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FREE-PISTON GENERATOR OF ELECTRIC CURRENT

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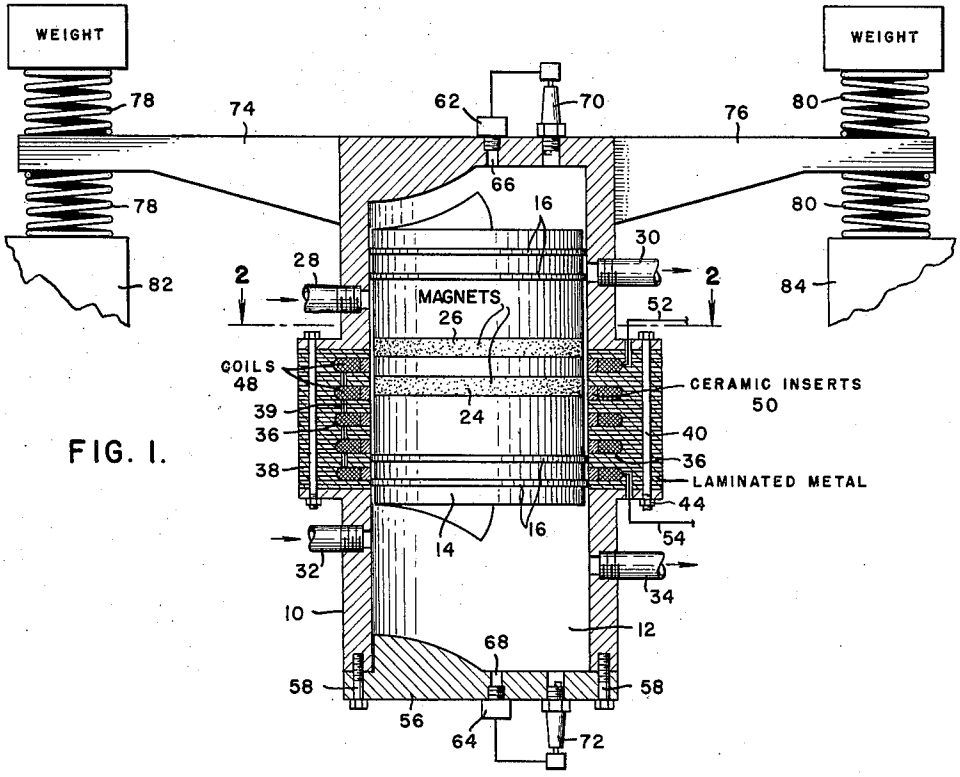

FIG. 1.

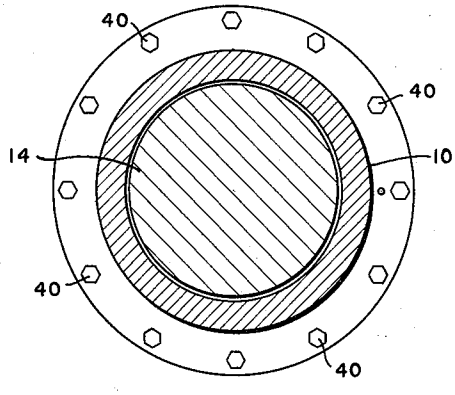

FIG. 2.

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FREE-PISTON GENERATOR OF ELECTRIC CURRENT

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This invention relates to generators of electric current and particularly to a free-piston reciprocating engine in which current is generated directly by the reciprocation of a freely moving piston actuated by the expansion of a fluid.

Because of its high thermal efficiency, a number of free-piston power generation stations have been constructed. Some of these power generation stations include therein a reciprocating member having appropriate means for generating an electric current. However, all of the previous reciprocating free-piston type power generating devices have been bulky and/or have included a plurality of moving parts. For many applications requiring the generation of electric power, it is highly desirable that the power unit be as small and compact as possible. One example of such an application is the power for a unit air conditioner. Many other applications requiring small and compact units with a minimum number of moving parts can be mentioned.

The invention to be described herein provides the art with a small, compact reciprocating free-piston type electric power generator which has only one moving part, the reciprocating piston. Piston shafts, piston synchronizing linkages, slip rings, and various other elements which are necessary in currently utilized electric current generating units are eliminated by this invention. This invention is simple and compact, hence, can be made at relatively low cost. The structure is also such that a complete overhaul of the generator can be made simply, quickly, and cheaply.

The invention as well as its many advantages will be further understood by reference to the following detailed description and drawing in which:

FIG. 1 is a schematic sectional elevational view showing a preferred embodiment of the invention, and

FIG. 2 is a sectional view taken along the line 2—2 of FIG. 1.

Referring to the drawing, the new generator of electric current includes a cylinder 10 having a combustion chamber 12. A free-piston 14 is disposed within the chamber 12 for reciprocating motion within the chamber 12. Upper and lower piston rings 16 are mounted about the outer periphery of the solid piston 14. A portion of the piston 14 is provided with permanent magnetic material. To this end, the permanent magnets 24 and 26 are provided within the piston 14 and extending transversely across said piston.

