

POWER SAVING DEVICE

1. TECHNICAL FIELD OF THE INVENTION

The present invention generally relates to power saving device and, in particular, to an electrical power saving device incorporating therein an autotransformer and a harmonic filtering means.

2. BACKGROUND OF THE INVENTION

Typical electrical power saving devices are generally known in the art. Normally, such power saving device consists of a reactive power compensation means that is utilized to reduce the power factor of the electrical system to an acceptable level that also reduces the real power consumption. However, such solution does not always work. In certain countries, the power utility companies require that the power factor of the consumer facility to be not less than a certain level and would impose penalty if the power factor is less than the set level because low power factor leads to inefficient power supply distribution. Further, the loading characteristic of the electrical system is not always consistent. If it is an inductive load, capacitor bank is needed to correct the power factor and if it is a capacitive load, then an inductor is needed to correct the power factor. It would be difficult to utilize a single device that would be able to compensate the various loading characteristic of the electrical system. Normally, the power factor and the total current supplied to the electrical distribution system's distribution board is monitored by a controller which then switches the capacitor banks to maintain a power factor better than of the preset limit. In this regard, generally the term "power factor" refers to the ratio of real power to the apparent power (Voltage-Ampere) of the electrical system. It is also a measure of how effectively the current supplied is being converted into a useful work. In a resistive load, the current drawn in the circuit varies in accordance to the voltage applied. However, in a

capacitive or inductive load, the current varies not in the same manner as the applied voltage. The current will lead or lag, respectively and the correction device is to be applied accordingly.

5 In all of the known power saving device, current plays an important part. Current flowing in the load is in direct proportion with the voltage being applied ($I = V/R$). The real power consumption is basically defined as $P = VI \times \text{power factor}$. Replacing I with V/R , we would have $P = V^2/R \times \text{the power factor}$, where in this equation, voltage plays an important role. If we could reduce the supply voltage to a certain level while ensuring that all of the connected electrical devices would still
10 be able to work, then we would be able to reduce the real power consumption. This solution is generally possible since it is generally known that any electrical devices will still be able to work even if the supply voltage is reduce to a certain level. In addition, if we were to filter the line voltage and current from the harmonic noises, power factor of the distribution system may be improved. Such action lowers the
15 current drawn by the load thus, in effect reduces the apparent power. This in turn reduces the real power consumed by the load and therefore, increases the efficiency of the power distribution system. Further, by combining the solution of reducing the supply voltage up to a certain level and together with the incorporation of a reactor to filter harmonic noises associated with the power
20 distribution system thus improving the power factor, the real power consumption may be reduced even more. Therefore, the present invention proposes a power saving device that incorporates therein an autotransformer in the first embodiment and an autotransformer with a reactor for the second embodiment.

3. SUMMARY OF THE INVENTION

25 It is therefore an object of the present invention to provide a power saving device for application with a load connected to a power distribution system.

It is another object of the present invention to provide a power saving device that incorporates therein an autotransformer.

It is yet another object of the present invention to provide a power saving device that incorporates therein an autotransformer and a reactor.

5 These and other objects of the present invention are accomplished by providing,

A device for reducing power consumption associated with a load connected to an electrical power distribution system, said device is to be positioned at the input terminal of the connected load, characterized in that said device comprises of :-

10 an autotransformer (1), said autotransformer is adapted to reduce the supply voltage to said connected load from said electrical power distribution system to a pre-set level; and

said autotransformer (1) is provided with a change over switch (12) arranged between its output terminals for selectively short-circuiting the path of current flowing in said autotransformer (1).

15 Preferably, the autotransformer is provided with tapping terminals for selecting the suitable output voltage for application at the load.

Also preferable, the change over switch is of a smaller construction.

The objects may also be accomplished by providing;

20 A device for reducing power consumption associated with a load connected to an electrical power distribution system, said device is to be positioned at the input terminal of the connected load, characterized in that said device comprises of :-

a reactor (20), said reactor (20) is adapted for filtering the harmonic noises and correcting the power factor associated with said electrical power distribution system; and

5 an autotransformer (21), said autotransformer is connected to said reactor (20) whereby the output terminal of said autotransformer is to be connected to the load and said autotransformer is adapted to reduce the supply voltage of said connected load from said power distribution system to a pre-set level.

