United States Patent

Minowa

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[54] **AC GENERATOR DIRECTLY COUPLED TO AN INTERNAL COMBUSTION ENGINE**

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[30] **Foreign Application Priority Data**

Oct. 18, 1968 Japan 43/7599

[52] **U.S. Cl.** **290/1,** 310/168, 310/60

[51] **Int. Cl.** **H02k 19/20**

[58] **Field of Search** 240/1; 310/168, 263, 60, 62

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Primary Examiner—G. R. Simmons
Attorney—Craig and Antonelli

[57] **ABSTRACT**

An AC generator directly coupled to an engine wherein a cup-shaped rotor having a pair of claw pole pieces is mounted on an extension of the engine crankshaft which is projected to the outside of the engine block on the side reverse to the engine output such that an opening is provided on the side opposite to the engine, an armature core with an armature coil and a field core with a field coil are respectively disposed, being separated by a small air gap, at the radially outer and inner sides of the interposed claw pole pieces, and said armature core and said field core are securely mounted on the inside of a non-magnetic cover which is fastened to the engine block to cover said armature and field cores.

1 Claim, 6 Drawing Figures

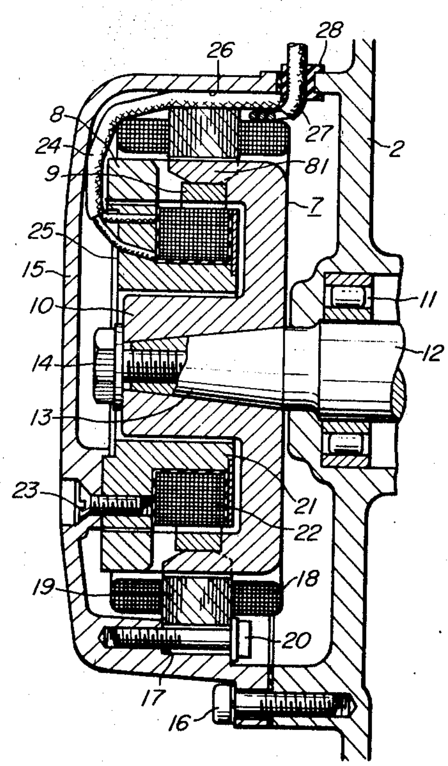

FIG. 1

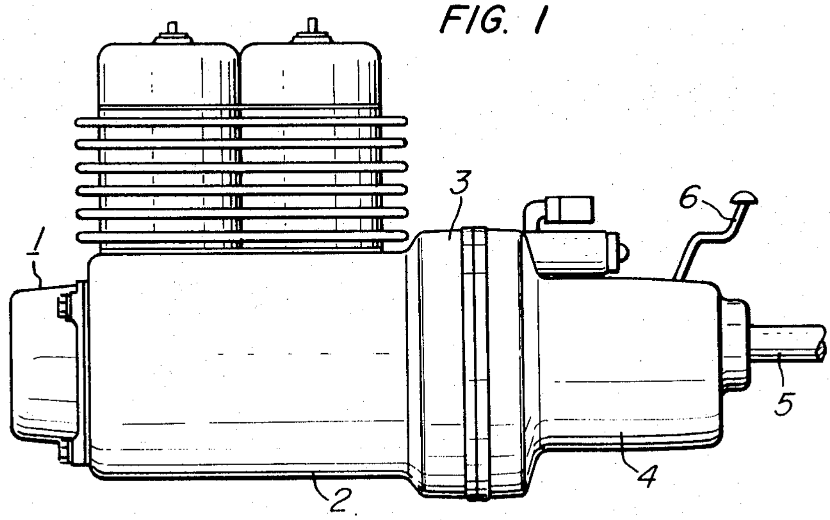

FIG. 6

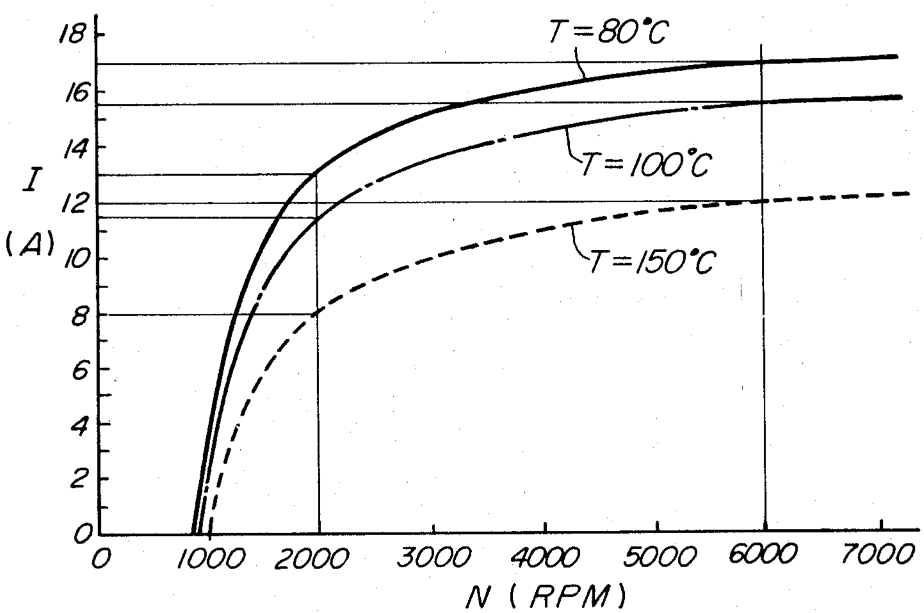

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FIG. 2

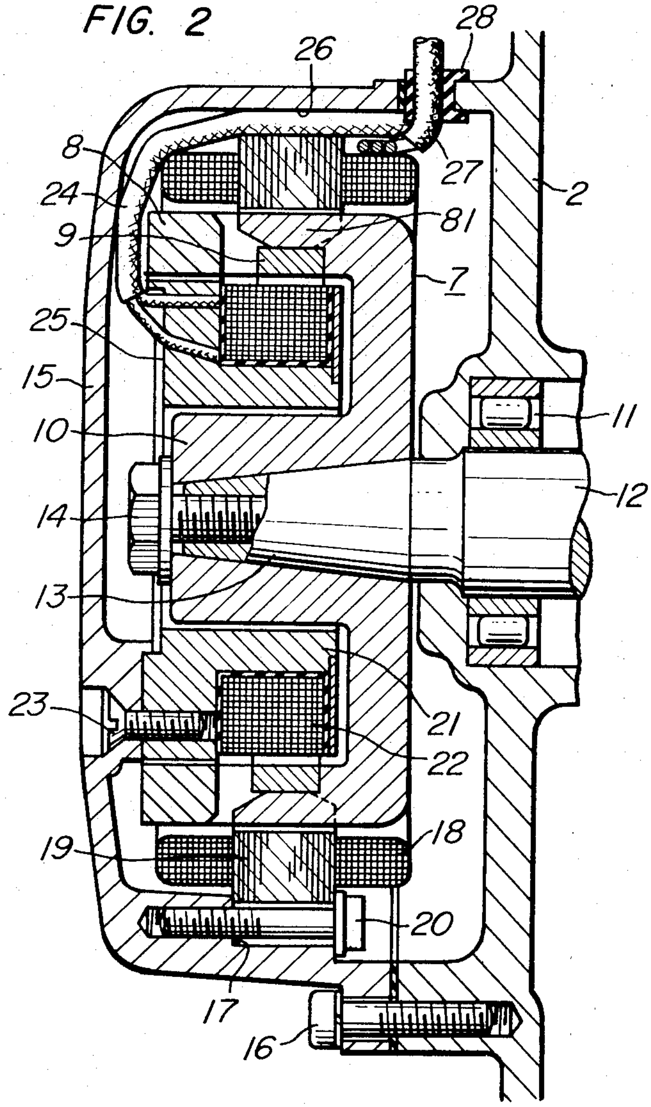

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FIG. 3

