Feb. 19, 1963 F. G. FEELEY, JR 3,077,736

GAS GENERATING DEVICE

Filed March 4, 1959 2 Sheets-Sheet 1

FIG. 1

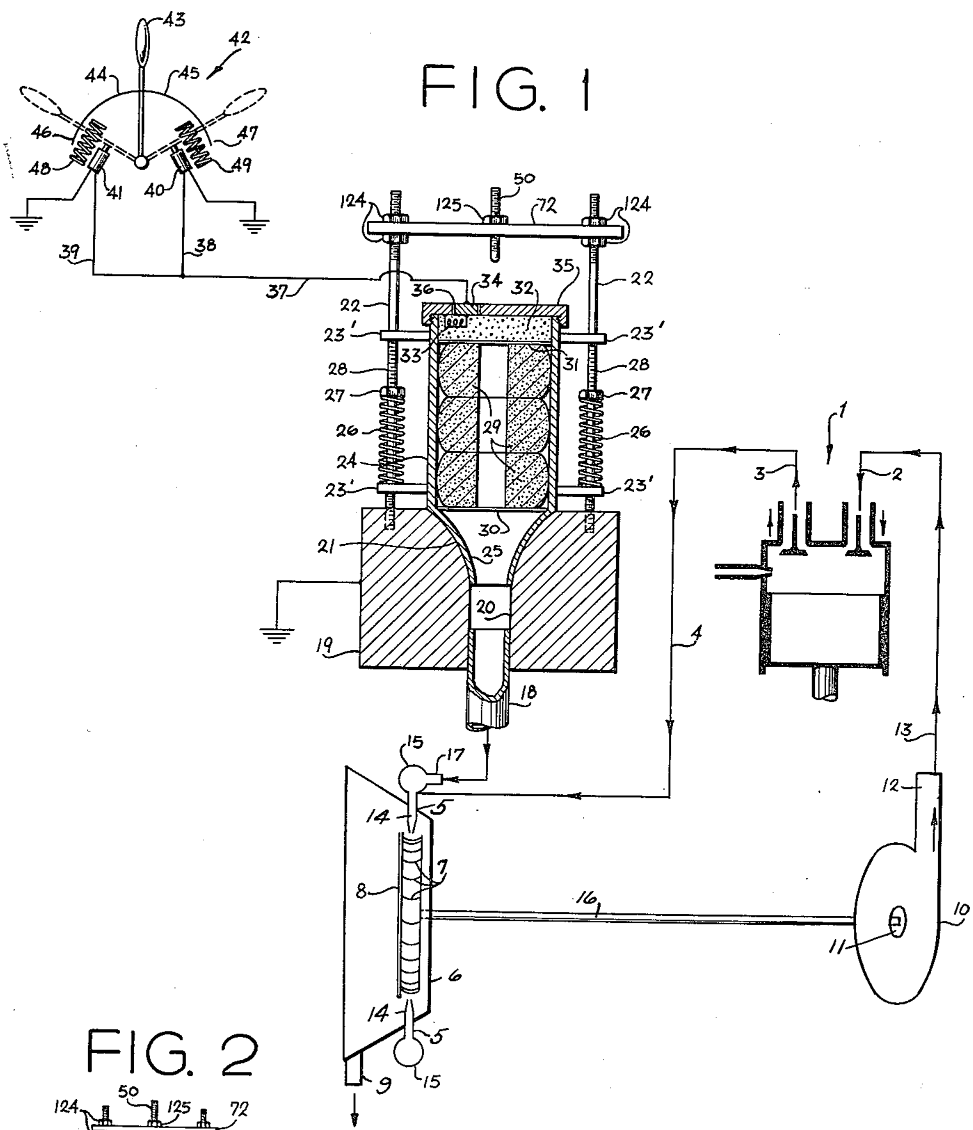
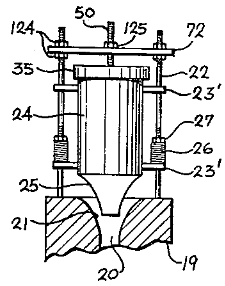


