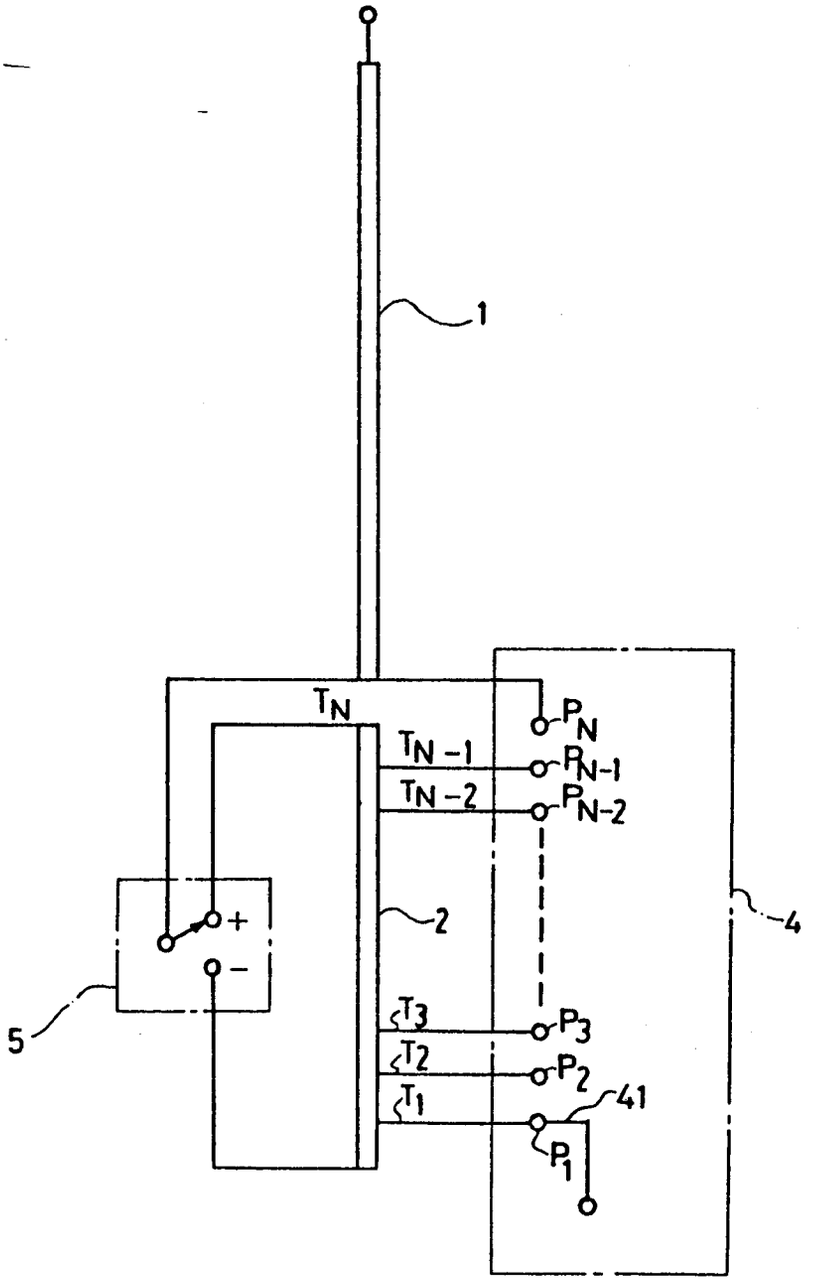

FIG. 2B (Prior Art)

Tap position		1	2	3	---	N-1	N	N+1	---	2N-3	2N-2	2N-1
Position of fixed contact		1	2	3	---	N-1	N	N+1	---	N-3	N-2	N-1
Pre-selecting switch	from 1 to 2N-1	+				+		−		−		
	from 2N-1 to 1	+				+		−		−		

FIG. 3A (Prior Art)

