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POWER TRANSFORMER TAP SWITCHING USING SEMICONDUCTOR DEVICES

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ABSTRACT:

The device used to provide the constant load voltage from the power transformer is known as "Tap changer". The input of the power transformer therefore fluctuates to provide a constant secondary processing of the power transformer as needed for charging. The change to the conventional mechanical column is used to change the faucet. The mechanical sliding mechanism has complex mechanisms of gear selectors, deflectors and switches. If you are using a mechanical gearbox slider, you will experience arc problems and delays, but it also requires the maintenance. To avoid problems that occur in the chin tap changer mechanical, the design of the tap changer's chin by using semiconductor devices. DIAC and TRIAC are the devices used in switching semiconductor switching faucet. The operation of the switching devices is controlled by a microcontroller.

KEYWORDS: Power transformer, switching, semiconductor devices, etc.

I. INTRODUCTION:

One of the major concerns of any power utility is the quality of power supplied to customers as needed. These customers will have a case of continuity with a minimum of disruption. The conventional problem switch was contributed to its mechanical structure of the complicated gearing mechanisms of selectors, deflectors and switches. These provisions are slow in response and susceptible to being brought into contact with the state of wear and deterioration of insulation oil, therefore requiring regular maintenance.

The power changers of the load changer of the changer are an essential part of any modern electrical system, since they allow maintaining the tensions to desired levels in spite of the changes of load. However, even if the first charge shifters were developed at the beginning of this century, modern versions have radically altered these drawings and, in essence, are a complex mechanical device. The power transformer mechanical switches to charge during the tap change process. To solve this situation, a thyristor pair switches arrangement connected through the arc contacts. This is further developed in a single deflector resistor and then in reverse pair of parallel thyristors which are connected through a series of mechanical switching contacts.

Instead of using oil-immersed contact and complicated mechanical drive, a vacuum switch and bi-stable electromechanical actuator were used. These vacuum switches had the advantages of high power handling capability and long life, thus, suitable for the use of the selector. The proposed diverter, consisting of two solid-state switches, was to be connected between each of the selector output leads and in parallel with those two solid-state switches. A faster form of GTO assisted tap changer with the advantage of reduced transformer outages. The speed of the intended vacuum switch moving is now controllable, since fatigue in the stainless steel bellows is the prime limitation, and reverts to fast operation during a system fault.

Two alternative ways of tap changer design have been proposed; fully electronic and electronically assisted. The electronic tap changer is based on thyristor technology, while the electronically assisted tap changer attempts to maintain the mechanical essence of the standard tap changer, but with greater ease of maintenance by incorporating semiconductors to eliminate the contact arc. Fully electronic schemes are inherently fast and maintenance free, but expansive to build compared to their thyristor-assisted counterparts, and do not address the problem of speed of operation and mechanical reliability.

The excitation control method is satisfactory only for relatively short lines. However, it is not suitable for long lines, since the voltage at the alternator terminals will have to vary too much so that the voltage at the far end of the line can be constant. Under such situations, the problem of voltage control can be solved using other methods. An important method is the use of the tap changer and is commonly used where the main transformer is needed. In this method, several shots are provided in the transformer secondary. The voltage drop on the line is supplied by changing the e.m.f. secondary from the transformer through the adjustment of its number of turns.

A. OFF LOAD TAP-CHANGING TRANSFORMER:

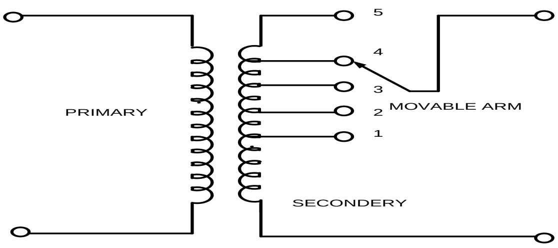

Fig.1: Off load tap changing transformer

Fig.1 shows the arrangement in which several shots have been provided in the secondary. As the position of the tap is varied, the effective number of secondary turns varies and, therefore, the output voltage of the secondary can be changed. Thus, with reference to Fig. 1, when the movable arm contacts the stud 1, the secondary tension is minimal and when contacts the stud 5, it is maximum. During the light charging period, the voltage across the primary is not well below the alternator voltage and the movable arm is placed on the pin 1. When the load increases, the voltage across the primary falls, but the voltage Secondary can be maintained in the previous value by placing the movable arm on a higher bolt. When a faucet is changed on this type of transformer, the load is maintained and hence the name of the load change transformer.