FIG. 2



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2 Sheets-Sheet 2

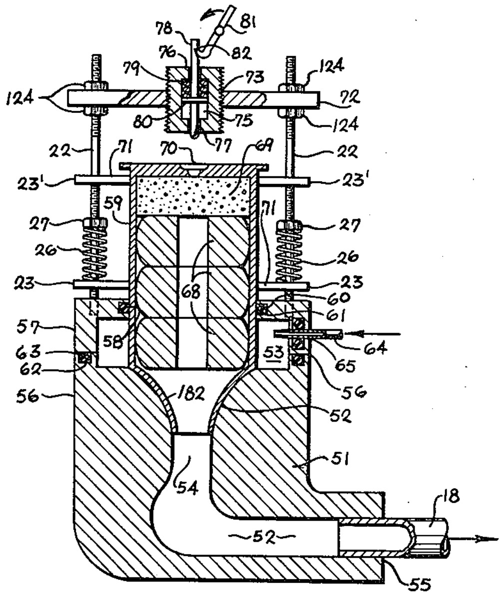

FIG. 3

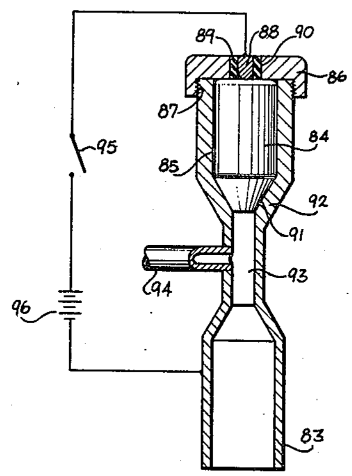

FIG. 4

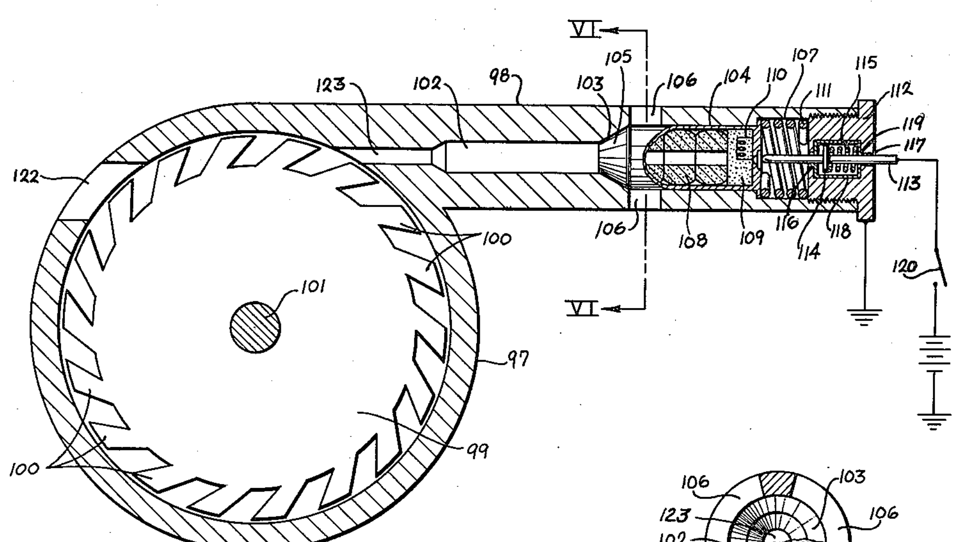

FIG. 5

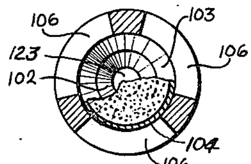

FIG. 6

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GAS GENERATING DEVICE

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3 Claims. (Cl. 60—39.47)

This invention relates to a gas generating device and more particularly to power units employed for applying motive power for driving superchargers for internal combustion engines, and for starting means used in aircraft propulsion, and the like.

In the operation of internal combustion engines, such as diesels employed in watercraft and railroads, it is common practice to supply air to support combustion of the fuel, in said engines, by means of a supercharger. The energy to drive the supercharger is often supplied by the exhaust products from the internal combustion engine. Clutching between the engine and the drive mechanism is accomplished by any conventional apparatus, such as a hydraulic mechanism. The speed of the engine is controlled by motion transmitting linkages terminating in a conventional accelerator lever, or the speed may be remotely controlled by having the aforesaid linkages terminate, at a distant point, in a conventional lever such as found in a control stand of a pilot house on watercraft. These levers not only control the speed of the engines, but also the direction of rotation of the shafts to which power is transmitted from the engines.

