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FREE PISTON GAS GENERATOR

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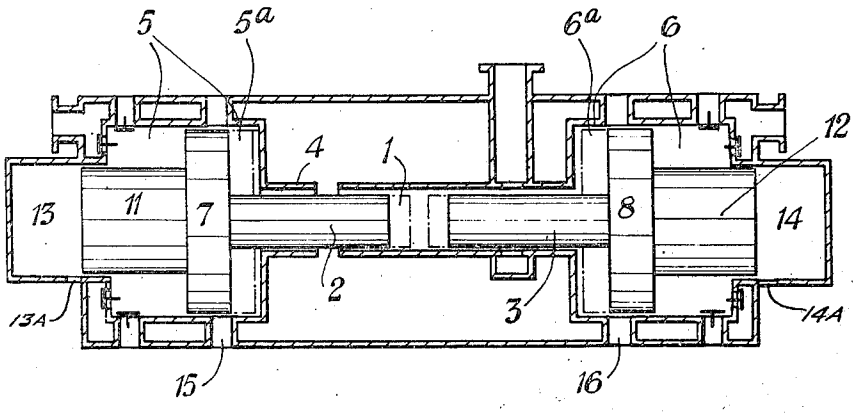


FIG. 1.

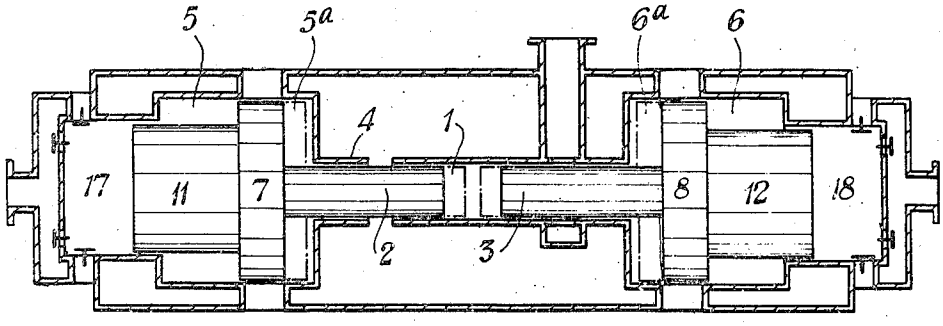


FIG. 2.

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FREE PISTON GAS GENERATOR

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2 Claims. (Cl. 123—46)

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This invention relates to free piston gas generators of the type in which the compressor pistons deliver, during the outward stroke of the combustion pistons in the combustion chamber, compressed air to be fed to the combustion chamber.

With existing free piston gas generators of the aforesaid type, when operating at reduced working pressure the compression pressure in the combuston cylinder reaches an undesirably high value, and introduces the possibility of the opposed ends of the combustion pistons in such cylinder contacting with each other. In order to obviate this possibility devices have been proposed heretofore which regulate automatically the pressure in cushion cylinders provided to store on the outward stroke no more than the required amount of energy for the return or inward stroke, to ensure stability under all conditions of load and operation. However, such heretofore proposed automatic control means for regulating the cushion pressure have been undesirably complicated and the object of the present invention is to provide cushioning means which will operate over the required range of power and not involve a complicated mechanism and arrangement of valves.

According to the present invention, gaseous fluid compressing means is provided to create a gaseous fluid stabilising cushion to absorb the surplus energy tending to bring the pistons in the combustion chamber into contact with each other during the compression stroke, whilst maintaining the compression pressure in the combustion chamber within the range required for efficient operation of the free piston gas generator, and the arrangement is such that the energy acquired or stored by reason of this absorption of surplus energy is returned to the moving parts of the gas generator at the commencement of the firing stroke of the pistons in the combustion chamber.