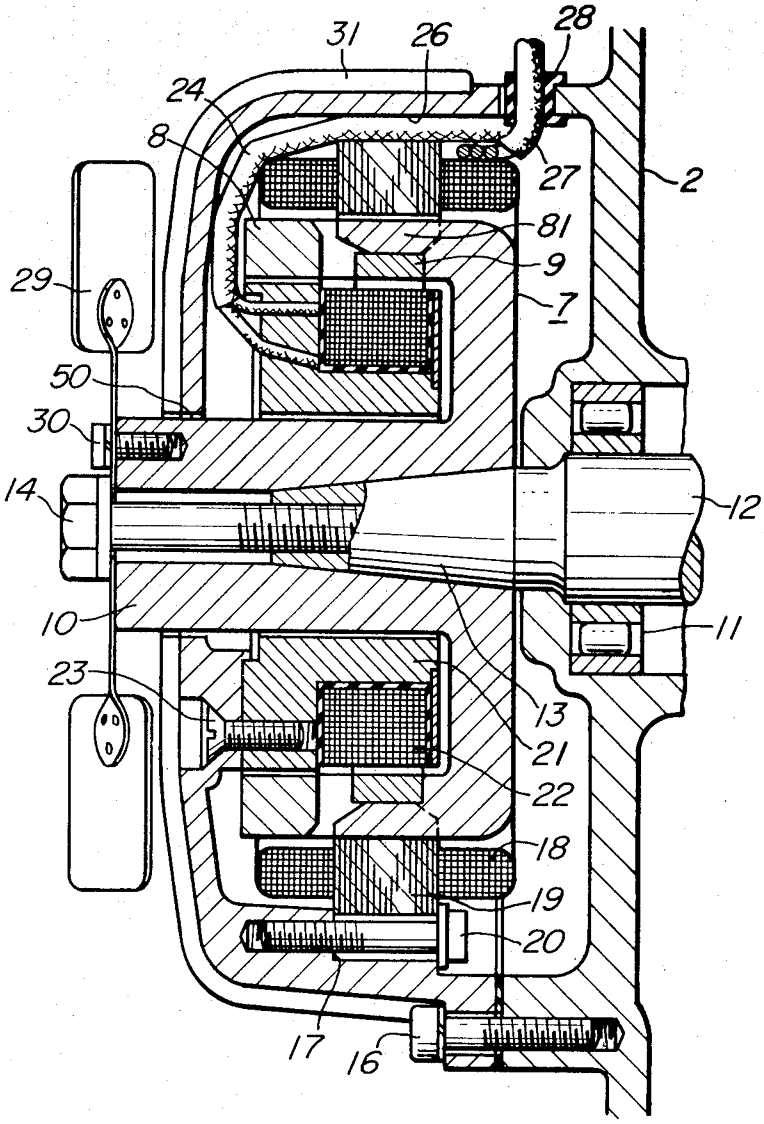

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FIG. 4

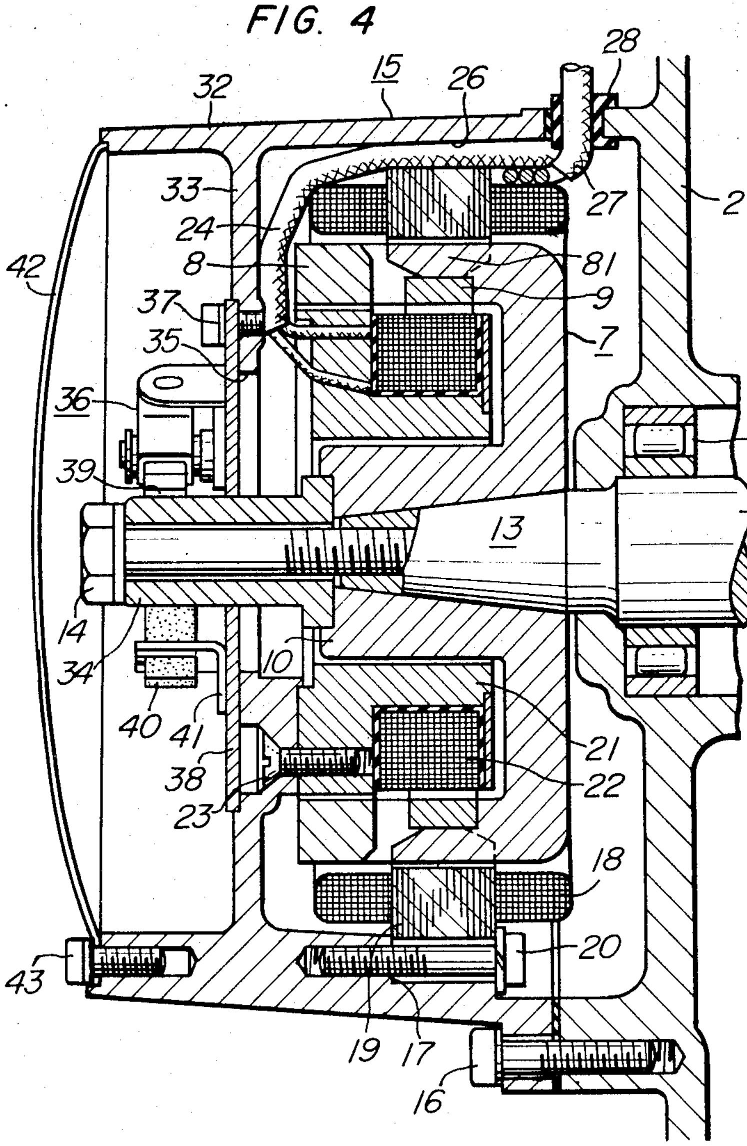

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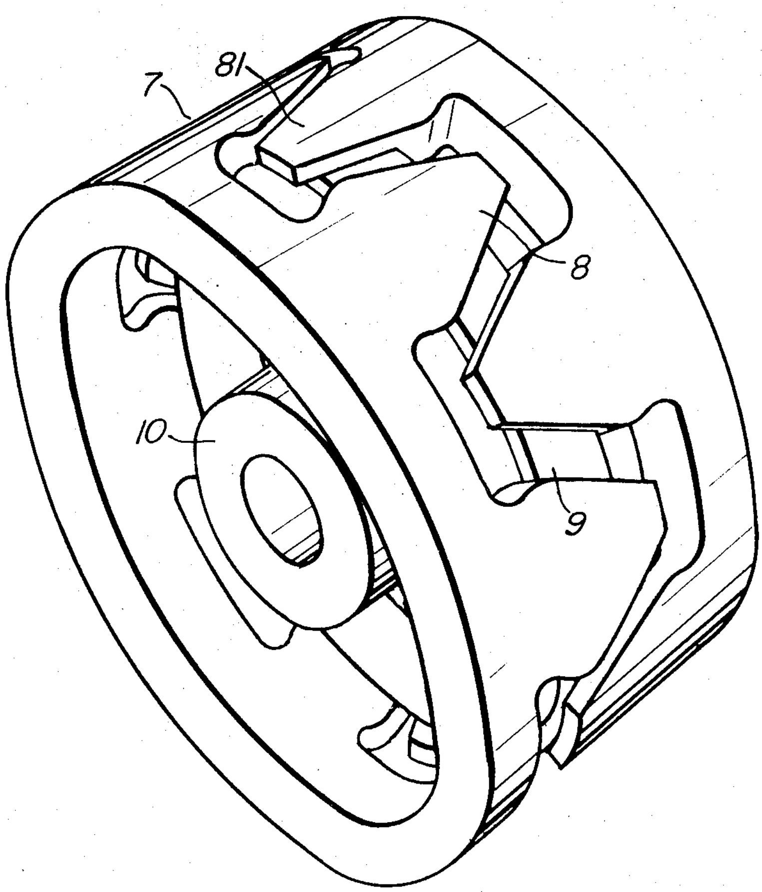
FIG. 5



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AC GENERATOR DIRECTLY COUPLED TO AN INTERNAL COMBUSTION ENGINE

The present invention relates to a brushless AC generator provided with a rotor directly coupled to the crankshaft of an engine for vehicles.