In the combination of a supercharger and an engine, when the engine is idling, the supercharger does essentially no work. However, when the clutch is engaged and the control lever is in position to increase the output of the engine, a governor in the engine receives an impulse to increase the fuel feed, but since the supercharger is driven by the exhaust products the air output is essentially nil, and accordingly, there is little air present for induction into the cylinders of the engines to burn the injected fuel. The result is not only a slow acceleration but also an extreme exhaust smoke generation, commonly referred-to as "black stacking." Attempts to overcome the problem of black stacking have been proposed in various accelerator rate control devices, which attempt to measure supercharger air pressure and then restrict the fuel oil feed to a value approximately that which can be burned in the air available. Such devices tend to reduce the black stacking, but however, unduly extend the acceleration time of the engine. The time involved, with such devices, in accelerating from idling to full speed is of the order of fifty seconds and is not considered an extreme delay in the normal process of accelerating watercraft, such as a barge train, for a long pull. However, in an emergency involving a "crash" maneuver to avoid danger of collision, the approximate fifty seconds can be the margin necessary to avoid disaster.

The above problems are not peculiar only to watercraft but are common to all heavily supercharged engines. The railroads are also plagued with these problems.

Any solution, heretofore proposed, necessarily involved a compromise between excessive smoking and excessive acceleration times. For example, an obvious solution to overcome the aforesaid problems is an installation of separately driven auxiliary superchargers but when it is realized that the duty of the superchargers necessitates units with inputs of approximately 1500 h. p., for internal engines producing 3,000 h. p., the folly of installing a separate supercharger becomes apparent. Such installation necessitates increased weight per horsepower of the engines, in view of the large capacity necessitated of them, together with provision of installation space for them which is all times at a premium. To date, further progress

in the supercharging of internal combustion engines, such as diesels, spark ignited engines and the like, which would decrease the weight per horsepower and increase efficiency, is virtually stalemated by problems involved in the compromise.

An alternate solution proposed to overcome the problems of smoking and accelerating is the provision of compressed air booster jets in the shroud of the supercharger which are piped to a source of high pressure air. However, in view of the volume of air and the amount of piping and controlling necessary, the disadvantages, to obtain the desired result, are excessive. For example, additional compressor horsepower necessary to maintain air pressure during maneuvering of the propelled vehicle is a major detriment. Also the maintenance of tightness of the piping and necessary control valves is also difficult. Further, since the compressed air blast is in effect a refrigerated expansion through jets, it is capable of causing damaging thermal stresses to the driving mechanisms of the supercharger.

Accordingly it is the object of this invention to provide for the elimination of the aforesaid problem of black stacking occuring in supercharged internal combustion engines without increasing the time necessary for acceleration.

Another object of this invention is to provide for an auxiliary motive means for superchargers which substantially eliminate problems of excessive smoking of internal combustion engines without substantially increasing their acceleration time.

A still another object of this invention is to provide an auxiliary motive means for superchargers employed with internal combustion engines which embody a gas generating charge.

A still another object of this invention is to provide a novel power unit for superchargers, and the like, embodying a gas generating charge capable of generating high energies which can be accurately controlled.

A still another object of this invention is to provide a novel power generating means embodying a gas generating charge whose motivating energy relative to quantity and temperature, can be accurately controlled.

A still another object of this invention is to provide a novel gas generating unit embodying a novel fluid transmitting means which is actuated by the gases generated when a propellant charge is ignited.

A further object of this invention is to provide a novel gas generating unit which embodies novel means of transmitting the resultant fluid pressure to a part to be moved.

A still further object of this invention is to provide a novel means and methods for controlling a combustion of an explosive charge.

The above objects are accomplished in a method which utilizes a controlled explosive charge which delivers a blast of hot gases to directly drive a supercharger to boost its output at the same time that an engine fuel control receives an impulse to increase the fuel supply.

