April 26, 1949. J. A. SENN 2,468,120

AIR TURBINE GENERATOR FOR FUSES

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Fig. 1.

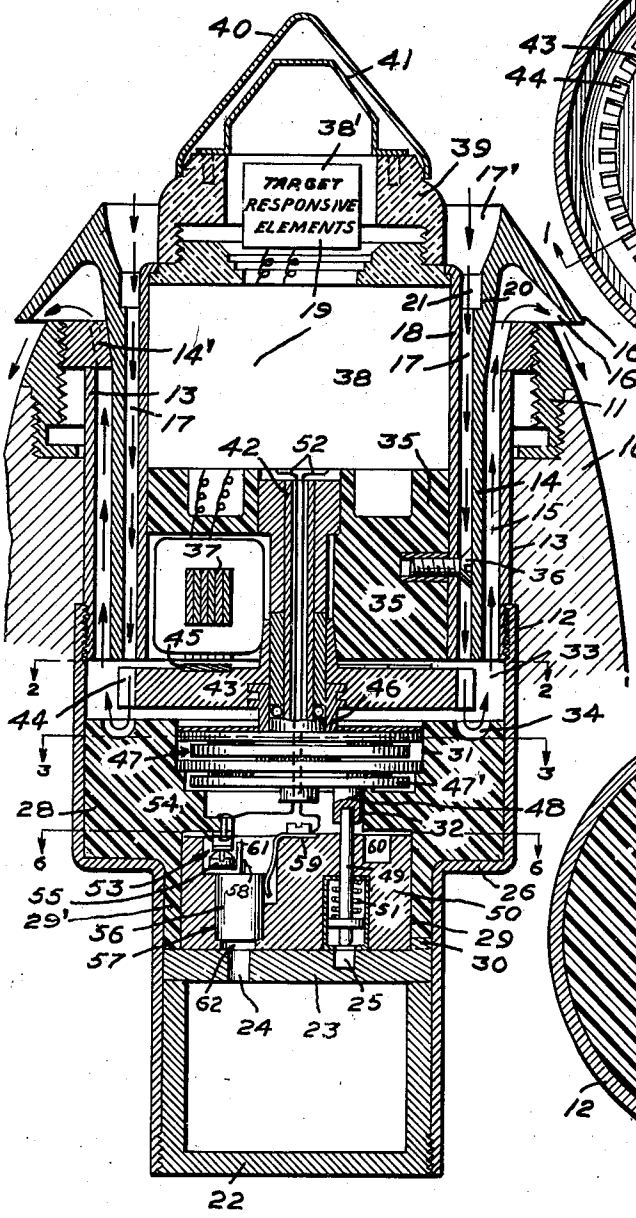

Fig. 2

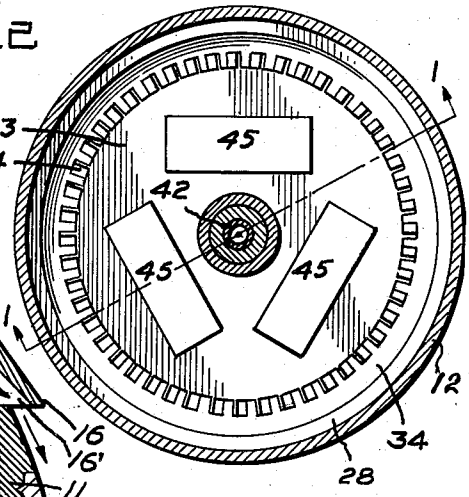

Fig. 3

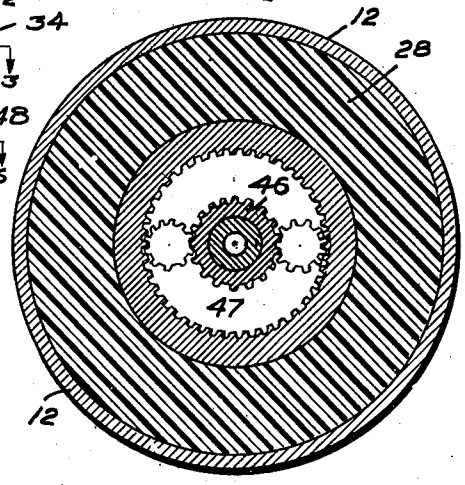

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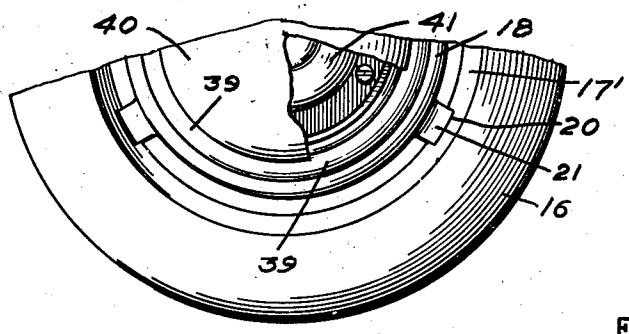
Fig. 4



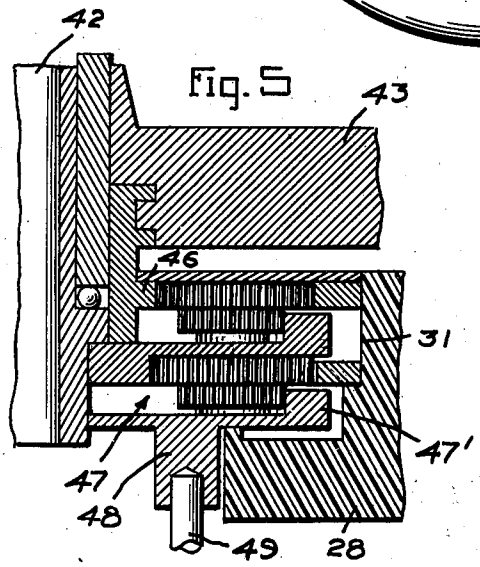


Fig. 5

Fig. 6

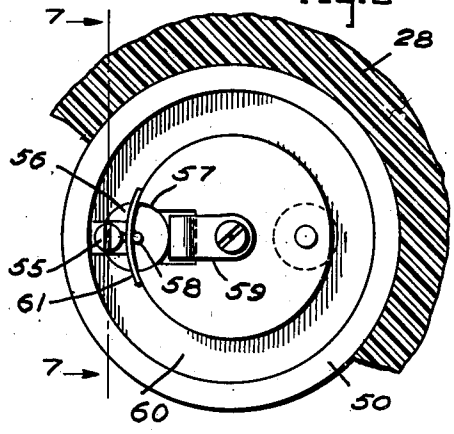


Fig. 7

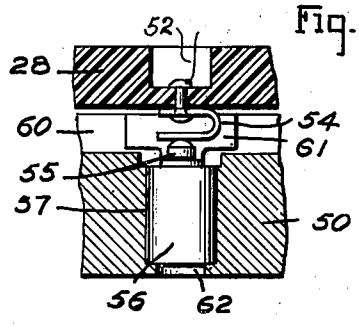
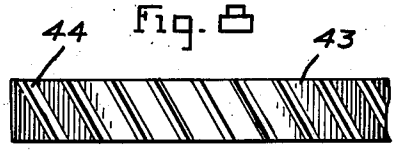


Fig. 8



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Patented Apr. 26, 1949

2,468,120

UNITED STATES PATENT OFFICE

2,468,120

AIR TURBINE GENERATOR FOR FUSES

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Application December 17, 1947, Serial No. 792,251

8 Claims. (Cl. 102—70.2)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

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The invention described in the following specification and claims may be manufactured and used by or for the Government for governmental purposes without the payment to me of any royalty thereon.

This invention relates to projectile fuzes and more particularly to proximity fuzes having a rotary electric generator constituting the power source for various control apparatus contained within the fuze casing.