The AC generator installed in a vehicle is usually driven by the engine which drives the vehicle. Ordinary vehicles employ an arrangement whereby the crankshaft of an engine is extended to the outside of the engine block and a pulley is mounted on this extension of the crankshaft so that the generator, together with a cooling fan and the like, is driven by means of a belt. However, this belt-driven system is extremely disadvantageous from the aspect of the miniaturization of engine assemblies, and moreover the belt-driven type is impracticable as the AC generator for small motor vehicles such as a motorcycle. Such being the case, a flywheel magneto or a starter dynamo was used in a motorcycle, both of which were, in fact, disadvantageous from the aspects of maintenance, inspection and life because the flywheel magneto could not generally produce a large power and the starter dynamo included brushes and a commutator.

To eliminate these drawbacks, a form of drive was developed whereby an AC generator was directly coupled to the crankshaft of an engine, and moreover brushless-type AC generators were proposed to solve the problem of maintenance due to the brushes and others. Their examples were described in the specifications of U.S. Pats. Nos. 3,215,877 and 2,928,963, but both of them still involved serious drawbacks structurally from the aspect of temperature rise in the AC generator. First, in the case of the former the armature and the field cores were subjected to the heat from the engine since they were mounted on the engine block and moreover the temperature of the armature and the field windings tended to become exceedingly high due to the generation of heat in these windings. In the latter case, the AC generator had its armature and field cores supported on the side reverse to the engine so that the direct thermal effect due to the heat generated by the engine was not great. However, since this AC generator was mounted between the engine block and the transmission case, its construction was not convenient for the dissipation of the heat generated by the current in the armature and field coils themselves. In other words, besides the fact that the transmission case was usually coupled to the engine block mechanically, thus being subject to the heat from the engine, its temperature was caused to increase considerably by the heat generation due to the transmission gears and lubricating oil and therefore the heat dissipation, particularly the dissipation of heat generated in the field coil mounted on the inner side thereof was difficult. Thus, a considerable temperature rise was unavoidable in this AC generator.

In this type of AC generators, the effect of the temperature rise would have a deteriorating effect on the electrical insulation of the two coils and result in a decrease in the electrical output due to an increase in the electric resistance. In particular, a decreased current flow due to an increase in the resistance of the field coil would reduce the intensity of a magnetic field produced thus becoming a major factor of a decrease in the electrical output.

It is therefore a primary object of the present invention to provide a brushless-type AC generator directly coupled to an engine.

Another object of the present invention is to provide a brushless-type AC generator directly coupled to an engine, whose temperature rise is low and which is compact, yet produces a relatively large electrical output.

Further object of the present invention is to provide an AC generator which can be assembled or disassembled easily and whose assembly, inspection or later adjustment operation is simple and easy.

Still further object of the present invention is to provide an AC generator consisting of a smaller number of component parts.

Still further objects of the present invention will be apparent from the following description of the embodiments when read in conjunction with the accompanying drawings, in which:

FIG. 1 is a general view of an engine assembly on which is mounted an AC generator directly coupled to an engine according to the present invention;

FIG. 2 is a longitudinal sectional side view of an AC generator directly coupled to an engine according to the present invention;

FIG. 3 is a longitudinal sectional side view of another embodiment of the AC generator directly coupled to an engine;

FIG. 4 is a longitudinal sectional side view of a further embodiment of the AC generator directly coupled to an engine;

FIG. 5 is a perspective view of a rotor used in the AC generator of the present invention; and

FIG. 6 is an output characteristic diagram of the AC generator according to the present invention.