In view of inherent disadvantages, explosive charges have heretofore not been universally employed for direct application to a prime mover, as in the manner of this invention. Among the disadvantages of explosive charges, for the generation of hot gases for direct application to prime movers are the excessively high temperatures which will cause the prime mover to heat up to dangerously high temperature values if the hot gases are maintained in operation for more than a relatively short time. These high temperatures result in the rapid deterioration of the parts impacted by the hot gases, and also injures other parts through which the hot gases pass. Such a disadvantage requires the provision of special alloys which are capable of withstanding the high temperatures generated by explosive charges. In addition, some of the charge is ejected by the hot gases generated in the form of unburnt or burning particles which are exhausted not only into the apparatus to be moved, but also into the atmosphere with resultant dangerous consequences to equipment and personnel in the vicinity of the exhaust. It has been discovered that such disadvantages are overcome, in accordance with this invention, by aspirating into the stream of combustion gases, cool and inert gases which insure the complete combustion of any ejective unburnt particles and reduces the temperature of the gases to safe operating levels. As a result of this discovery, the gas generating charge may be readily controlled for application heretofore thought impossible.

In accordance with the invention, the diluent gases are aspirated by a novel combination of means in which the stream of combustion gases is directed into a tubular passage creating a vacuum which draws in surrounding atmospheric gases into the stream to admix, therein, with the combustion gases, thereby cooling them and insuring complete combustion. Accordingly, this combination of means is hereinafter referred to as an aspirator, and is restricted to a hollow structure communicating with the atmosphere in any portion intermediate the outlet and extending to the inlet, through which hollow a rapid stream of fluid passes to create a vacuum drawing in the atmospheric gases. The aspirator of this invention is self sufficient for movement of gases and excludes any secondary movers, such as suction pumps, exhaust fans, etc., required for producing a primary movement of the aforesaid fluid and gases, but does not exclude any means of supplying the surrounding atmospheric gases.

Other objects and advantages become more apparent from the following description and drawings in which:

FIGURE 1 is a partial schematic and partial detail drawing of an embodiment of this invention in driving a super charger for diesel engines;

FIGURE 2 is an elevational view of an embodiment of this invention employed in FIGURE 1;

FIGURE 3 is an elevational view in cross-section showing another embodiment of this invention;

FIGURE 4 is an elevational view in cross-section illustrating still another embodiment of this invention utilizing a venturi tube;

FIGURE 5 is a cross-sectional view illustrating still another embodiment; and

FIGURE 6 is a cross-sectional view in elevation taken on lines VI—VI of FIGURE 5.

Referring to the drawings in FIGURE 1, 1 represents a single four or two cycle diesel engine in which the air to support combustion of the injected fuel enters at 2 with the combustion gases exhausted at 3.

No details of the diesel engine have been given since any conventional internal combustion engine may be used. However, in actual practice, two diesel engines actually supplying motive power for a tow boat plying the Mississippi and Ohio Rivers are employed. The engines are of the Nordberg type FS–1312; HSC 12-cylinder single acting V-type; 4-cycle producing 3000 h.p. each at 514 r.p.m. These engines operate at brake mean effective pressure of 185 p.s.i.g.

Each engine drives its propeller through a DeLaval Hindmarch combined clutch and reverse reduction gear. In operation the engine speed is controlled at idling speed of 220 r.p.m. and at full speed of 520 r.p.m. with the engines running in one direction only. Clutching in the ahead, or astern direction, is accomplished by hydraulic mechanisms. A local control stand in the engine room and a remote control stand in the pilot house control both the direction of rotation and the speed of rotation of the propeller shafts by conventional mechanisms, such as a Westinghouse Airbrake control stand.

The exhaust gases 3 from engine 1 are directed by means of suitable conduit 4 to inlet 5 of the turbine diagrammatically represented at 6 wherein the exhaust gases impinge on a series of vanes 7 carried on the turbine rotor a typical wheel of which is shown at 8 and exit from outlet 9. In this manner the motive power supplied by the exhaust gases drive rotor 8, which through a suitable motion transmitting means, such as a shaft 16, drives a blower 10. The compression type blower 10 receives ambient air in inlet 11, suitably compresses it and delivers it from outlet 12 through suitable piping 13 to inlet 2 of engine 1.

As above, with respect to engine 1, no further details of turbine 6 and blower 10 have been given since any conventional types may be used. However, in the instant application, turbine 6 and blower 10 are combined into a single unit, such as the Monorotor, manufactured by the DeLaval Steam Turbine Company which is an exhaust gas driven blower. This blower derives its name from the fact that it consists of a single flat circular structure mounted on a shaft with turbine blades mounted on one side and blower blades mounted on the other. The specific turbine employed is served by engine exhaust gases at a pressure of 32.6 inches of mercury at 910° F. which are exhausted from the turbine, to the atmosphere at about 700° F. The blower receives ambient air which is delivered to the engines at a pressure of 42.5 inches of mercury at 292° F., before after-cooling.

