

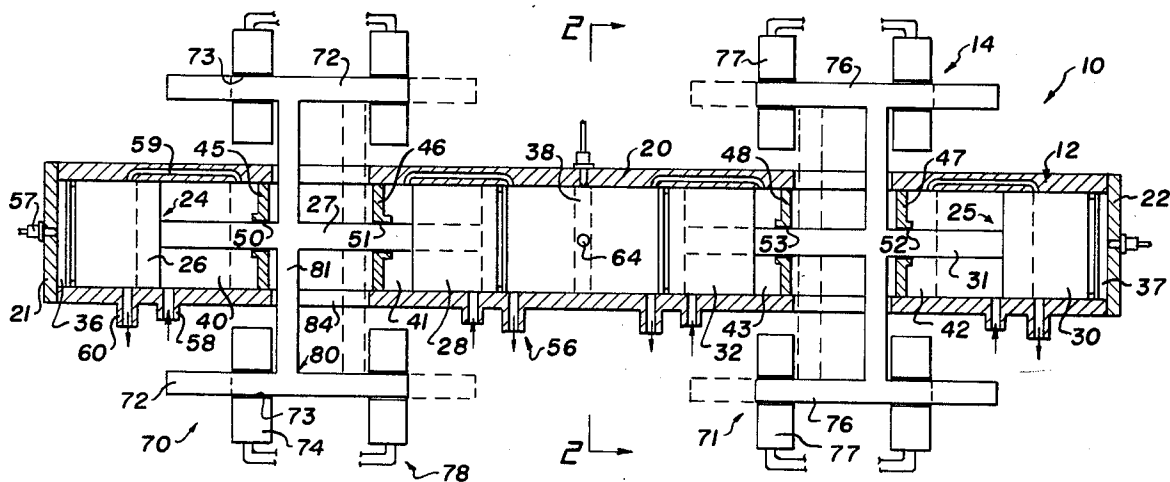
[54] **FREE PISTON ENGINE**
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[58] Field of Search 123/46 R, 46 A

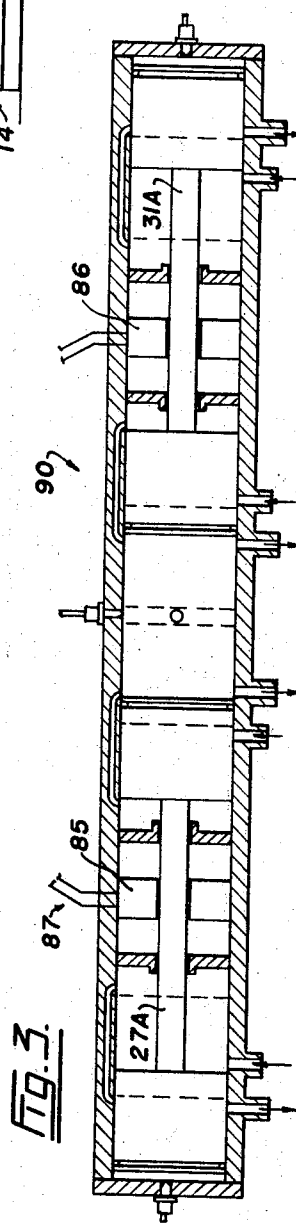
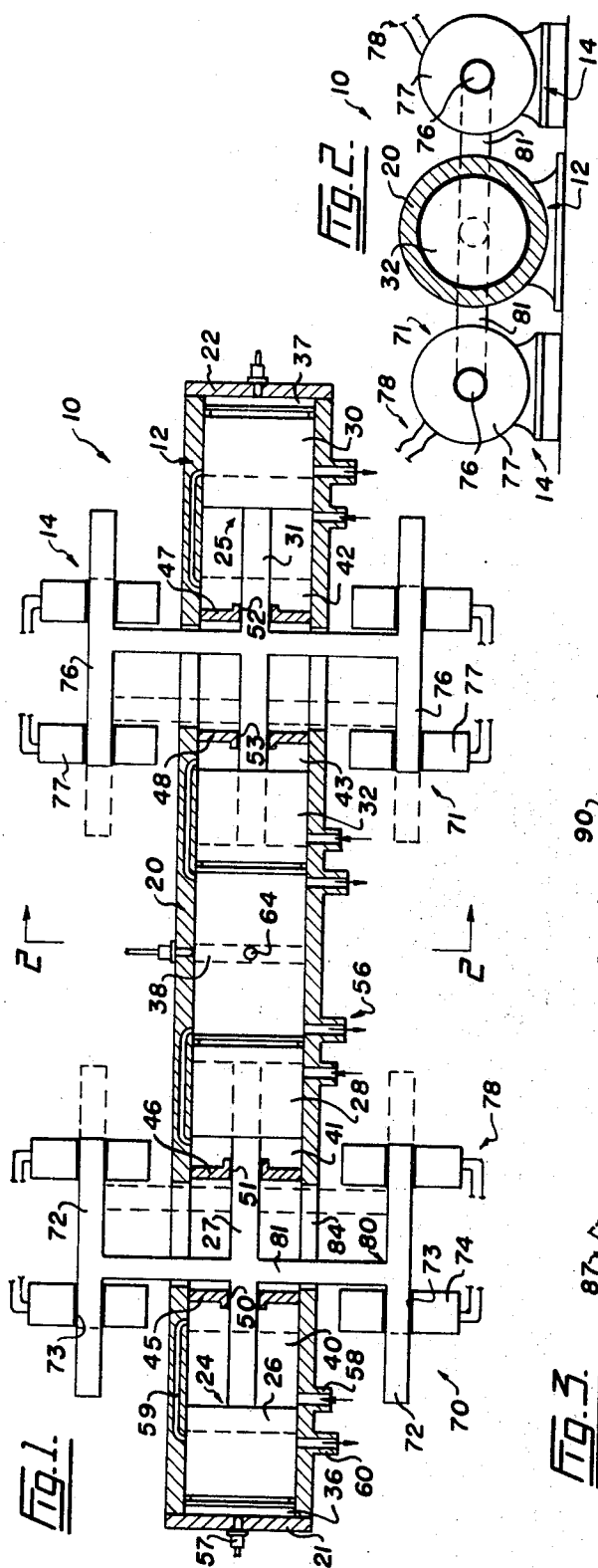
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[57] **ABSTRACT**
A free piston engine is provided which has a pair of opposed piston units mounted for reciprocation in a cylindrical sleeve. The engine has a large combustion chamber between the piston units and a small combustion chamber at each end of the sleeve. The arrangement provides for compression within the large chamber as a result of the simultaneous firing of explosive charges within the small chambers and, conversly, compression within the small chambers as a result of the firing of an explosive charge within the large cylinder.