Referring to FIG. 1, numeral **1** designates an AC generator directly coupled to an engine, the subject matter of the present invention, which is mounted on the side of an engine block **2** reverse to the clutch of an ordinary engine assembly comprising, in addition to said engine block **2**, a clutch **3**, a transmission **4** and a gear shift lever **6** for adjusting the number of revolutions of a driving shaft **5**, and the AC generator is driven by the rotation of the engine. This generator **1** is constructed as shown in FIG. 2. That is, in FIG. 2, **7** designates a cup-shaped rotor having separate claw pole pieces **8** and **81** interconnected by means of a non-magnetic ring **9** and it has an external appearance as shown separately in FIG. 5. This rotor **7** has its boss **10** mounted on an extended portion **13** of the crankshaft **12** journaled in the engine block **2** by means of roller bearings **11** and the rotor is then securely fixed by a locking bolt **14**. Numeral **15** designates a generator cover made of a non-magnetic material such as aluminum, the cover being securely fixed on the side of the engine block **2** by a plurality of bolts **16** and having an armature core **19** with an armature coil **18** mounted on its inner periphery by means of a stepped surface **17** and secured by fastening bolts **20**. Numeral **21** designates a cylindrical field core having a field coil **22** wound concentrically thereon and fitted in the hollow portion of the cup-shaped rotor **7** with an air gap interposed therebetween, and this field core is attached to the inner wall of the generator cover **15** by means of fastening screws **23** so that, together with the armature core 19, it is located concentrically with the crankshaft 12. Numeral 24 designates a lead wire brought out through an attaching side 25 of the field core 21, through the clearance provided between the attaching side 25 and the generator cover 15 and through a guide slot 26 formed in the armature core 19, whereby both the lead wire 24 and an output lead wire 27 are brought out of the generator for external connection. Here, the outlet hole is usually provided with a rubber bushing 28 for insulating purpose.

With an arrangement as described above, it is a well known fact that as the engine is operated and the crankshaft 12 rotates to turn the rotor 7, the claw pole pieces 8 and 81 produce a rotating field and an AC current is induced in the armature coil 18 and that the generator output decreases in proportion to the internal temperature rise. According to the construction of the present invention, however, the field core 21 with the field coil 22 is directly fitted to the generator cover 15 provided on the side reverse to the engine and exposed to the atmosphere so that it does not conduct the large quantity of heat on the side of the engine and the heat generated by itself is conducted to the aluminum generator cover 15 which is a good heat radiator, whereby an excellent cooling effect is attained with a considerable improvement in the generator performance. In addition, as the field core 21 used here has a L-shaped cross section and can be threadedly secured by means of the locking screws 23 from the exterior of the generator cover 15, there is no need to provide a mounting base exclusively for the field core 21 with a resultant reduction in size and moreover, since the armature coil 18 and the field coil 22 can be removed together with the generator cover 15 by unfastening the bolts 16 when the maintenance, inspection or later adjustment operation of these coils is required, a considerable improvement in the operating efficiency is ensured.

Referring now to FIG. 3 showing another embodiment of the present invention, a boss 10 of a rotor 7 is axially extended to project through an opening 50 of a generator cover 15 and a propeller fan 29 is mounted at the end of the extended boss 10 at the same time that a locking bolt 14 is fastened, with a screw 30 securing the fan 29 to prevent slipping thereof, whereby, by providing an effective fan performance by the rotation of the rotor 7, the generator cover 15 is positively cooled to attain an improved heat dissipation of the generator. In the figure, 31 designates radially disposed fins and the cooling performance can be improved by these fins. constantly apply a the end In addition, ventilation holes may be formed in the generator cover 15 at any desired places thereof, if needed, to thereby provide an improved cooling efficiency.