In accordance with this invention, a series of supplementary nozzles 14 are mounted to the shroud of turbine 6 to extend within the turbine, and are directed against vanes 7. The nozzles are suitably interconnected to each other by means of a manifold 15 provided with an inlet 17. The inlet 17, in turn, is connected by suitable tubing 18 to a mixer 19.

Mixer 19 depicting the preferred embodiment of the invention is provided with a bore 20 communicating with a flaring inlet 21 surrounded by a plurality of guide rods 22 suitably inserted, as by a screw thread engagement, into the body 19. Slidably mounted on guide rods 22, by means of bored ears 23 and 23′ is a cylindrical container 24 provided at its lower end with an inwardly flaring or converging outlet 25 of a configuration similar to the flared inlet 21 of mixer 19, so that it may seat and mate in sealing relationship with inlet 21.

Container 24 is urged against mixer 19 by means of a pressure responsive resilient member, such as helical springs 26, adjustably held in compression against ears 23 by nuts 27 mounted about the threaded portion 28 of guide rods 22. Container 24 contains a suitable gas generating charge 29 which will burn progressively without detonation thereby generating solely relatively large volumes of gases at a relatively high temperature and pressure. Charge 29 is sealed within the container by means of flammable discs 30 and 31. Also placed within container 24, above disc 31, is a quantity of an ignitor 32 adapted to be ignited by a suitable bridge wire 33 connected to an electrode 34 and end cap 35. Electrode 34 is insulated by suitable non-conducting material 36 from the end cap which is adapted to be suitably mounted on container 24.

Although as specifically described, charge 29 and ignitor 32 are shown to be placed within container 24. However, as will be understood, container 24 may be adapted to also act as a receiving chamber to receive a self-contained gas generating cartridge.

Electrode 34 is electrically connected by electrical conducting wires 37, 38 and 39 to two momentary contact switches 40 and 41 mounted at the extreme points of travel of a single lever control 42 of the type customarily employed for control of variable speed engines, such as used in marine and railway work. These types of control have a quadrant 45 with a handle 43 striking up through a slot 44 which travels through a range from full power ahead, at one extreme limit of travel 46, to full power reverse at the other extreme limit of travel 47. At mid-position, of handle 43 within the quadrant, the engine (S) is idling, and the acceleration and/or reversal of the ultimate driver, as for example propeller, is accomplished by moving the handle a desired distance to the left or to the right. The motive power to the ultimate driver is supplied to the engine by an appropriate and conventional clutching mechanism.

In the instant embodiment, detention springs 48 and 49 are mounted, together with momentary contacts which are 41 and 40, respectively, at the extreme ends of the quadrant and are adapted to normally stop the movement of lever 43. In addition, the detention springs are also adapted to yield under a continuing firm movement, of lever 43, to close one of the momentary contact switches to complete an electrical circuit which ignites the charge within container 24. Mounted on guide rods 22 by means of nuts 124 is a backing plate 72 in which an adjusting screw 50 is threadedly mounted to limit the upward travel of cartridge 24 upon ignition of the gas generating charge contained within the cartridge. The seating of adjusting screw 50 is set by a nut 125.

In normal operation, if supercharger boosting is not required, it is not necessary to fire the charge since it is possible for the operator to accelerate the engine slowly. Generally, the operator can watch the stack discharge and deliberately retard acceleration to a value which will permit the inertia of the supercharger to be overcome by the increasing exhaust gas flow 3 of engine 1. However, when rapid acceleration is essential, as in emergency or crash maneuvers, he will throw the control lever 43 to one of the extreme positions 46 or 47 where it will strike one of the detention springs 48 or 49 which would normally stop it. However, a continuing firm movement of the control lever, will depress the detention spring and move the momentary contact switch, which by an electrical impulse, will fire the gas generating charge.