The proximity fuze is one which is automatically ignited by the proximity of the target when and if it approaches within a predetermined distance therefrom. In order to adapt such fuzes to standard ordnance projectiles, such as bombs, rockets, or shells, it is usually necessary to crowd a large number of components into a small space. Known types of proximity fuzes usually utilize electric circuits including electric components, and hence require a source of electric power, which is often an air-driven generator, the power being furnished by a windmill mounted in the nose of the projectile. Since proximity fuzes are inherently very dangerous, it is necessary to provide them with safety arming devices to insure that the projectile will not become armed until it has proceeded a safe distance from its starting point. Such safety arming devices have been driven from the same vane which provides the motive power for the generator. Mechanical and space considerations prior to my invention usually required the safety arming devices be located in the base oft he fuze, near the detonating element. The preceding requirements have in the past dictated the design of a relatively long fuze projecting a considerable distance from the projectile casing, and a long shaft extending from a vane on the nose to the arming mechanism in the rear. The shaft, with such design, must pass through the very sensitive electronic section with consequent parasitical electrical disturbances and impairment of the electronic output, particularly in radiant transmission devices. Special precautions were devised to overcome these difficulties, which my invention obviates. Slight vibration of a shaft passing near electronic circuits constituted a source of serious interference. It is difficult to prevent vibration of a long shaft at the high speeds usually involved, so that the problem is not a simple one. A fuze of great longitudinal measurement may also interfere with the ballistics of the projectile.

It is a primary object of my invention to obviate the above difficulties by providing an air drive for a proximity fuze generator and arming system, said drive and all moving parts being located at a distance from the nose or near the base of the fuze, without requiring alteration of standard types of projectile casings and without requiring the use of a long fuze.

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Another object is to provide a compact system of the type described, having no exteriorly exposed blades liable to damage or accessible to tampering, and capable of ample speed. Other objects will appear as my description proceeds, and these, as defined by the appended claims, I intend to embrace within the scope of my invention.

In the drawings:

Figure 1 is a longitudinal section on line 1—1 of Figure 2 of the nose portion of a projectile containing a fuze constructed in accordance with my invention.

Figure 2 is a section on line 2—2 of Figure 1.

Figure 3 is a section on line 3—3 of Figure 1.

Figure 4 is a front end view of the fuze apart from the shell.

Figure 5 is a detail of the gear train.

Figure 6 is a section on the line 6—6 of Figure 1.

Figure 7 is a fragmentary section on the line 7—7 of Figure 6.

Figure 8 is a fragmentary edge view of the rotor.

Referring to the drawings, there is illustrated a forward portion 10 of a projectile body, in which a suitable coaxial recess is provided to receive a fuze assembly in a convenient manner, the recess opening forwardly through the end of the projectile, and the fuze assembly supplying surfaces approximating the conventional nose form of the projectile, as will appear.

An adapter ring 11 is shown as one means for mounting my assembly in a conventional fuze receptacle of the projectile, this ring being standard for projectiles so as to thread into the opening therein flush with the ogive of the shell.

The fuze assembly comprises a tubing case 12 having a reduced diameter at its rear end and a major forward part of greater diameter, including a forward sleeve or wall extension 13 threadedly connected to the front portion of the larger part of the case, and stopping just short of the plane of the forward side of the adapter ring. The latter is interiorly threaded, and receives a retainer ring 14' screwed into the adapter ring and against the outer or forward end of the wall extension sleeve 13.

Either integral with, attached to, or separate from, the retainer ring there is a tube 14 which is

arranged in concentric spaced relation with the wall 13, so as to afford an annular air outlet or exhaust duct 15 between the two. The outer end of the tube is enlarged so as to form an annular apron 16 projecting radially over the open end of the duct 15, and slightly beyond a symmetrical geometrical projection of the ogive surface of the ring 11. The under side of the apron is suitably shaped to afford guidance to air from the duct with a minimum of resistance and to form an ejector mouth 16'. While not material, the terminal edge or lip of the apron lies in a plane with the outer end of the ring 11. The inner side of the tube 14 is flared at its forward end to form an enlarged throat 17' or intake for the air entering the fuze, through an annular intake duct 17 which is constituted between the tube 14 and the case 18 of an electrical unit 19 to be described. The tube 14 is formed with notches 20 at the base of the throat, into which fit snugly lugs 21 carried by the case 18, as a centering means, and as retainers for the tube if the latter is separate from the ring 14'.