In carrying the present invention into practice, there is introduced an auxiliary stabilising cushion which prevents the building up of undesirably high compression pressures in the combustion cylinder, and enables the free piston gas generator to remain stable in operation over the full range of power without resorting to complicated stabilising mechanisms proposed heretofore. For this purpose the normal piston-like enlargements provided on the combustion pistons or connected thereto near the ends remote from the combustion chamber are arranged so as to operate between the normal air compressor space and an

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air compression space in which the stabilising pressure is generated. For example, in a symmetrical arrangement of a free piston gas generator, the ends of the pistons remote from the combustion chamber are formed with the said piston-like enlargements which operate in cylinders forming the air compressors in which the required volume of air is compressed and delivered to the combustion cylinder in the normal way and the energy on the inward stroke results from the compressor re-expansion together with the expansion of air in relatively small but concentric extensions of the aforesaid compression chambers, these extensions forming the main cushion cylinders receiving rams comprising concentric co-axial extensions of the piston-like enlargements of the pistons in the combustion chamber. These cushioning cylinders can be of the known type.

The stabilising pressure is generated in the annular spaces surrounding the combustion pistons between the opposed faces of the two piston-like enlargements of such pistons and the inner opposed ends of the cylinders in which they operate, the required quantity of air being trapped in such annular spaces by any convenient means such as, e. g., by the covering of ports over the appropriate period by the two piston-like enlargements, following which covering of the ports the air required for obtaining the stabilising pressure is compressed, resulting in the surplus energy being absorbed and the pistons arrested on the compression stroke in the combustion cylinder before the opposed ends of the two pistons can contact or the compression pressure become excessive.

The stabilising cushion, as described, can also be applied to an arrangement of free-piston gas generator in which instead of utilising the aforesaid co-axial extensions of the air compression cylinders as cushioning cylinders, the reverse arrangement is adopted and the spaces between them and the opposed or outer faces of the piston-like enlargements of the combustion pistons used as the spaces in which is compressed the air supplied to the combustion chamber. That is to say, the annular space surrounding each concentric ram-like extension of each piston-like enlargement comprises the air cushioning space, and the spaces between the ends of such rams and the co-operating extension of the cylinders form the air compression spaces for delivery of air to the combustion cylinder.

In order that the invention may be clearly understood and readily carried into effect, draw-

ings are appended hereto illustrating, somewhat diagrammatically, alternative embodiments thereof, and wherein—

Figure 1 is a sectional side elevation view of one embodiment; and

Figure 2 is a sectional side elevation view of another embodiment.

Referring to the drawings, both embodiments introduce an auxiliary stabilising cushion which prevents the building up of undesirably high compression pressures in the combustion cylinder, and enables the free piston gas generator to remain stable in operation over the full range of power.

In the embodiment illustrated in Figure 1, the combustion chamber is indicated by the reference numeral 1, and the free pistons by the reference numerals 2 and 3, the cylinder 4 appropriate to the combustion chamber being connected across air compression cylinders 5 and 6 in which reciprocate pistons 7 and 8 respectively formed as enlargements of the pistons 2 and 3. The required volume of air to be compressed and delivered to the combustion chamber 1 is obtained by the compression of the air in the cylindrical enlargements 5 and 6 between the pistons 7 and 8 and the outer ends of such cylindrical enlargements.

The pistons 7 and 8 carry concentric extensions 11 and 12 respectively operating in cylindrical extensions 13 and 14 of the cylindrical enlargements 5 and 6 respectively, such extensions 13 and 14 forming the main cushion cylinders and providing, during the combustion state in the cylinder 4, a cushioning action, and during the inward stroke providing, together with the air compressor re-expansion energy, the required re-expansion energy for driving the pistons 2 and 3 towards each other to compress the air in the combustion chamber 1 to ignition temperature. The walls of the extensions 13 and 14 are formed with ports 13*a* and 14*a* which open to atmosphere, the opening and closing of these ports being controlled by the extensions 11 and 12.