An upper air-fuel mixture inlet 28 and an upper exmixture inlet 32 and a lower exhaust 34 are provided within the cylinder 10. The air-fuel mixture is fed into the chamber 12 through inlet 28. Upon upward movement of the piston 14, the mixture is compressed and exploded to move the piston 14 downwardly. The exploded gases are exhausted through exhaust 30. As the piston 14 moves downwardly, it compresses the air-fuel mixture which has previously been fed into the lower portion of the chamber 12 through inlet 32. These gases are compressed and exploded to move the piston upwardly again with exhaust gases going out of the exhaust 34. The cycle is continuously repeated. Valves are provided in inlets 28 and 32 and outlets 30 and 34 to provide proper timing for the feeding of the air-fuel mixture to the chamber at the proper time. These valves (not shown)

are conventional and well known to those skilled in the art.

Annular recesses 36 are formed within the inside wall of the cylinder 10 and extend outwardly from the chamber 12. Recesses 36 extend into the laminated metal 38. The laminated metal portions are held together by bolts 40 and nuts 44. The laminations provide for temperature control, and provide high permeability magnetic flux paths.

Mounted within each of the recesses 36 are insulated coil windings 48. These windings can be arranged in series. Grooves or holes 39 may be formed through the laminations 38 to receive wires for connecting the coil windings 48 in series.

An annular insulating insert 50 is inserted in the entrance of each recess 36. The inserts 50 are made of a high heat resistant material such as ceramic, quartz, or epoxy. The inserts 50 are primarily to provide smooth inner walls to avoid piston ring snagging. The inserts also serve to protect the coils against products of combustion, oil, etc., as well as provide some insulation from heat. The alternating current output is conducted from the reciprocating electric current generator by means of conducting lines 52 and 54.

The lower extremity of the cylinder 10 is provided with a cylinder head 56. The cylinder head 56 is detachably secured to the cylinder 10 by means of bolts 58.

An upper pressure transducer 62 and a lower pressure transducer 64 are provided in the upper portion of the cylinder 10 and the cylinder head 56, respectively. Ports 66 and 68 provide for passage of pressure from the upper part of chamber 12 and the lower part of chamber 12 to the pressure transducers 62 and 64, respectively. As the pressure within the chamber 12 increases due to the approach of the piston 14 toward a particular pressure transducer, a particular pressure is reached and sensed by the transducer to generate an electric signal to trigger a spark plug 70, located in the upper portion of the cylinder 10, or 72, located in the lower portion of cylinder 10.

In operation, the alternate injection of the air-fuel mixture into inlets 28 and 32 is controlled to reciprocate piston 14 within the chamber 12 at a constant speed. The movement of the permanent magnets 24 and 26 through the magnetic flux caused by the coil 48 cuts through this flux and generates an alternating current which corresponds in frequency to the frequency of the reciprocating movement of the piston 14. The resulting alternating current is fed through lines 52 and 54 to the point at which the current is needed.

In order to substantially eliminate vertical oscillations of the cylinder caused by the reciprocating movement of the piston, the cylinder 10 may be provided with cross members 74 and 76. Cross members 74 and 76 are mounted within weighted springs 78 and 80, respectively, which are supported by the support members 82 and 84, respectively. The springs 78 and 80 are tuned dynamic vibration absorbers designed to reduce or eliminate the vertical oscillations of the cylinder.

When it is desired to overhaul this invention, it is only necessary that the bolts 58 be removed, the cylinder head 56 removed, and the piston 14 taken out of the chamber 12. After the overhauling operations, the piston is simply inserted in the chamber 12 and the head 56 replaced and the generator of electric current is ready for reuse.

I claim:

1. A generator of electric current comprising: a cylinder; induced current coils mounted in recesses formed in the inside perimeter of said cylinder; a free piston of uniform diameter throughout its length and having permanent magnetic material adapted to reciprocate within the cylinder whereby induced currents are gen-

erated by the displacement of the piston; a pair of inlets in said cylinder for the introduction into said cylinder of an explosive fluid mixture, said inlets being located so that fluid mixture exploded in the cylinder impinges upon each end of the piston; and a pair of exhausts in said cylinder.

2. A generator of electric current comprising: a cylinder; induced current coils mounted in recesses formed in the inside perimeter of said cylinder; a free piston of uniform diameter throughout its length and having a transverse portion of permanent magnetic material adapted to reciprocate within the cylinder whereby induced currents are generated by the displacement of the piston; a pair of inlets in said cylinder for the introduction into said cylinder of an explosive fluid mixture, said inlets being located so that fluid mixture exploded in the cylinder impinges upon each end of the piston; and a pair of exhausts in said cylinder.

3. A generator of electric current comprising: a cylinder having annular recesses formed in the inside wall thereof, said recesses extending outwardly from the chamber of the cylinder; induced current coils mounted in said recesses; an annular insulating insert of heat resistant material inserted in the entrance of each recess

to protect the induced current coils from the heat in the chamber; and a free piston of uniform diameter throughout its length and having permanent magnetic material adapted to reciprocate within the cylinder whereby induced currents are generated by the displacement of the piston; a pair of inlets in said cylinder for the introduction into said cylinder of an explosive fluid mixture, said inlets being located so that fluid mixture exploded in the cylinder impinges upon each end of the piston; and a pair of exhausts in said cylinder.

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