The main disadvantage of the circuit arrangement shown in Figure 1 is that it cannot be used to change the load-taking. Let's assume for a moment that the change of take from position 1 to position 2 when the transformer is supplying the load. If the contact with the stud 1 is broken before the stud 2 is contacted, a breakage occurs in the circuit and arcs occur. On the other hand, if contact with the stud 2 is made before the contact with the stud 1 is broken; the coils connected between these two sockets are short circuited and carry harmful heavy currents. For this reason, the above circuit arrangement cannot be used to change the tap on load.

B. ON-LOAD TAP-CHANGING TRANSFORMER:

In the supply system, the change of intake should normally be made in the load so that there is no interruption in supply.

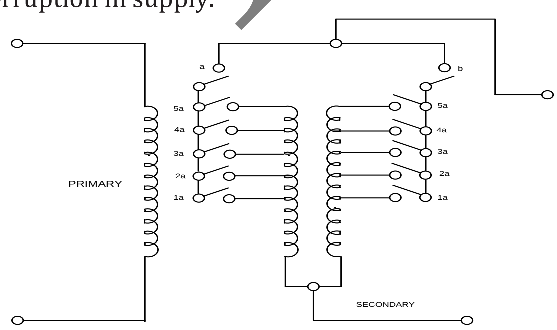

Fig.2: On-load tap-changing transformer

Figure 2 schematically illustrates a type of transformer transmitted by the load switching. The second is constituted by two equal parallel windings having similar connections 1a to 5a and 1b to 5b. Under normal operating conditions, switches A, B and branches with the same number are closed and each secondary winding employs a total current means. Referring to Fig. 2, the secondary voltage will be maximum when the switches a, b and 5a, 5b are closed. However, the secondary voltage will be minimal when the switches A, B and 1a, 1b are closed. Assume that the transformer operates with the pickup position at 4a, 4b and wishes to change its position to 5a, 5b. For this purpose, one of switches A and B is opened, for example. This takes the secondary winding controlled by the switch. Now, the secondary winding controlled by the gate current switch b total current is twice its rated capacity. Then the intermediate connection winding disconnected changes from 5a and the switch is closed. Subsequently, b opens the switch to disconnect the winding thereof, the start position of this winding is changed by 5b and then switch b is closed. This changes the firing position without interrupting the power supply.

This method has the following disadvantages:

- During switching increases impedance transformer and there will be an increase in voltage.
- There are twice as many tappings as the voltage steps.

C. SWITCHING PRINCIPLE:

The OLTC changes the proportion of a transformer by adding curves or subtracting curves from the primary or secondary winding. Therefore, the transformer is equipped with a regulation winding or connectors connected to the OLTC. The main components of an OLTC are the contact systems for rupture and rupture currents, as well as transport currents, transition impedances, gears, spring energy accumulators and a drive mechanism. Depending on the different winding devices and OLTC designs, selector switches and selector switches (reverse or coarse type) are used separately. The transition impedance in the form of a resistor or reactor is constituted by one or more units which are adjacent bridges of bridges for transferring the load from one take to the other without interruption or a significant change in the load current. At the same time, they limit the circulation current (IC) for the period in which both taps are used. Typically, the OLTC reactor type uses the jumper position as a service position and therefore the reactor is designed for continuous loading. The voltage between the indicated faucets is the phase voltage; normally it is between 0.8% and 2.5% of the rated voltage of the transformer.

II. LITERATURE SURVEY:

The problem for the conventional tap changer contributes to its mechanical structure of complicated gear selector, diverter and switch gears. These arrangements are slow in response and susceptible to the condition of contact wear and damage of the insulating oil, so they require regular maintenance [1].