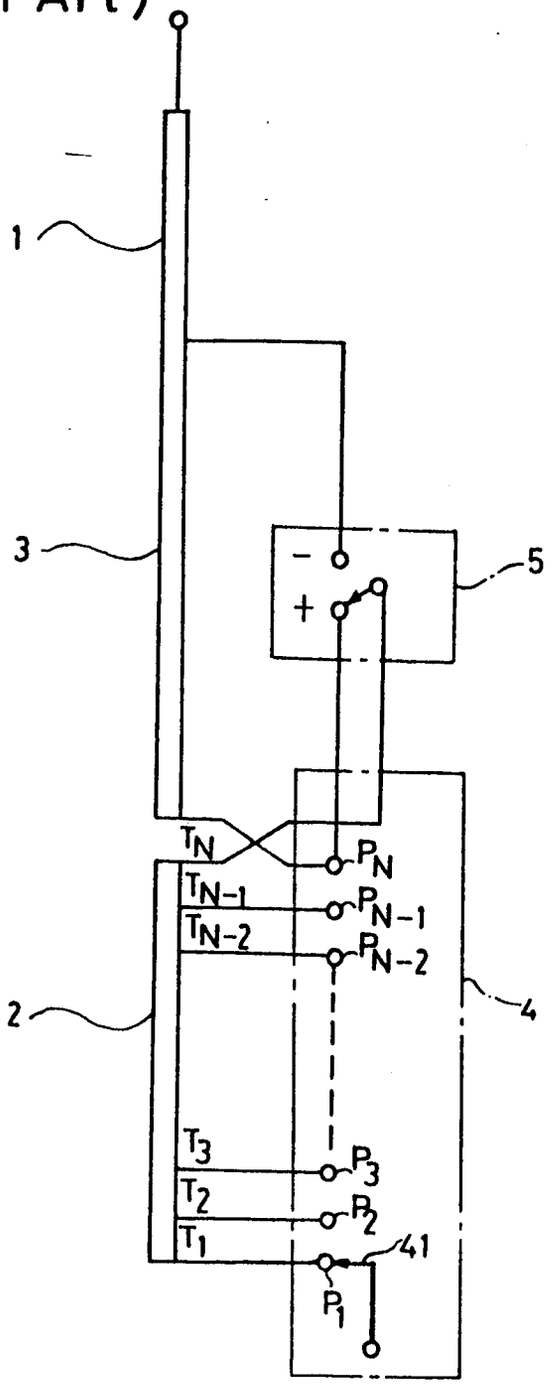

FIG. 3B (Prior Art)

Tap position		1	2	3	---	N-1	N	N+1	---	2N-3	2N-2	2N-1
Position of fixed contact		1	2	3	---	N-1	N	N+1	---	N-3	N-2	N-1
Pre-selecting switch	from 1 to 2N+1	+				+		−		−		
	from 2N+1 to 1	+				+		−		−		