To prevent contact of the opposed ends of the pistons 2 and 3 during the compression stroke when operating at reduced working pressure, auxiliary stabilising cushions are provided in the form of annular extensions 5*a* and 6*a* on the inner ends of the compression cylinders 5 and 6, the extensions being arranged to inter-act with the inner faces of the pistons 7 and 8 to compress the air in said extensions 5*a* and 6*a* during the end of the inward stroke of said pistons and following the covering of ports 15 and 16 formed near the inner ends of the compression cylinders 5 and 6 respectively. This results in the surplus energy, which otherwise may cause the opposed ends of the pistons 2 and 3 to contact to be absorbed so that the pistons 2 and 3 are arrested on their compression strokes within safe mechanical limits at the same time for maintaining the compression pressure in the combustion chamber within the range appropriate for the most efficient operation. It will be apparent that the energy stored within the annular extensions 5*a* and 6*a* will be returned to the moving parts at the commencement of the firing stroke thereby obtaining an arrangement in which increased acceleration of the pistons takes place at the most appropriate stage giving improved efficiency of combustion.

In the modified arrangement shown in Figure 2 the stabilising pressure is still provided for by means of the annular extensions 5*a* and 6*a* between the inner or opposed faces of the pistons 7 and 8 and the inner end walls of the cylindrical enlargements 5 and 6, but the compression of the required volume of air for delivery to the cylinder 4 is effected by operation of the concentric extensions 11 and 12 of the pistons 7 and 8 within chambers 17 and 18 occupying the same position as the cushioning cylinders 13 and 14 illustrated in the arrangement shown in Figure 1, the required re-expansion energy for driving the pistons 2 and 3 towards each other to compress the air in the combustion chamber 1 to ignition temperature being derived by the re-expansion of the air in the spaces in the cylinders 5 and 6 between the outer faces of the pistons 7 and 8 and the outer end walls of such cylindrical enlargements, together with the air compressor re-expansion energy. That is to say, the arrangement illustrated by Figure 2 in effect exchanges the positions of the chamber shown in Figure 1 for supplying the compressed air to the cylinder 4 and the chamber forming the main air cushion providing re-expansion energy. By this arrangement the stabilising cushion and the main cushion are located within the same cylinder and the cylinder parts may be common to both, as illustrated.

I claim:

1. A free-piston gas generator of the type specified comprising a combustion cylinder, opposed combustion pistons operating in said cylinder, air compression cylinders mounted co-axially with said combustion cylinder one at each extremity thereof, piston-like enlargements mounted one on the end of each combustion piston remote from said combustion cylinder and arranged to reciprocate in said air compression cylinders to provide compressed air which is fed to the combustion cylinder, main pneumatic cushioning means associated with the ends of said air compression cylinders to provide a cushioning action during the outward stroke of the said pistons and piston-like enlargements and to provide part of the expansion energy for driving the pistons on the inward stroke, annular extensions on the inner end of each said compression cylinder said extensions being arranged to interact with the inner faces of said piston-like enlargements to compress the air in said extensions during the end of the inward stroke of said pistons and piston-like enlargements to provide auxiliary stabilizing cushions said auxiliary stabilizing cushions being at other times freely in communication with atmosphere through ports in the walls of said compression cylinders adjacent said extensions.

2. A free-piston gas generator of the type specified comprising a combustion cylinder, opposed combustion pistons operating in said cylinder, cylindrical enlargements formed at each end of said combustion cylinder, piston-like enlargements mounted one on the end of each combustion piston remote from said combustion cylinder and arranged to reciprocate in said cylindrical enlargements to provide a stabilizing cushion during the outward stroke of said pistons and piston-like enlargements by compression of the air in said cylindrical enlargements between the outer ends thereof and the outer faces of said piston-like enlargements, and also to provide part of the expansion energy necessary for driving the pistons on the inward stroke, annular extensions on the inner end of each said cylindrical enlargement, said extensions being arranged to interact with the inner surfaces of said piston-like en-

largements to compress the air in said extensions during the end of the inward stroke of said pistons and piston-like enlargements to provide auxiliary stabilizing cushions, ports formed in the walls of said cylindrical enlargements through which the said main cushions are open to atmosphere during the end of the inward stroke of said pistons and piston-like enlargements and through which the said stabilizing cushions are freely open to atmosphere at other times and air compression means associated with said cylindrical enlargements for providing compressed air which is fed to the combustion cylinder.

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