On firing of the charge, the blast reaction resulting from the ignition of the charge will push container 24 upwardly away from the mixer 19 aagainst springs 26 to a stop against an adjustment screw 50 as indicated in FIGURE 2. This movement of the container forms an annular opening between the exterior walls of the outlet 25 and the flaring inlet 21. The flow of the generated gases is directed into bore 20 which result in the generation of a reduced pressure, about the annular opening, causing air to be drawn into mixer 19 to not only cool, but also insure the complete combustion of any particles blown out of container 24.

The amount of air aspirated will be a function of the specific nozzle design, of outlet 25 and flaring inlet 21, and the lift permitted by adjusting screw 50. The gases injected into mixer 19 aspirate sufficient air, depending on the nozzle design, type charge and adjustment of screw 50, to dilute the combustion gases, and drive turbine 6. The turbine is driven by the projection of the blended gases through conduit 18, manifold 15 and nozzles 14 to impinge against vanes 7.

The gas generating charge is a solid propellant of the type commonly employed in rocket or reaction motors, such as those used in starting engines or assisting the take-off of planes, which when ignited will burn at a relatively sustained constant and rapid rate until completely consumed. The time of burning will depend primarily on the type and length of the charge while the rate of energy released, in the form of hot combustion gases, is substantially proportional to the cross-sectional area and the surface area of the charge presented for ignition, and upon the cross-section of the constriction of outlet 25 of container 24. In the instant case, even though the characteristics of the charge in container 24 are fixed, the amount of aspirated air can be controlled by means of the adjusting screw 50 which controls the outward limit of travel of container 24, and the corresponding annular opening between outlet 25 and the flaring inlet 21 of mixer 19.

In practice, for the pieces of equipment specifically described above, a suitable gas generating charge should deliver combined blended gases to the turbine 6, from mixer 19, at a magnitude of 40 H.P. with the gases usually at a temperature between 900° to 1800° F. at a pressure of 50 to 250 pounds per square inch for a duration of 15 seconds. The gas generating charge contemplated for use with this invention may be readily selected from conventional propellants that are commercially available. Examples of such propellants are conventional ammonium nitrate propellants with suitable binder; double base propellant such as a gelatinous composition of nitro cellulose-nitro glycerin such as described in U.S. Patent No. 2,417,-090 issued March 11, 1947 to C. E. Silk, et al.; and composite solid propellants of higher energy. The composite higher energy propellants are, broadly, dispersion of inorganic oxides such as ammonium perchlorate and ammonium nitrate in a fuel matrix. The fuel binder is normally an asphaltic or rubber like material which may have included therein modifiers such as ammonium oxolate, ammonium carbonate and carbon black for lowering the burning temperatures, or guanidine nitrate, nitro guanidine and trinitrotolulene to increase the burning rate of the propellant. In addition the propellant may contain catalysts, such as various chromates and other compounds based on chromatic oxides, for the decomposition of ammonium nitrate. Of the indicated propellants, the ammonium nitrate propellant is preferred since it has a property of burning at a cooler rate, thus requiring a smaller volume of diluent gases for cooling the stream of combustion gases. In the case of the two 3,000 H.P. engines, described above, the quantity of the propellant selected should be capable of generating a stream of blended gases at a magnitude of 40 H.P. to decrease the acceleration time from idle speed (220 r.p.m.) to full speed (520 r.p.m.) from fifty-plus seconds to about ten seconds. As will be appreciated, this time difference, particularly in an emergency involving crash maneuvers, can be very critical. In the embodiment described, the specific arrangement of the quadrant with lever 43 and momentary contact switches 40 and 41 is particularly preferred since it requires no special thought or additional operation on the part of the operator, in an emergency, to ignite the gas generating charge since it utilizes the operator's natural reaction of jamming the control handle when he is under stress.

Although a specific mixer 19 and container 24 have been described, it is to be understood that the configurations of the aforesaid elements are not restricted to the embodiments described. For example, the cartridge may be partially extended within the bore of a mixing tube to provide an annular opening between the exterior walls of the inserted portion, of the cartridge, and the wall of the bore to provide for the aspiration of air. However, the preferred form contemplates the structure as described wherein the configuration of the outlet 25 forms with the flaring inlet 21 of mixer 19 in effect a venturi shaped mixing throat when container 24 is moved upward by the blast reaction.