In the innermost and reduced part of the case 12 a booster container 22 is fixed, over which within the reduced part of the case there is a partition plate 23 fitted to the inner surface of the reduced wall of the case and having a flash port 24 therethrough at one side, and a small socket recess 25 on the same diameter at the opposite side of the center of the plate. The enlargement of the case 12 affords a shoulder or shelf 26 a short distance above the partition 23, and in the enlargement of the case thereadjacent there is set and fixed a base body 28 of insulating material fitted to the large wall of the case 12, and stopping short of the wall extension sleeve 13 a short distance. The body 28 also has a part of reduced diameter fitted within the reduced lower portion of the case 12 and extending to the partition 23. This extension of the body is formed with a concentric cylindrical socket or interrupter chamber 29 opening on the base end of the body 28, to receive an interrupter and arming rotor to be described. A cylindrical wall 29' of reduced diameter is thereby formed on the body 28, the lower edge of which is notched and receives a key lug 30 on the partition 23, by which the partition and body 28 are fixed in a definite angular relation on the axis of the fuze and are locked against relative rotation, which is important. In the forward side of the base body a concentric gear box recess 31 is formed, and a large concentric bore 32 forms communication between the latter and the recess 25.

The electrical unit 19 stops in spaced relation to the base body 28, affording a rotor chamber 33 occupying the full diameter of the large part of the case 12. The tube 14 may extend to the lower side of this chamber or stop at the upper side as shown. In the top face of the base body near its periphery an annular channel 34 is formed concentric with the fuze so as to be aligned at its inner side with the inlet duct 17. The channel is semicircular in cross section, with the axis of the transversely curved surface approximately in line with the tube 14, so that the outer side of the channel is under the exhaust duct 15. It consequently serves to reverse the direction of entrant air with a minimum of turbulence.

A generator stator body block 35 of insulating material is fixed in the lower part of the case 18, forming the forward boundary of the rotor chamber. The block 35 is secured to this case by screws 36, the heads of which project from the case 13 radially sufficiently to engage the inner face of the tube 14, serving to space the latter from the case 18 and preserve the symmetry of the intake duct 17.

In the stator body material there are set a plurality of windings and cores 37, the cores having poles exposed at the rotor chamber. The windings and cores may conform to various approved practices for such machines to cooperate with a magnet rotor and corresponding generally to magneto practice.

Over the stator a considerable space is afforded in the case 18, in which a part of a target-responsive electronic system 38 is installed, which may include an element 38' sometimes used in the extreme nose of the fuze responsive to light focussed thereon by a lens 39 mounted on the forward end of the case 18. Other elements of different function may be substituted, or additionally mounted in the nose for producing response to target proximity in the electronic system when energized by the generator, as found advisable or expedient. While in the present instance a windshield cap 40 and an inner cap 41 are shown mounted on the lens, this part of the fuze may be variously constructed as required.

In the specific instance illustrated, the lens periphery forms the inner wall of the throat 17' and aids in focussing air into the latter, but in alternative systems casing parts or other elements may be similarly located and similarly effective or not. The air-focussing shaping of such lens and alternative parts is not essential, and the flare of the tube 14 will be adquate for the uses intended if a simple cylindrical wall is located at the inner side of the throat. Modifications of the throat form may also be practiced as requirements may dictate, to augment or diminish the air pressure in the throat.

Fixed coaxially in the stator body there is a hollow shaft 42, opening through the forward side of the stator, and extending therebelow across the rotor chamber through the gear box recess, and into the bore 32 between the latter recess and the interrupter rotor recess 29.