Earn during the mechanical change on the on-load tap transformer power transformer faucet process. To address this situation, Roberts and Ashman had described the arrangement of the switches to switch the thyristor pairs of arcing contacts. It has been further developed for a single driver resistance and then to reverse the parallel thyristor pair which is a set of mechanical switch contacts [2] [3].

The application of semiconductor or solid state device gets advantage of rapid response in designing tap changer, compared to its conventional equivalent, almost free maintenance-free and better performance in terms of power quality [4].

III. RESEARCH METHODOLOGY:

The main concern of this work is to design a completely electronic shifts with a prototype built as the model of operation as shown in Figure 3. The triac is used as a switching device to turn on the selected power tap transformer. The step down transformer and opto-isolator connected between the input and output of the microcontroller respectively isolating the high voltage power transformer damage of the low voltage circuit microcontroller circuit.

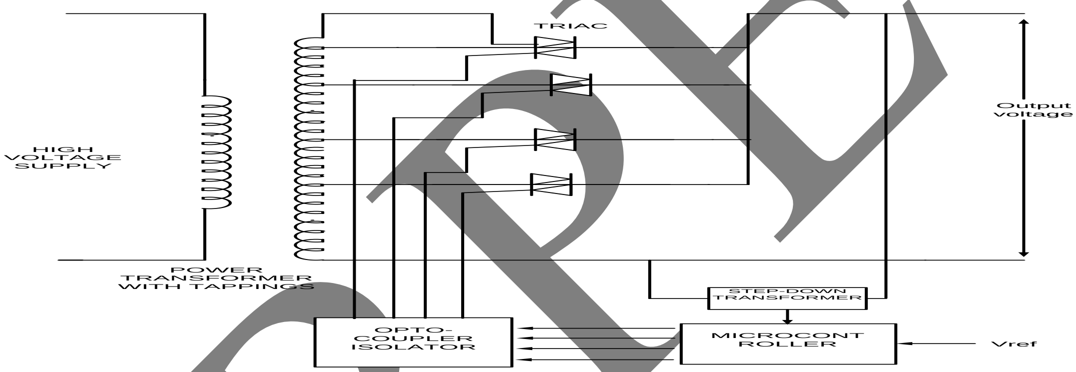

Fig.3: Layout of prototype on-load electronic semiconductor tap-changer

The peak signal peak output detector of the rectifier is detected and provides an equivalent constant DC voltage and then filters any noise is filtered and further improves the signal so that it is free from undulations and within the true range of frequency. While the opto-isolator acts as an electrical insulator to protect the input of the microcontroller. Microcontroller used as a central processing control logic to process the input signal and produces an appropriate output signal according to the program loaded in the microprocessor. The microcontroller acts as a trigger by injecting impulses to the selected TRIAC representing the appropriate taps. At any time, only a TRIAC is in its ON status while others are OFF.