Although the instant device is intended to operate for approximately 15 seconds and despite the high temperatures involved, in the generated gas, the combustion products are cooled to a sufficiently low value to prevent the turbine from reaching a temperature of a dangerous value before the termination of the operation. The temperatures of the specific turbine described are well below any dangerous values. It is to be understood that if the device is to operate for other values of time, shorter and longer, other charges and quantities thereof, may be readily substituted in the device with the volume of the air aspirated controlled by the adjustment of screw 50.

While a single power unit has been shown, which requires the charge to be replaced after it has been ignited, it is to be understood that a plurality of holders may be provided which permit one or more units to be fired simultaneously. Also, although turbine 6 and a gas generating unit have been described as distinct structures connected by conduit 18, it is to be understood that the gas generating unit may be provided as an integral part of the turbine shroud along which one or more power units may be dispersed with the outlets suitably directed against the turbine blades 7. Also the invention contemplates the employment of a suitable magazine for a plurality of gas generating units whereby a plurality of firings may be obtained before replacing the cartridges.

Although the above describes an electrically initiated gas generating charge for the aspiration of air in accordance with this invention, FIGURE 3 illustrates another embodiment of the invention utilizing a gas generating charge which is mechanically ignited for the aspiration of gases other than air. A mixer 51, similar to 19 of FIGURE 1, is provided with a flaring inlet 52 communicating with an annular space 53 contained within an annular shoulder or wall 56. The inlet 52 also extends as passageway 54 with a conduit 18 mounted on outlet 55. Mounted on shoulder 56 is a cover 57 provided with an opening 58 in which a cartridge 59 is slidably engaged in sealing relationship by a circular groove 60 and an O-ring 61. In like manner, sealing relationship between cover 57 and shoulder 56 is also provided by means of a circular groove 62 and O-ring 63.

A nozzle 64 extends within chamber 53 through a radial opening 65 provided in either shoulder 56 or cover 57, in which opening nozzle 64 is sealed by means of a circular groove 66 provided with an O-ring 67. Nozzle 64 is connected to a source of saturated steam which is injected into chamber 53 at low pressure. A cartridge 59 contains a suitable gas generating charge 68, ignitor 69 and a primer 70, and is mounted to the mixer by means of clamps 71 which are slidably engaged on guide rods 22 by means of ears 23 and 23'. The remaining supporting structure and limiting structure is similar to that described with respect to FIGURE 1 with the exception that backing plate 72 has threadedly engaged within the opening 73 a firing and limiting means 74.

Means 74 is provided with an annular chamber 75 and passages 76 and 77 through which a firing pin 78 is slidably mounted in limited movement. A resilient means such as a spring 79 acting on a shoulder 80 of firing pin 78 urges a firing pin in the firing position, however, the pin is maintained in the armed position by means of a trigger 81 engaged in a notch 82 provided in the upper portion of firing pin 78.

In operation, trigger 81 is withdrawn from the notch provided in firing pin 78 which permits the firing pin to snap forward into primer 70 to ignite ignitor 69 and charge 68. The blast reaction causes cartridge 59 to be urged upward until arrested by means 77. This movement forms an annular opening between the flared outlet 182 of cartridge 59 and flaring inlet 52 or mixer 51. The annular opening causes chamber 53 to communicate with passageway 54 thus permitting the stream of gas generated products to aspirate within the mixer a quantity of saturated steam, at low pressure, wherein they are super heated to cool the combustion products. The resultant stream of blended gases projected from conduit 18 is directed against the part to be moved, such as turbine blade 7 of turbine 6.

FIGURE 4 illustrates a further embodiment of the invention in which the aspiration and blending of the cooling gases is accomplished by a venturi tube 83, and in which the sealing relationship of a cartridge 84 within a breech 85 in tube 83 is accomplished by a cap 86 threadedly attached to the inlet portion 87 of venturi tube 83. Cartridge 84 contains suitable gas generating charge adapted to be ignited by any conventional means such as a bridge wire, not shown. Electrical contact with the cartridge is made by an electrode 88 embedded in a plug of electrical insulating material 89 and inserted in an opening 90 in cap 86. An inlet portion venturi tube 83 to serve as a breech, and cartridge 84 is adapted so that a frusto-conical portion 91, of cartridge 84 seats in the frusto-conical portion 92 of tube 83, so that the flow of gases is directed along the throat 93 which communicates with the atmosphere through conduit 94. A suitable electrical circuit connected to a source of electrical energy, such as a plurality of batteries 96, is broken by switch 95 and connected across electrode 88 and venturi tube 83.