Revoluble on this shaft there is a rotor 43, which is in the form of a flat disc lying in close relation to the stator and to the base body 28. On its substantially cylindrical periphery there are formed a multiplicity of helicoidal vanes 44, in line with and close to the lower end of the intake duct 17, but stopping short of the outlet duct 15. In the upper side of the rotor there are set a plurality of permanent magnets 45, which as shown are flat plates of small dimension in a direction parallel to the axis of the rotor. They may be coordinated in size and number with the proportions and number of the cores of the stator, in conformity with known principles governing or applicable to the building of such machines.

The rotor carries a small spur sun gear 46 fixed on the rotor and meshed with the uppermost floating planetary gear or other gear of a speed reduction train 47 of any approved form suitable to the use contemplated. In the present instance the lowermost or driven gear of the train is a revoluble member 47' engaged revolubly around the lower end of the shaft 42 and so centered by the latter in the assembly. This lower driven element carries a wrist pin or crank 48 fixed on its lower side and projecting into the

bore 32, for orbital movement therein in a path concentric with the fuze axis and close to the wall of the bore. The lower end of the crank is recessed and receives retractably therein from below a plunger pin 49, which is mounted slidably in an interrupter and arming rotor 50 disposed revolubly in the interrupter chamber 29. This pin is parallel to the axis of the fuze, and of such length that when its upper end is set in the recess of the crank 48, its lower end rides slidingly on the partition plate 23, which holds it so engaged in the crank until travel of the interrupter brings the plunger over the socket 25. The plunger is loaded by a spring 51 in a lower enlargement or counter bore of the interrupter in which the plunger slides, and the spring is confined against the upper end of the counter bore by a collar on the pin, so that the pin is thrust downward and moves into the socket in the plate 23 as soon as the pin arrives in line with the latter. The plunger thus locks the interrupter in the arming position, and also frees the interrupter from the gear train so that operation of the generator rotor is not interrupted. From then on the generator is effective in maintaining potential for a detonating circuit 52 (two leads only of which are shown) which is open in the electronic system, but will be closed there in response to certain external effects by which the electronic system is designed to be controlled. This same detonating circuit is also normally open at a switch 53 having a contact fixed on the interrupter diametrically opposite the plunger 49 in the present instance although this position may be otherwise in angular relation to the position of the plunger. A wiper or brush 54 is mounted on the base body 28 diametrically opposite the socket 25, and constructed with a resiliently supported wiper proper arranged to engage and wipe the top of an insulated contact button or screw head 55 carried by the arming rotor. This contact 55 is part of a detonator device which includes a squib or primer 56 set in a suitable socket 57 in the interrupter. This socket opens through the top of the interrupter for insertion of the squib therein, the central insulated lead 58 from which may be secured to the contact 55. As a conventional illustration, a spring contact 59 is shown at one side of the socket to which one of the leads 52 in the circuit is connected and insertion of the primer causes its cup to effect contact with the contact 59, so that when the circuit is completed otherwise, and the wiper 54 has been engaged with the contact 55 detonation will occur.

The contact 54 extends into a channel 60 formed concentrically in the top of the interrupter and extending across the outer side of the socket 57. The contact 55 may be fixed on the primer for insertion therewith and may include an upstanding substantially planiform flange 61, ears on which are arranged to project into the channel 60 at opposite sides of the socket 57, thereby assuring proper position, of the contact 54. The bottom of the socket 57 has a flash port 62 therethrough, which is aligned with the flash port 24 when the plunger 49 engages in the socket 25.

When the projectile is in flight, air pressure will be built up at inlet 17', due to its configuration, while a reduction in pressure will exist at outlet mouth 16' due to the aspirating effect of air deflected by the apron 16 past the mouth 16'. This pressure differential causes flow of air down through passageway 17, across turbine blades 44 and up through passageway 15. Inasmuch as both the inlet and outlet air pressures are a function of the projectile velocity, their difference tends to remain relatively constant over a fairly wide range of projectile velocities, although the algebraic sum is proportoinal to the speed of the projectile.