Further embodiment of the present invention will be explained with reference to FIG. 4 in which 32 designates an auxiliary cover formed by extending the periphery of the generator cover 15 outward from a partition wall 33. Numeral 34 designates a camshaft extending through an opening 35 of the partition wall 33 and secured to the rotor boss 10 by the locking bolt 14 and a breaker 36 is operatively associated with this camshaft. The breaker 36 is adjustably mounted on a base 38 secured to the partition wall by means of screws 37 so that a breaker cam follower 39 contacts the periphery of the camshaft 34. Numeral 40 designates a lubricating felt carried by a supporting bracket 41 projected to the base 38 to constantly apply a lubricant to the cam surface to prevent the wear of the breaker cam follower 39. Numeral 42 designates a dust cover located to cover an open end of the auxiliary cover 32 and it is fixed to the end portion of the auxiliary cover 32 by screws 43 to protect the breaker 36. In this embodiment wherein the breaker 36 is mounted near the end portion of the same shaft, the heat generated by the breaker is nevertheless negligibly small so that an improved generator performance is attained as the heat can be effectively radiated through the generator cover 15 provided with the auxiliary cover 32.

According to the embodiments of the present invention described above, the temperature rise of the armature unit and the field unit may be held between 60°C and 80°C. If the temperature rise is limited within this range, the ordinary class F insulation will be sufficient as the electrical insulation for the respective coils. With the conventional direct-coupled AC generators, however, particularly the temperature of the field unit frequently rose to as high as 100°C to 150°C, and at 150°C, for example, the class F insulation would reach the allowable limit and thus it could not withstand a long service. In addition, since the temperature rise of the field coil would result in an increased electrical resistance of the field coil preventing the flowing of the field current, it tended to reduce the produced magnetic flux decreasing the electrical output of the armature coil. FIG. 6 shows the relationship between the rpm N and the output current I of an AC generator with the field coil temperature T being 80°C, 100°C and 150°C, respectively. According to the figure, at N = **2,000** rpm and T = 80°C, the output current I was 13 amperes, whereas at T = 100°C, the I was 11.5 amperes, and at T = 150°C, it still dropped to 8 amperes. Then, the output current I which was 17 amperes at N = 6,000 rpm and T = 80°C dropped to 15.5 amperes at T = 100°C and it further dropped to 12 amperes at T = 150°C. It will be apparent from the foregoing that the temperature rise of the field coil has an important effect on the magnitude of the output current, and the superiority of the AC generator of the present invention will be understood even from this fact.

What is claimed is:

1. An AC generator directly coupled to an internal combustion engine comprising an armature unit and a field unit which are disposed concentrically with the crankshaft of an engine such that a magnetic flux applied to the armature unit is varied by a rotor unit mounted on the crankshaft and adapted to rotate between the units, characterized in that a cup-shaped claw rotor is provided wherein a first magnetic path is formed radially extending from the end of an extension of the engine crankshaft reverse to the engine which projects outside the engine block, a plurality of first claw pole pieces of the same polarity are formed axially extending from the end portion of said first magnetic path and disposed equally spaced from one another, a plurality of second claw pole pieces of the other same polarity are formed, said second pole pieces being mechanically coupled so that said second pole pieces are arranged between said first claw pole pieces and

form a second magnetic path with a ring-shaped portion at the other end thereof, and said pole pieces of the respective polarities are mechanically interconnected by a non-magnetic material on the inside thereof; an armature core with an armature coil is disposed with a small air gap with respect to and outside of the outer periphery of said claw pole pieces; a field coil is formed, said field coil being wound on a cylindrical field core having a L-shaped cross section; said field core is disposed on the inner side of said claw rotor such that one side of the L-shaped cross section of said field core is opposed to the boss of said rotor connected to said first claw pole pieces and another side of said L-shaped cross section is opposed to said ring-shaped portion of said second claw pole pieces with a small air gap being interposed therebetween, respectively; and said armature core and said field core are securely supported on the inside of a non-magnetic supporting member extending from the engine block to cover said cores.

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