Preferably, the autotransformer is provided with a plurality of tapping terminals.

10 Also preferable, the reactor include an inductor connected in series with the autotransformer.

4. BRIEF DESCRIPTION OF THE DRAWINGS

The embodiments of the invention will now be described, by way of example only, with reference to the accompanying figures in which :

15 Figure 1 shows a schematic diagram representation of a power saving device configured according to the first embodiment of the present invention;

Figure 2 illustrates the circuit if one the tapping terminal of the autotransformer is set into operation;

Figure 3 illustrates the circuit if the change over switch for short-circuiting the autotransformer in the first embodiment is set into operation;

20 Figure 4 illustrates the arrangement of a prior art power saving device; and

Figure 5 shows a schematic diagram of a power saving device configured according to the second embodiment of the present invention.

5. DETAILED DESCRIPTION OF THE DRAWINGS

Referring now to the figures, especially to Figure 1, there is shown the circuit diagram representation of a power saving device configured according to the first embodiment of the present invention. In this embodiment, an autotransformer (1) is incorporated in the device for reducing the supply voltage to an acceptable level whereby the output voltage is to be applied to the load via the tapping terminals (3, 4, 5). In principle, the lower the supply voltage, the lower power is consumed. This principle may be illustrated by the following formula. For a purely resistive load, Power (P) = V^2/R . If we were to reduce the voltage supply by about 10 %, power will be reduced to about 20 %. It is commonly known that an electrical device will still be able to operate even if the supply voltage is reduce to a certain level. In the embodiment, the output voltage is reduced to the acceptable level via the tapping terminals (3, 4, 5). In this figure, the device is to be positioned between the power supply source and the terminals of the load. The primary winding (10) of the autotransformer is connected to one of the live wire (14) and the neutral line of the supply voltage is connected to the common input/output terminal (16) of the autotransformer. The output voltage is then derived from terminals of La and Lb (16, 15) which is the direct proportion to the number of turns in the secondary winding with the primary winding. As depicted in the figure, the autotransformer (1) is provided with the plurality of tapping terminals (3, 4, 5) whereby the tapping terminals are each to be selectively connected to the secondary winding of the autotransformer via the corresponding selecting switches (6, 7, 8) to set the appropriate voltage output. Selection of the suitable tapping terminal to set the output voltage from the device would generally depend on the requirement of the particular power distribution system. A change over switch (12) is also provided in the circuit in order to short-circuit or by-passing all the tapping terminals if

necessary, particularly if the output voltage is set to be equal with the rating of the autotransformer for application at the connected load.

If the autotransformer is put into operation by closing the change over switch (13, Figure 4) to the terminal (9) of the autotransformer in a power saving device of the prior art, current will flow to the load through the change over switch (13). Under this circumstance, the current would be quite large. Such large current would correspondingly requires large change over switch, thus the size of the device would also be larger. This would also create some other disadvantages such as higher cost of fabrication and heavier device. However, with the features of the present invention as depicted in Figures 1 and 2, such common problems are particularly reduced or even eliminated altogether. This is due to the fact that a relatively low current will be flowing in the secondary winding of the autotransformer if the change over switch (12) is closed. This action is best illustrated in Figure 2. Input current (I_a) flows in one direction whereas the output current (I_b) flows in the opposite direction. The resulting current in the secondary winding (2) is the different between the input current (I_a) and the output current (I_b) which is, rather small. Thus a fairly thin wire winding may be used in the secondary winding (2). On the other hand, the primary winding requires a relatively thicker wire as the fairly high input current (I_a).

Reference is now made to Figure 3. If the input voltage is already low and no action in the part of the autotransformer to further reduce the input voltage is necessary, the change over switch (12) can be closed and the selecting switches (6, 7, 8) opened. This action provides the path for current to flow through the by-passing circuit (17). At this stage, current at the load (I_c) flows through the primary winding (10) of the autotransformer. This current is basically an excitation current and if no current path is available through the by-passing circuit (17), the core may saturate and excessive heat will generate. This would be equivalent to an opened secondary side. In the presence of the by-passing circuit path (17), the circulating current (I_d) is produced in the common winding (2) and circulates which yields a

magnetic flux in the opposite direction of the magnetic flux induced by the load current (I_c) thereby canceling each other. As a result, the problem of saturation of the core and heat generation is advantageously eliminated. In addition, negligible or no reactive impedance will be detected in the primary winding (10) as the low number of winding turns and the relatively thicker wire used. At this instant, the impedance is purely resistive and the voltage drop is almost negligible.

