BACKGROUND OF THE INVENTION

This invention relates to a method of increasing the efficiency of an electrical generator which generates real power by a change of the reluctance in the magnetic flux path through the rotor and stator. In particular, this invention relates to a method of increasing the efficiency of such generators by providing specific components, features and characteristics of the generator in a combination so as to reduce the relative effect of the load on the generator.

In the past, electrical generators of the type described herein have been subject to inefficiencies. One of the difficulties was that as the real output power was increased, there was a concomitant increase in the real input power. As the load on the generator increased, there was the concomitant increase in real input power, but the output current was low.

Also, in generators of this type, the inventor has discovered that during operation there is an alternating current superimposed on the excitation current in the excitation coil of the prior art generators. This alternating current has the effect of reducing current passing through the load, which has the tendency of reducing the efficiency of the generator.

SUMMARY OF THE INVENTION

1 Accordingly, it is an object of this invention to at least partially overcome the disadvantages of the prior art. Also, it is an object of this invention to provide an alternative type of electrical generator in which the relative effect of the load is reduced. And, it is a further object of this invention to reduce the effect of the alternating current that is superimposed on the excitation current of such generators.

Accordingly, in one of its broad aspects, this invention resides in providing a method of increasing the efficiency of an electrical generator for use in association with a generator having a stator and a rotor which form a magnetic flux path and wherein the generator generates real output power by a change of the reluctance of the magnetic flux path; the method comprising: providing the following components, features and characteristics of the generator:

(a) number of turns [N1] of excitation coils of an excitation circuit around the magnetic flux path;

(b) number of turns [N2] of load coils around the magnetic flux path;

(c) number of poles [p] on the rotor;

(d) revolutions per minute [n] of the rotor;

(e) average reluctance [Ra] of the magnetic flux path; and

(f) amplitude of change [Rc] of the reluctance of the magnetic flux path:

in a combination so as to reduce the relative effect of a load [RL ohms] in the load coil in the following relationship:

$$\frac{(N1/N2) \times \frac{1}{Rc}}{\frac{1}{Ra} + \frac{jRL}{N2^2w}}$$

where $w = \frac{2\pi np}{60}$.

Further aspects of the invention reside in providing methods and means for reducing the effect of the alternating current which is superimposed on the excitation coil.

Further aspects of the invention will become apparent upon reading the following detailed desciption and the drawings which illustrate the invention and preferred embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

Figure 1 is a schematic, perspective view of a preferred embodiment of the invention;

Figure 2 is a preferred embodiment of a reducing circuit of the invention;

Figure 3 is a schematic drawing of a preferred embodiment of the logic and thyristor circuits of a reducing circuit of the invention;

Figure 4 is a schematic, perspective view of two generators of the invention having common stator and rotor; and

Figure 5 is a schematic, perspective view of two generators of the invention constructed substantially identically.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

Shown in Figure 1 is a simplified generator 10 of the type that generates real output power Por by change of the reluctance R in a magnetic flux path 12. The generator 10 has a stator 14 and a rotor 16 which form the magnetic flux path 12. Rotor 16 is rotated by shaft 18. Shaft 18 is driven by input power Pi. Shaft 18 and, therefore, rotor 16 rotate at a rate of "n" revolutions per minute.

When rotor 16 is in position 16A as shown in Figure 1, the reluctance R of the magnetic flux path is maximum. When the rotor 16 is in position 16B as shown by dashed lines in Figure 1, the reluctance R is a minimum. The average reluctance "Ra" of the magnetic flux path 12 can be determined with respect to time. Also, the rate of change "Rc" of the reluctance R of the magnetic flux path 12 can be determined with respect to time.

As shown in Figure 1, the number of poles "p" of rotor 16 is two poles, p1 and p2. However, it is possible for the rotor 16 to have a greater number of poles as is practical. In practical generators, the number of poles p would usually be in the range of about 2 to 36.

Excitation circuit 20 has an excitation source 22 which is a d.c. or a.c. source. The excitation source 22 supplies excitation current Iex through excitation coils 24, which are coiled around the magnetic flux path 12. The number of excitation coils 24 is "N1". As shown for simplicity in Figure 1, N1 is three. However, in practical generators, N1 would usually be in the range of about 3 to several thousands, say to about 50,000.