IV. TAP CHANGER DESIGN:

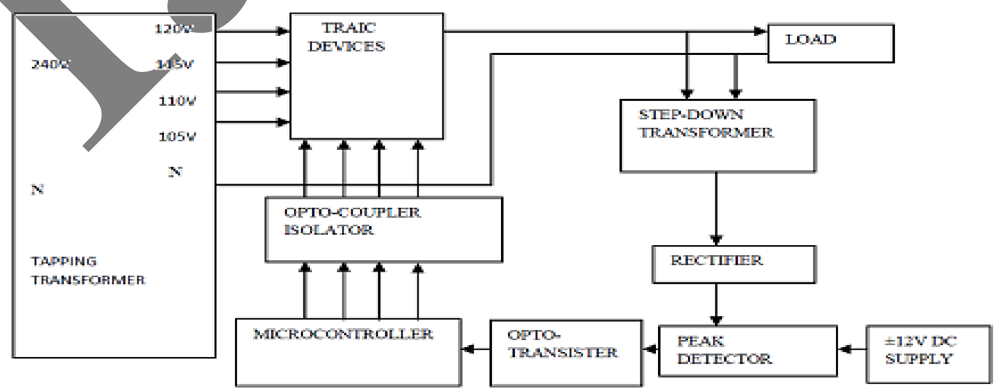

Fig.4: Block diagram of detailed on-load electronic semiconductor tap changer

Fig.4 shows the block diagram of the detailed semiconductor tap changer used in this work. Some additional devices are inserted into the prototype to provide greater precision and security for the system. In the 120V / 6V transformer step down loop feedback prototype, rectifier, peak detector, filter and transistor opto-isolator is incorporated. Its function is to convert the voltage of the 120V AC line voltage to an acceptable DC level for the operation of the microcontroller and provide protection against microcontroller damage. The rectifier converts the alternating voltage signal into continuous voltage signal. As the output of the rectifier is not constant but with ripples, the peak detector and filter are used to get better signals.

The signal is first converted to digital value by the analog to digital converter internally before the microcontroller can process information. If the value is 10% or 10% lower than the nominal value, the microcontroller will quickly change the tap settings to a lower or higher value, respectively. The microcontroller will continue to change the setting to keep the voltage within the set value.

V. PROJECT RESULT:

Fig. 5: Project Output voltage and present tap display on LCD display.

As per role of project, getting 110 volt ac output either variation in voltage of power transformer primary side. Fig.5 shows Project Output voltage and present tap display on LCD display.

A. FOR INPUT VOLTAGE INCREASING ORDER:

Table 1: Project output voltage and tap depending on input voltage increasing order

SR. NO	INPUT VOLTAGE	PAST TAP	PRESENT TAP	OUTPUT VOLTAGE
1	227	1	1	114
2	231	1	2	111
3	233	2	2	112
4	235	2	2	113
5	240	3	3	110
6	248	3	3	114
7	253	3	4	111
8	255	4	4	112

The result of project power transformer tap switching using semiconductor devices in which increasing voltage from 227 volt to 255 volt by increasing order, then gets output voltage 110 ±4V.as per table 1.

B. FOR INPUT VOLTAGE DECREASING ORDER:

Table 2: Project output voltage and tap depending on input voltage decreasing order

SR. NO	INPUT VOLTAGE	PAST TAP	PRESENT TAP	OUTPUT VOLTAGE
1	255	4	4	112
2	253	4	4	111
3	248	4	4	109
4	240	4	3	110
5	235	3	3	108
6	233	3	3	107
7	231	3	2	111
8	227	2	2	109

The result of project power transformer tap switching using semiconductor devices in which decreasing voltage from 255volt to 227 volt by decreasing order, then gets output voltage 110 ±4V.as per showing table 2.

C. THE RESULT CHECKING THROUGH BULB LUMINOUS:

Fig. 6: The result checking through bulb luminous.

At the time of project running input voltage changes by trimmer and visual checking of bulb luminous and tap checking. When vary the input voltage minor luminous change occurs at the time of tap switching due to ±4 volt tolerance at the output voltage.

VI. APPLICATIONS:

In sugar factory sugarcane is unloaded by crane. Crane operates on constant AC 110 volt. The supply from secondary power transformer is fluctuated, then providing constant input voltage to the crane semiconductor tap changer is use. Use the semiconductor based tap changer to provide better efficiency without maintenance. In surface mounting techniques, if provide a constant 110 ACV to chip placer machine then it create a vacuum as per requirement. Semiconductor tap changer is used to provide constant voltage then it removes the problem of placing component on wrong place.

VII. CONCLUSION:

Any variation of the output voltage of the power transformer will be detected by the microcontroller which in term computes and executes necessary command instruction to be passed on to the appropriate TRIAC. The semiconductor tap changer will change the tap position if the variation is out of the permissible range 110±4VAC. Thus the voltage, the system could be maintained at normal value. From the result, the semiconductor tap changer could be associated as an automatic electronic on load tap changer for power transformer to improve the voltage regulation of the system during variation of system voltage. Distinguished characteristics of this semiconductor tap changer are fast response and less negligible spark during tap changing process. TRIAC devices as the switching device that had eliminated all disadvantages of arching, contact wear and maintenance that associated with conventional mechanical tap changer.

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