FIG. 4A

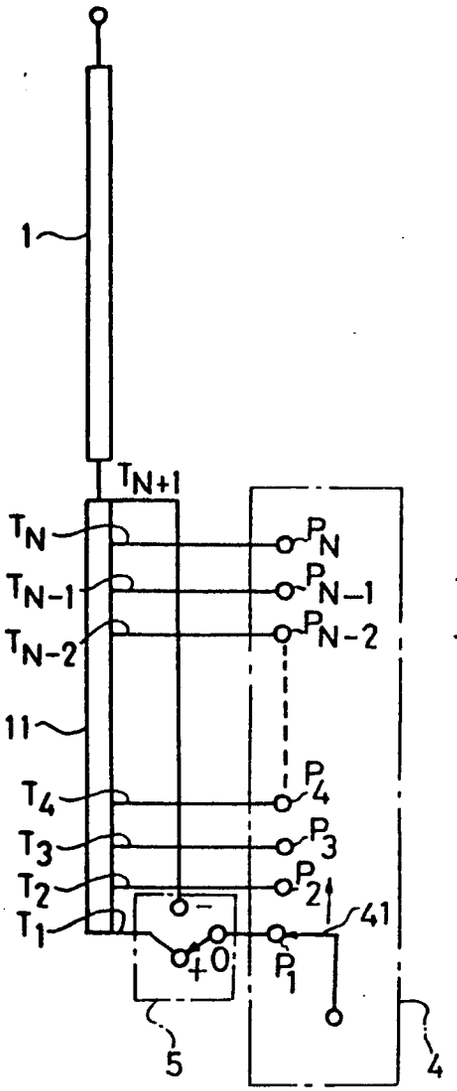

FIG. 4B

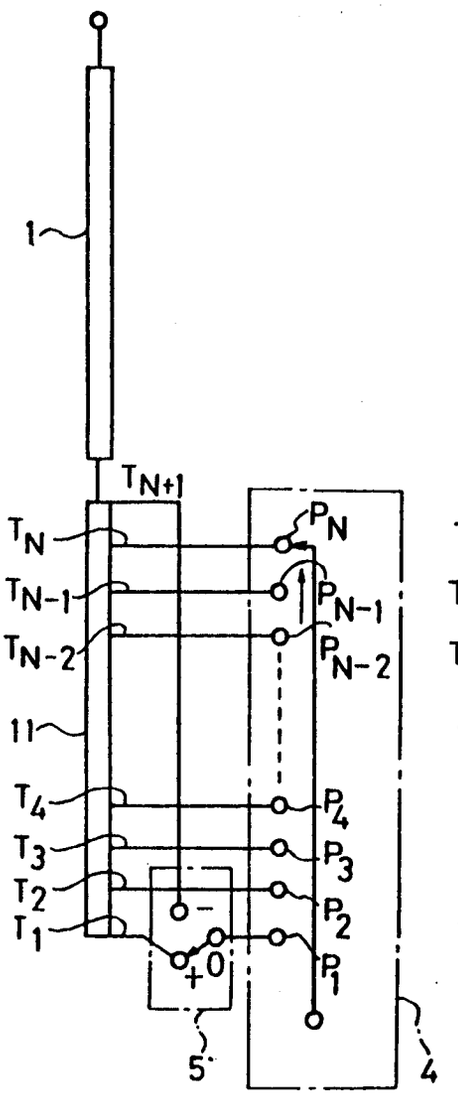

FIG. 4C

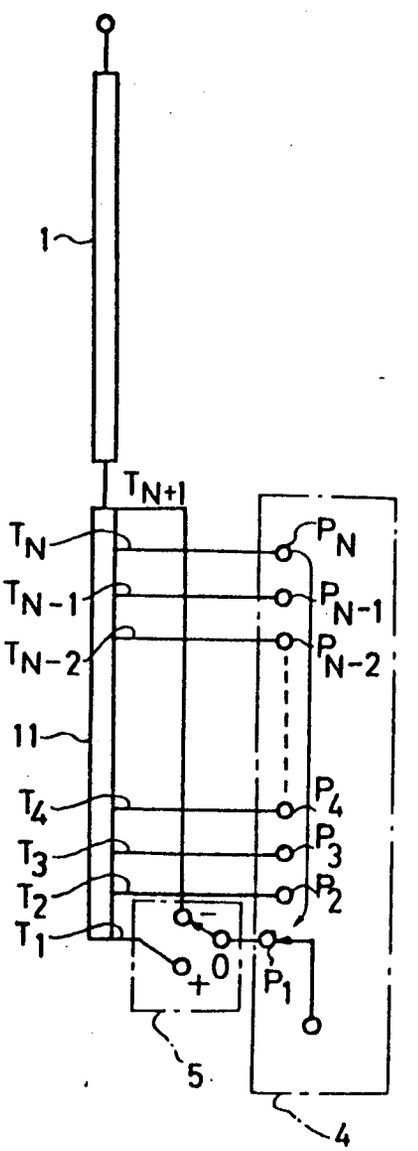

FIG. 4D

Tap position		1	2	3	--------	N-1	N	N+1
Position of fixed contact		1	2	3	--------	N-1	N	N+1
Pre-selecting switch	from 1 to N+1	+						−
	from N+1 to 1	+					−	

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FIG. 5A

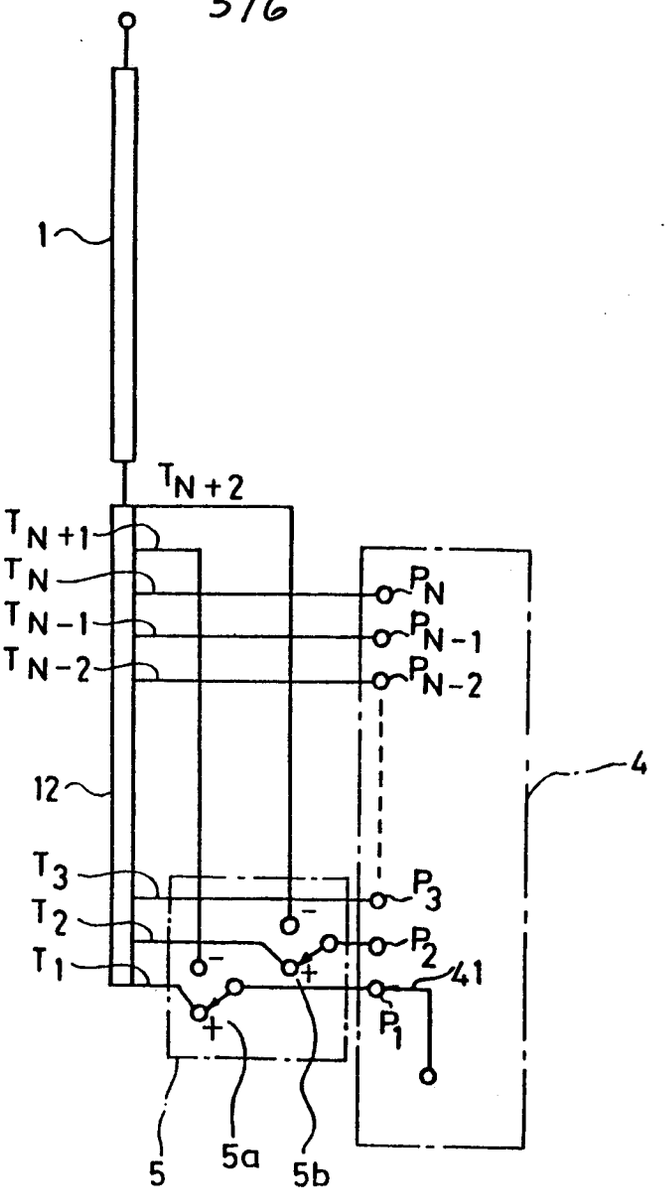

FIG. 5B

Tap position		1	2	3	------	N-1	N	N+1	N+2
Position of fixed contact		1	2	3	------	N-1	N	1	2
Pre-selecting switch	from 1 to N+2	+						−	
	from N+2 to 1	+					−		