As mentioned earlier, the current presence in the secondary winding is not large enough that requires higher capacity rating of the change over switch (12) as compared to the prior art (Figure 4). Therefore, it becomes unnecessary to use larger capacity for the change over switch (12). The change over switch (12) selected in by-passing circuit (17) may be made small due to the small amount of circulating current that flow into the by-passing circuit (17). As a result, the overall construction may be made compact, lightweight, the frame miniaturized and reduces the cost of fabrication, easier handling and simpler production process.

Figure 4 shows the prior art arrangement of a power saving device. A path for by-passing the autotransformer (1) operation is usually provided through a connection for the live wire of the input voltage to the output terminal via the change over switch (13). If the switch (13) is switched on to close the circuit path, the autotransformer is isolated from the device. At this instance, the output at terminals (La, Lb) is equal with the input voltage. As mentioned earlier, as the current that flows through the change over switch (13) is quite large, the selected change over switch must be of a higher rating capacity in order to withstand such high current. Normally, such type of change over switch is also quite large, thus problems associated with larger housing, more cost and etc as discussed earlier.

Reference is now made to Figure 5. Figure 5 shows the second embodiment of the present invention. In this figure a reactor (20), normally an inductor, is connected to the circuit. One end of the inductor is to be connected to the input and the other end to the output terminal of the autotransformer (21). The autotransformer is also

provided with at least one tapping terminal in order to select the suitable voltage setting for the connected load similar to the first embodiment. The reactor (20) is used for filtering the harmonic noises presence in the input and also correcting the power factor associated with the power distribution system. As the power factor of the distribution system is improved, the current drawn by the load is reduced, thus reducing the apparent power. This in turn reduces the real power consumed by the load and therefore, increases the efficiency of the power distribution system.

It can readily be seen here that, apart from using the smaller change over switch, various other switching device may also be used, for example magnet switch, relay switch, semiconductor switch and other type of switches without any foreseeable problem. The power saving device of the present invention could also be used in the three-phase system; in a house, at the office or factory or any other locations where electrical power is used. While the preferred embodiments of the present invention have been described, it should be understood that various changes, adaptations and modifications may be made thereto. It should be understood, therefore, that the invention is not limited to details of the illustrated invention shown in the figures and that variations in such minor details will be apparent to one skilled in the art.

WHAT IS CLAIMED IS:

1. A device for reducing power consumption associated with a load connected to an electrical power distribution system, said device is to be positioned at the input terminal of the connected load, characterized in that said device
5 comprises of :-

an autotransformer (1), said autotransformer is adapted to reduce the supply voltage to said connected load from said electrical power distribution system to a pre-set level; and

said autotransformer (1) is provided with a change over switch (12)
10 arranged between its output terminals for selectively short-circuiting the path of current flowing in said autotransformer (1).
2. A device as claimed in claim 1, further characterized in that said voltage is reduced to said pre-set level through at least a tapping terminal (3, 4, 5).
3. A device as claimed in claim 2, further characterized in that said tapping
15 terminal (3, 4, 5) is provided with its corresponding selecting switch (6, 7, 8), and each of said tapping terminal is selectively connected to one of said input terminal through its corresponding selecting switch (6, 7, 8).
4. A device for reducing power consumption associated with a load connected to an electrical power distribution system, said device is to be positioned at
20 the input terminal of the connected load, characterized in that said device comprises of :-

a reactor (20), said reactor (20) is adapted for filtering the harmonic noises and correcting the power factor associated with said electrical power distribution system; and

5 an autotransformer (21), said autotransformer is connected to said reactor (20) whereby the output terminal of said autotransformer is to be connected to the load and said autotransformer is adapted to reduce the supply voltage of said connected load from said power distribution system to a pre-set level.

10 5. A device as claimed in claim 4, further characterized in that that said voltage is reduced to said pre-set level through at least a tapping terminal (23, 24, 25).

6. A device as claimed in claim 5, further characterized in that said tapping terminal is provided with its corresponding selecting switch (26, 27, 28).

15 7. A device as claimed in 4, further characterized in that said reactor is an inductor.