2 Claims, 3 Drawing Figures





FREE PISTON ENGINE

My invention relates generally to a free piston engine and more particularly to an engine having three combustion chambers and primarily intended for use in driving a rectilinear generator.

A conventional free piston engine normally has a cylinder in which a pair of opposed pistons are mounted to reciprocate towards and away from one another. There is a combustion chamber between the opposed pistons and, when a combustible fuel-air mixture is burned in this chamber, the pistons are driven apart. The return stroke of the opposed pistons to compress the next fuel-air charge in the combustion chamber usually is achieved by means of compressed air generated as a result of outward movement of the opposed pistons during the preceding power stroke. The compartments within the cylinder where the air is compressed to power the return stroke are often referred to as "bounce" chambers since their pressurization provides pneumatic springs which powers the compression strokes of the opposed pistons.

I provide an improved free piston engine which produces additional power by virtue of the fact that it has, in addition to the normal centrally disposed combustion chamber, two extra combustion chambers which take the place of the commonly used bounce chambers. Thus, the number of power strokes is doubled and the arrangement is particularly well suited for use in providing the power needed to drive an electrical generator having a pair of reciprocating armatures. Each of the armatures can be associated with one of the opposed piston units of the free piston engine so that the mechanism is properly balanced and can be operated to produce electricity efficiently and with a minimum number of moving parts.

In drawings which illustrate preferred embodiments of the invention,

FIG. 1 is a schematic longitudinal section of a rectilinear generator powered by a three combustion chamber, free piston engine in accordance with the present invention,

FIG. 2 is a schematic transverse section taken on the line 2—2 of FIG. 1, and

FIG. 3 is a view similar to FIG. 1 but showing another embodiment of the invention.

Referring to FIGS. 1 and 2, the numeral 10 indicated generally a mechanism for producing electric power. Mechanism 10 comprises a free piston engine and a rectilinear generator which are indicated generally by the numerals 12 and 14 respectively. Many of the numerous components which are fitted to the engine 12 and generator 14 had been purposely omitted from the schematic views for the sake of clarity since an explanation of the construction and operation of such well-known components is not considered necessary to a proper understanding of the present invention.

The engine 12 is provided with an elongated and cylindrical sleeve 20, the ends of which are closed by end walls 21 and 22. Sleeve 20 provides a common cylinder for a pair of opposed piston units 24 and 25. Unit 24 comprises a pair of pistons including a piston 26 which is mounted in the sleeve 20 to reciprocate near the end wall 21, this piston being connected by a longitudinally extending rod 27 to another piston 28 which reciprocates near the center of the sleeve. The identical unit

25 is made up of an end piston 30, a connecting rod 31, and a central piston 32.

Between the pistons 26 and 30 and the adjacent end walls of the sleeves 20, there are small combustion chambers 36 and 37 respectively. A relatively large combustion chamber 38 is formed within the sleeve 20 between the opposed pistons 28 and 32.