In use, the plunger 49 will be disposed an angular distance from the socket 25 proportionate to the time of flight desired for the projectile in unarmed condition. In such condition, upon firing of the projectile, the air entering the inlet duct 17 and passing out through the duct 15 will operate the rotor 43, and the latter through the gear train 47 will move the crank 48 in a circular path, carrying with it the plunger 49, whose rear end slides upon plate 23 forming the flat bottom of the socket 29. When the plunger comes to the socket 25, it is thrust downward thereinto by its spring shortly after the circuit is closed at switch 53 through the squib 56, and locking the interrupter in this armed position. Continuation of the operation of the generator rotor supplies the necessary energy to the electronic unit. In the latter the firing circuit will still be open until proper target response of the fuze occurs, which will occur subsequently in the conventional manner.

I claim:

1. A fuze for ordnance projectiles comprising an annular air inlet passageway having an annular forwardly directed inlet opening, an annular air outlet passageway concentrically disposed with respect to said annular air inlet passageway and substantially coextensive therewith in circumferential extent and having an annular rearwardly directed outlet opening, a common wall between said two passageways, a turbine rotor having its axis concentric with said annular passageways and its blades disposed in the path of said inlet passageway, and fuze elements driven by said turbine rotor.

2. A fuze for ordnance projectiles comprising a streamlined nose portion, a cylindrical body portion rearwardly of said nose portion, an annular air inlet passageway having an annular forwardly directed inlet opening disposed forwardly of said body portion and rearwardly of said nose portion, an annular air outlet passageway concentrically disposed with respect to said air inlet passageway and substantially coextensive therewith, a common wall between said passageways, an annular rearwardly directed outlet opening for said outlet passageway comprising an annular skirt joined to the forward edge of the said common wall and extending rearwardly therefrom, the exterior configuration of said skirt being such that it and the nose portion together form a streamlined fuze head, and a turbine rotor disposed rearwardly of said cylindrical body portion for actuation by air flowing down said air inlet passage.

3. The invention as recited in claim 2 and comprising an electric generator and a delayed arming device driven by said turbine.

4. The invention as recited in claim 2 and comprising a generator and a delayed arming device driven by said turbine and disposed adjacent thereto.

5. The invention as recited in claim 2 and comprising a shaft driven by said turbine, speed reduction means driven by said shaft and disposed rearwardly of said turbine, and a delayed arming device disposed rearwardly of said speed reduction means and driven thereby.

6. The structure of claim 5 in which said speed reduction means comprises a driven member concentric with the fuze and having an eccentric socket in its lower side, said arming device comprising a rotatable arming member having a plunger therein normally set in said socket, a stationary surface beneath the rotatable arming member, plunger spring means urging said plunger against said surface while still engaged in said socket, a recess in said surface in the path of the proximal end of the plunger to receive the same when aligned therewith, said plunger being of a length to clear the said socket when engaged in the recess, and an electrical switch arranged to be closed by the arming member when the plunger is engaged in said recess.

7. An air-operated turbine apparatus comprising a substantially cylindrical casing structure adapted to be propelled at high speed along the axis thereof, the advance portion of said casing structure having a central nose section and an outer annular section spaced therefrom, said outer section having a retrorsely flaring skirt portion, means providing an interior annular passageway extending coaxially within said casing structure, said passageway having an annular inlet opening between said nose section and said outer annular section and an annular discharge outlet opening adjacent said skirt portion, and a turbine rotor journalled within said casing structure in the path of air flowing through said passage.

8. In a projectile, a body, a cylindrical shell section secured to said body coaxially thereof, said shell section terminating in an annular retrorse shroud portion, a central nose section carried by said shell section in spaced relation within said shroud portion to define an annular inlet opening, means mounted within said shell section forming an annular interior passageway communicating with said inlet opening, means mounted on said body and disposed outwardly of said shell section to form an annular outlet passageway communicating with said interior passageway and opening rearwardly of said shroud portion, whereby forward motion of said projectile causes air to flow into said inlet opening and be drawn out of said outlet passageway, and turbine rotor means journalled within said projectile between said passageways.

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