Innovative Method of Demand Side Management

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***Abstract* - Represented an innovative method of load management, which can be used to power electrical equipment, lighting networks, communications systems, automation and remote control, residential and public buildings in order to control the quality of electricity substation consumer optimization of electrical and conservation**

***Index Terms* - *Technological Innovation, Load* management, Regulators, Voltage control, Energy efficiency**

I. INTRODUCTION

There is a number of ways which provide power saving up properties of converters of voltage, and also the devices realizing these ways. [1]. These ways possess rather low efficiency and, besides, the form of a curve of target voltage is deformed. Some patents tried to overcome existing lacks these deficiencies [2-5].

The core consists in a method [3,5] that are used both magnetic, and electric communications. Voltage on loading is regulated by knot of management and switching . The knot of the combined protection carries out the basic functions, disconnecting or loading from a network, or a network from loading.

The transformer included under the scheme of the autotransformer, i.e. primary and secondary windings of the transformer is applied to regulation additional transformer on voltage at all modes ("norm", restriction "from below" or "from above") have electric communication.

Figure 1 illustrates a voltage regulator in one embodiment of the present invention comprising a power circuit 2 and a control circuit 4. The voltage regulator has an input that is electrically connected with the AC power source 1 in any conventional manner and an output that is connected with the electrical load 3. The control circuit 4 can be any control circuit known in the art and is electrically connected with the power circuit 2 and the AC power source 1.

II. THE BASE SCHEME OF A REGULATOR

The base scheme is represented in Fig.1. A protection circuit 5 is also electrically connected with the AC power source 1 and the electrical load 3.

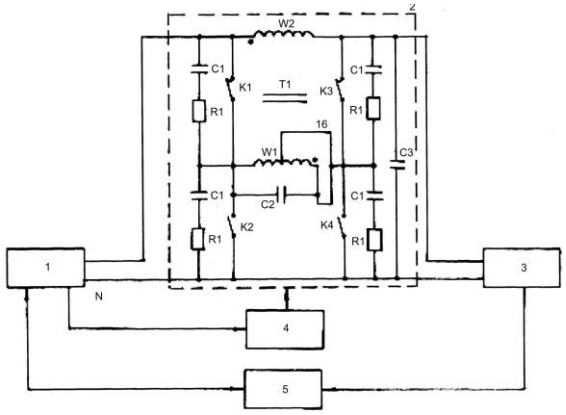


Fig.1 The base scheme of a regulator of Regulating Voltage AN AC Current

As used herein, electrically connected means of two or more components of a circuit or electrical device are connected so that electrical current is able to pass from one component to the other. Two or more components that are electrically connected to each other may have additional objects or components placed between them.

The power circuit 2 comprises a regulator transformer T1, power switches K1, K3, K2 and K4, a first capacitor C2, a second capacitor C3, a tapped relay and RC circuits comprising RC capacitors C1 and RC resistors R1. The power circuit 2 produces the regulated AC voltage at its output within a predetermined range. The load 3 can be any electrical load.

The regulator transformer T1 comprises a primary winding W1 and a secondary winding W2. The secondary winding W2 is connected in series with the AC power source 1 and the electrical load 3. The primary winding W1 is connected to the AC power source 1 so that the primary winding W1 and the secondary winding W2 have opposite polarities16 (as shown by the dots in Figure 1), thus, providing the number of

connection modes for the appropriate voltage regulation through the variably set power switches K1, K2 and K3, K4.

As shown in Figure 1, power switch K1 is coupled between the output of the primary winding W1 and the input of the secondary winding W2. Power switch K3 is coupled between the output of the secondary winding W2 and the input of the primary winding W1, power switch K2 is coupled between the output of the primary winding W1 and the common return N, power switch K4 is coupled between the input of the primary winding W1 and the common return N. Power switches K1 and K3 are preferably normally closed, and switches K2 and K4 are normally open. The variably set positions of the switches control the current flow through the system. Any switch or relay known in the art can be used. Preferably, small and reliable electro-mechanical switches can be used for the purpose of this invention, although many present art switch arrangements can be also utilized.

The first capacitor C2 is in parallel with the primary winding W1 of the regulator transformer T1. At one end the first capacitor C2 is connected to the output of the primary winding W1, at another end it is connected to the input of the primary winding W1 as shown in Figure 1. The second capacitor C3 is connected to the output of the secondary winding W2 and to the common return N. The second capacitor C3 is in parallel with the load 3 and serves for reactive current compensation (full or partial), decreasing nominal current and power of the voltage regulator and as result its cost.

The tapped relay 16, having one or more tap points coupled to the primary winding W1, is able to change the transformation ratio of the regulator transformer providing very smooth regulation and a wider range for voltage regulation.

The RC circuits comprise the set of capacitors C1 and resistors R1 connected in series between each other and in parallel with switches K1, K2 and K3, K4. An RC circuit is connected in parallel with the power switch K1 and is located between the power source input and the point of connection of the power switch K1 and the output of the primary winding W1; another RC circuit is connected in parallel with the power switch K3 and is located between the load output and the point of connection of the power switch K3 and the input of the primary winding W1; another RC circuit is connected in parallel with the power switch K2 and is located between common return and the point of connection of the power switch K2 and the output of the primary winding W1; another RC circuit is connected in parallel with the power switch K4 and is located between the common return and the point of connection of the power switch K4 and the input of the primary winding W1. The function of the first capacitor C2 and the RC circuits is to provide reliable and safe system operation during switching transient (when switches K1, K3, K2 and K4 change between open and close positions) to avoid saturation of the regulator transformer T1 and eliminate any failure (breakdown) in the primary winding insulation due to an overvoltage.