The engine 12 can be operated in any one of several different ways as a free piston internal combustion engine. In the example illustrated in FIGS. 1 and 2, the engine 12 is a two-cycle diesel in which case the sleeve 20 is provided with two pairs of precompression chambers numbered individually as 40, 41, 42, and 43. Chamber 40 is formed between a wall 45 extending across the sleeve to the right (FIG. 1) of piston 26. In a like manner, similar transversely extending walls 46, 47 and 48 within the sleeve provide the precompression chambers 41, 42 and 43 near the pistons 28, 30 and 32 respectively. The connecting rods 27 and 31 slidably extend through suitably pressure-sealed openings 50 and 53 in the pairs of transverse inner walls of the sleeve 20.

When operating on the two-cycle diesel principal, the engine 12 is provided with operating means generally indicated at 56. The operating means 56 which is shown schematically in the drawings is intended to include all the usual components for delivering air and fuel to the appropriate chambers; for removing the products of combustion; for cooling; for timing; and so on as will be readily appreciated by those familiar with this type of engine. With regard to the piston 26, the end wall 21 is fitted with a fuel injector valve 57 which communicates with the small combustion chamber 36. Air reaches the precompression chamber 40 through an inlet port 58 in the sleeve 20 and a transfer port 59 connects said chamber to the combustion chamber 36. An exhaust port 60 is provided in the sleeve 20 for the combustion chamber 36. The operating means 56 provides the same sort of port arrangements for the chambers on either side of each of the other pistons, the arrangement being illustrated in the drawings although the parts are not numbered for the sake of clarity.

The engine 12 may be provided with a spark plug 64 mounted centrally of the sleeve 20 to extend into the large combustion chamber 38. This plug 64 would be fired only to start the motor which otherwise operates as a two-cycle diesel and the pair of opposed piston units 24 and 25 are driven back and forth within the sleeve each time a charge of fuel is injected into the air-pressurized combustion chambers 36, 37 and 38. Each stroke of the opposing units 24 and 25 is a power stroke and no pneumatic springs are required to return the units after each such stroke.

The rectilinear generator 14 of the present mechanism comprises longitudinally spaced apart generating units 70 and 71. Unit 70 has a pair of armatures each designated by the numeral 72 and disposed one on each side of the sleeve 20. The spaced apart and parallel armatures 72 each extend through central openings 73 formed in longitudinally aligned annular field windings 74. Generator unit 71 is similarly constructed and is provided with a pair of armatures 76 and field windings 77. The several field windings of the generator 14 are connected together by suitable circuitry indicated generally at 78 and by means of this circuitry the electric power generated is taken off to be used where and as required.

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In order to operatively connect the pair of piston units 24 and 25 to the four armatures of the generator 14, the engine 12 is provided with power take-off means 80, there being two such means for each of said units. As shown in the drawings, the power take-off means 80 for each armature of the unit 70 comprises a transversely extending connecting rod 81 which is secured at one end to the center of the longitudinally extending connecting rod 27 and at the opposite end to an armature. Sleeve 20 is provided with diametrically opposed and longitudinally extending slots 84 and the transverse rods 81 slidably project through these slots.

Referring now to FIG. 3, the numeral 90 indicates generally a modified electric generator the construction and operation of which is as previously described except that the connecting rods 27A and 31A, or at least central portions thereof, are reciprocating armatures. The rods 27A and 31A extend through annular field windings 85 and 86 which are included in circuitry 87. Thus, electricity is generated within the mechanism rather than externally thereof as is the case with the mechanism shown in FIGS. 1 and 2.

I claim:

1. A free piston engine comprising a sleeve, an end wall closing each opposite end of the sleeve, a pair of opposed piston units slidably mounted in the sleeve,

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each of the pair of opposed piston units comprising a pair of pistons joined together by a longitudinal connecting rod, a small combustion chamber within the sleeve between each end wall and adjacent piston unit, a large combustion chamber within the sleeve between the pair of opposed piston units, a pair of spaced transverse walls within the sleeve between each pair of pistons and having pressure sealed openings through which one of the longitudinal connecting rods slidably projects, each of said pair of transverse walls defining with the sleeve and the adjacent pair of pistons a pair of precompression chambers; and operating means associated with the sleeve, the small and large combustion chambers, and the pair of precompression chambers for reciprocating the pair of opposed piston units substantially in the manner of a free piston internal combustion engine.

2. A free piston engine as claimed in claim 1, in which said sleeve has a pair of diametrically opposed longitudinal slots between each pair of transverse walls and a pair of transverse connecting rods connected at their inner ends to each longitudinal connecting rod and slidably projecting outwardly one through each longitudinal slot for connection to a reciprocating part of a driven machine.

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