Also shown in Figure 1 a load circuit 26. Load circuit 26 has a load "RL" which is connected to load coils 28 which are coiled around the magnetic flux path 12. The number of load coils 28 is "N2". As shown for simplicity in Figure 1, N2 is five. However, in practical generators, N2 would usually be in the range of about 3 to several thousands, say to about 45,000.

It has been discovered, recognized and determined by the present inventor that the effective current Ieff passing through the load circuit 26, and thus the load RL, is proportional to the following relationship (where the symbols have the meanings as given above):

$$\frac{(N1/N2) \times \frac{1}{Rc}}{\frac{1}{Ra} + \frac{jRL}{N2^2 w}}$$

where $w = \frac{2\pi np}{60}$.

Equation 1

By recognizing that the real output power Por of the generator 10 is defined by the following relationship:

$$Por = (Ieff)^2 \times RL$$

Equation 2

the present inventor has recognized that the effect of the load RL on the real input power requirement can be reduced by reducing the relative effect of the load RL in Equation 1 above.

The relative effect of the load RL in Equation 1 can be reduced by providing the generator 10 with a combination of components, features and characteristics C so as to increase the value of Equation 1 for a given load RL, or even an increased load RL, without decreasing the load RL itself. Particularily, this task is accomplished by providing the following components, features and characteristics (referred to collectively as components C) of the generator 10 in a combination so as to reduce the relative effect of the load Rl in the relationship as defined by Equation 1.

In a preferred embodiment of the invention, the components C are provided such that the value of:

$$\frac{RL}{N2^2 w}$$

Equation 3

approaches zero by increasing the product N2 w by increasing the number of turns N2 of the load coils 28 and/or w, or both, and the ratio of N1/N2 does decrease substantially.

In a further preferred embodiment of the invention, the ratio N1/N2 increases substantially when the number of turns N2 of the load coils 28 is increased by further increasing the number of turns N1 of the excitation coils 24.

The present inventor has also discovered, recognized and determined that during operation of the generators of the type as described herein, there is an alternating current Is which is superimposed on the excitation current Iex in the excitation coils 24 of excitation circuit 20. This superimposed current Is has an effect of reducing the effective current Ieff passing through the load coils 28 and the load RL. Thus, having discovered, recognized and determined the existence of this deleterious superimposed current Is, it is recognized that the effect of the superimposed current Is should be reduced.

In a preferred embodiment of the invention. the effect of the superimposed current Is is reduced by inserting in the excitation circuit 20 a reducing circuit 30 as shown generally in Figure 1. Preferrably, as shown in Figure 2, the reducing circuit 30 comprises a comparator means 32 for comparing the varying amplitude Iex-amp of the excitation current Iex to an amplitude Idc-amp of a d.c. current Idc. The reducing circuit 30 also comprises a reduction means 34 for reducing the difference D between the varying amplitude Iex-amp of the excitation current Iex and the amplitude Idc-amp of the d.c. current Idc.

Preferably, the comparator means 32 and the reducing means 34 are comprised of logic and thyristor circuits which could be designed, constructed and implemented by those skilled in the art of electronic circuitry. An example of such circuits is shown in Figure 3.

In another preferred embodiment for reducing the effect of the superimposed current Is, the effect of the superimposed current Is is reduced by providing a common d.c. supply 50 to excite the first generator 10 and to excite a second generator 100. The second generator 100 may be constructed together with the first generator 10, and having a common rotor 16, as shown in Figure 4, or a common stator (not shown). Alternatively, the second generator 100' may be constructed separately from the first generator 10 and substantially identical to the first generator 10, as shown in Figure 5.

It will be understood that, although various features of the invention have been described with respect to one or another of the embodiments of the invention, the various features and embodiments of the invention may be combined or used in conjunction with other features and embodiments of the invention as described and illustrated herein.

Although this disclosure has described and illustrated certain preferred embodiments of the invention, it is to be understood that the invention is not restricted to these particular embodiments. Rather, the invention includes all embodiments which are functional, electrical, magnetic or mechanical equivalents of the specific embodiments and features that have been described and illustrated herein.