On closure of switch 95 the electrical circuit is completed to ignite a gas generating charge in cartridge 84 causing a flow of combustion products through the venturi throat 93. The rapid flow of combustion gases creates a reduced pressure in conduit 94 which aspirates diluent atmospheric gases to blend with and cool the combustion products. The gases projected from the outlet of venturi tube 83 are in an appropriate manner, such as in FIGURE 1, directed against a part to be moved, as for example, a turbine.

Although the invention has been specifically described in relation to its application in a supercharger for diesel engines, it is to be understood that it has other applications, such as other internal combustion reciprocating engine gas generators inclusive of free piston devices, engine starters, in aircraft propulsion, or other force transmitting devices, connected through an appropriate gear reduction and clutch arrangement to drive, or accelerate, an aircraft engine to its starting speed. For example, FIGURE 5 illustrates a still further embodiment of this invention which comprises a rotor 99 provided about its periphery with a series of vanes 100. The rotor 99 is rotatably mounted on a shaft 101 within a casing 97 having an integral tubular extension 98 which is tangential to the periphery of rotor 99. The extension 98 has an inner bore 102 in which the outer end is chambered at 103 to receive a gas generating cartridge 104 with a constricted portion 105 seating in the chambered portion 103. The outer end of bore 102 which serves in effect as a breech for cartridge 104 is provided with a plurality of radial outlets 106, and has an extreme enlarged portion 107 to accommodate the head, or base, of cartridge 104. As above, cartridge 104 contains conventional charges of a propellant 108 and an ignitor 109 which is actuated by means of a bridge wire 110 within the cartridge.

A resilient means, such as spring 111, maintains cartridge 104 in sealing engagement with chamber 103, and is urged against the head, or base, of the cartridge by a plug 112 which is threaded into the end of bore 98. A firing pin 113 provided with a flange 114 is slidably mounted in a chamber 115 and openings 116 and 117 in plug 112 in insulating relationship by means of electrical non-conducting material 118. Firing pin, or electrode, 113 is urged against an appropriate electrical ignition means in cartridge 104 by means of resilient means, such as helical spring 119, held in compression against flange 114. The firing pin 113 is connected to a source of electrical energy 121 by an electrical switch 120. The source of energy and the casing 97, or extension 98, are suitably grounded to provided a complete circuit when switch 120 is closed.

Bore 102 is provided with a reduced nozzle portion 123 which leads into the interior of the housing to project the gases generated, upon ignition of cartridge 104, against vanes 100.

Casing 97 is also provided with an exhaust port 122 to exhaust gases from the casing, and shaft 101 is provided by suitable gear train to the part to be moved, such as for example, an airplane engine.

In operation when switch 120 is closed, the blast reaction from the ignited gas generating charge causes cartridge 104 to be moved rearward against spring 107 until it becomes arrested thereby causing the conical portion 105 of the cartridge to form with chamber 103 an annular opening which communicates with radial outlets 106. The flow of gases through bore 102 creates a reduced pressure which aspirates air through outlets 106 to blend into the stream of combustion gases thereby cooling the gases. The blended gases are then directed by the restricted opening 123 to impinge on vanes 100. After rotation of the rotor 99, the gases are exhausted through opening 123. The rotation of rotor 99 through conventional gear transmission transmit energy to perform work, as for example in cranking up an airplane engine.

Although the invention has been described with reference to specific embodiments, materials and details, various modifications and changes will be apparent to one skilled in the art and are contemplated to be embraced within the invention.

What is claimed is:

1. A power unit comprising an aspirator provided with a bore at one end in an outward flare, a hollow container with an outlet adapted to seat with fluid tight engagement in said flare, a charge of an explosive in said container, ignition means for said explosive, retaining means urging said container into sealing engagement in said bore, said retaining means adapted to permit said container to be urged outwardly from fluid tight engagement in response to a blast reaction upon ignition of said explosive, and limit means to limit the outward travel of said container.

2. The structure of claim 1 in which the retaining means comprises a resilient member.

3. The structure of claim 1 wherein the limit means is adjustable to control the outward travel.

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