FIG. 6A

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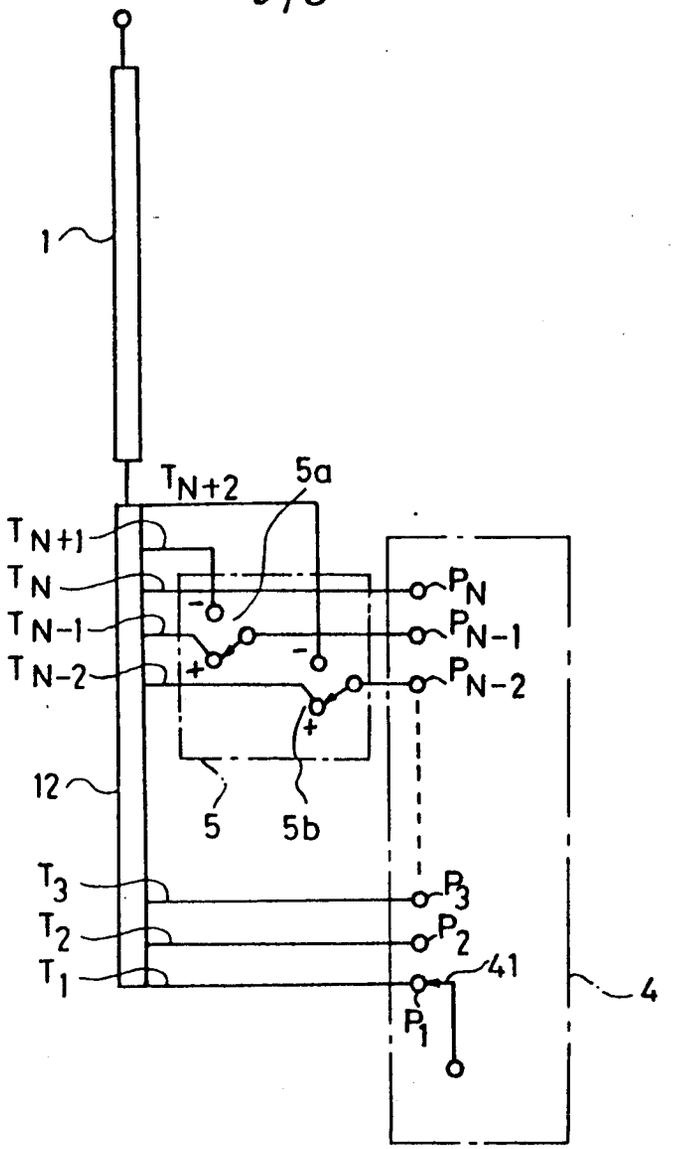

FIG. 6B

Tap position		1	2	3	------	N-1	N	N+1	N+2
Position of fixed contact		1	2	3	------	N-1	N	N-1	N-2
Pre-selecting switch	from 1 to N+2	+						-	
	from N+2 to 1	+					-		

European Patent Office

EUROPEAN SEARCH REPORT

0216125
Application number

EP 86 11 1362

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int Cl 4)
A	US-A-3 535 617 (THE LINCOLN ELECTRIC COMPANY) * Column 4, line 16 - column 5, line 52 *	1	H 01 F 29/04
A	PATENTS ABSTRACTS OF JAPAN; vol. 5, no. 63, (E-54)[735], 28th April 1981; & JP-A-56 12716 07-02-1981 * The whole document *	1	
A	PATENTS ABSTRACTS OF JAPAN, vol. 8, no. 123 (E-249)[1560], 8th June 1984; & JP-A-59 35409 (MEIDENSHA K.K.) 27-02-1984 * The whole document *	1	
A	SIEMENS REVIEW, vol. 43, no. 7, 1976, pages 271-279; R. BREHLER: "Arc furnace transformers with furnace control breaker in the intermediate circuit"		TECHNICAL FIELDS SEARCHED (Int Cl 4) H 01 F 29/00
A	DE-C- 902 656 (KOCK & STERZEL)		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	24-11-1986	VANHULLE R.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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