The voltage regulator shown in Figure 1 is a single phase AC voltage regulator, but those skilled in the art will appreciate that the present invention is likewise applicable to multi-phase power. For example, a three phase configuration of the present invention can be implemented using separate circuits like that shown in Figure 1 for regulating the voltage of each phase independently. A common control circuit may be used to control all three power circuits. The voltage regulation circuits can be connected in three phase or multi-phase circuits. The voltage regulator further may comprise n-power circuits connected in series and 2n-control circuits to provide very smooth and precise regulation of each phase independently.

A number of different connection modes to provide appropriate voltage regulation can be achieved. One of the modes may be termed as a normal connection mode. The regulator transformer T1 operates in this mode as an impedance coil with the parallel windings in electrical communication with each other. To achieve this mode of operation, switches K1 and K3 are maintained closed, and switches K2 and K4 are maintained open. The primary W1 and secondary W2 windings are connected in parallel with each other and in series with the load 3 having an electrical communication with each other. The secondary winding W2 has a very low impedance (the voltage drop from a few volts to fractions of a volt) and approximately the full voltage of the power source 1 passes to the load output 3.

A second connection mode may be termed as a step-down mode. In case the incoming voltage exceeds the designated limits for the load, the primary winding W1 and secondary winding W2 are connected to the power source 1 in such a way that the voltage delivered to the load 3 is reduced. To achieve this mode of operation switches K3 and K2 are closed and switches K1 and K4 are opened. The voltage induced in the secondary winding W2 opposes that of the applied voltage, and the voltage delivered at the load output 3 will be decreased and equal to the difference between the power source voltage and the voltage induced by the primary winding W1 in the secondary winding W2.

In a step-up connection mode, incoming voltage that falls below the designated limits for the load is increased. To achieve this mode of operation switches K1 and K4 are closed and switches K3 and K2 are opened. The voltage delivered to the load 3 is equal to a sum of the applied voltage and the voltage induced by the primary winding W2 in the secondary winding W1.

During the switching transition (also referred to as the “transient”) from the normal connection mode to the step-down connection mode, while switch K1 is opened and switch K2 is not yet closed, the secondary winding W2 causes significant electromotive force into the primary winding W1 due to a load current. The circuit of the primary winding W1 is never discontinued due to its electrical communication with

the power source 1 and common return N through the RC circuits (capacitors C1 and resistors R1). In this configuration, the demagnetizing current flows in the primary winding W1 through the capacitor C2. As a result, the regulating transformer T1 is never saturated and a potential failure in the primary winding insulation due to an overvoltage is eliminated. The currents during the switching transition are restricted by the resistors R1. When the switch K2 is closed the step-down connection mode is achieved.

Similarly, during the switching transition (transient) from the normal connection mode to the step-up connection modes, while switch K3 is opened and the switch K4 is not closed yet, the secondary winding W2 causes significant electromotive force due to a load current into the primary winding W1. The circuit of the primary winding W1 is never discontinued due to its electrical communication with the power source 1 and the common return N through the RC circuits (capacitors C1 and resistors R1). The current flows in the primary winding W1 through the capacitor C2. As a result the regulating transformer T1 is never saturated and a potential failure in the primary winding insulation due to an overvoltage is eliminated. When the switch K4 is closed the step-up connection mode is achieved.

While returning to the normal connection mode, the switches are positioned and opened/closed in reverse order. The primary winding W1 is connected in parallel to the secondary winding W2 through the RC circuits during the switching transition. The current during this transition will be significantly reduced (nearly 10 times compared with the short-circuited topologies) and as a result no sparking, burning contacts or other known disadvantages are observed, which significantly increases the reliability and longevity of the system compared to previous systems.

In the step-down and step-up connection modes, the voltage regulator performs as a boosting or bucking autotransformer and a bulk of the energy is transferred from the power source 1 to the load 3 by the means of electric coupling and a small part by the means of electromagnetic coupling. This ratio depends on the transformation ratio of the regulator transformer T1. The bigger the transformation ratio is the more energy that is transferred to the load 3 by the way of electric coupling. Depending on the load, the optimal transformation ratio is calculated to provide appropriate voltage regulation.

Generally, a desired AC voltage for a load means being within a predetermined range (load conditions) usually determined by a customer or local standards. However, optimal saving and performance can be achieved by maintaining an output voltage at the lower limit of the service voltage, typically supplied by utilities, within established operating tolerances, whereby the transformation ratio of the regulator transformer defines the predetermined range of the output voltage. The voltage will be appropriately regulated and delivered to the load even if the incoming AC power voltage falls outside the service voltage limits.

The design features all together provide the benefits and advantages associated with the achievement of this invention, such as, high efficiency (no less than 99.5%), reduced physical size and weight (which results in lower manufacturing cost), reduced energy consumption (and thus cost savings), and prolonged load equipment life.

It should be noted that all the foregoing descriptions and the schematic in Figure 1 depict the concept of this invention for but one AC phase unless otherwise stated. If more than one AC phase is to be provided with the subject voltage regulation, one such piece of equipment will be required for each phase in a self-explanatory manner. A control circuit can monitor all the phases of power simultaneously or each phase independently

In devices, control devices and protection against overloads on a current and short circuits, and also other service functions are provided.

The technological innovation could solve the following problems :a) to save electricity, material and financial resources by 10–50%; b) to save electricity by 10–15%; c) to provide operation of the equipment responsible for manufacturing science-intensive products ,etc.

The method is used at manufacturing of converters in a number of the countries (the Russian Federation, the USA, etc.) the Economy of the electric power makes 10-15 %. The Time of recovery of outlay 1.5 Years.

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