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SAFETY SYSTEM FOR EXPLOSIVE ACTUATED DEVICES

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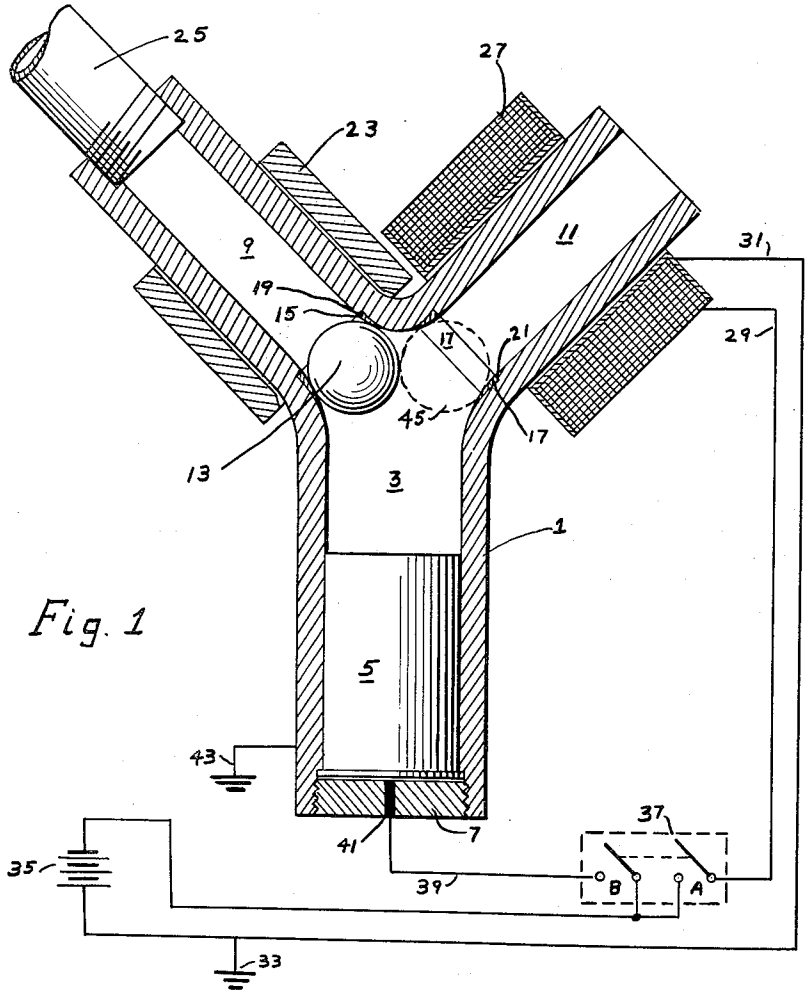


Fig. 1

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SAFETY SYSTEM FOR EXPLOSIVE ACTUATED DEVICES

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This invention relates to a safety system for cartridge actuated devices. Such devices are essentially explosive-powered prime movers which are particularly suitable for situations demanding the availability, on a standby basis, of a comparatively large force for a single cycle. The point of application may be some distance from the operator of the equipment, or perhaps in some hazardous or inaccessible location, thus requiring remote control.

Though varying in detail, these devices always include certain essential elements. Firstly, there must be a pressure chamber to contain an explosive charge. Secondly, a work chamber must be provided and a suitable gas-tight connection established from it to the pressure chamber. Thirdly, an ignition system is needed to explode the powder charge, and associated with it will be some form of control system, either local or remote.

Electrical ignition is desirable because it permits a simple firing mechanism and because with it remote control is relatively easy, even from alternative control stations. If electricity is not available, or if its use would merely complicate a simple apparatus, percussion firing may be employed. When electric ignition is used, but power-failure might prevent actuation at some critical time, it is possible to use combination initiators, susceptible to either percussion or electric ignition. Because cartridge actuation is often applied to emergency devices, much effort has been expended to assure certainty of firing upon demand.

Equal importance must be attached to safeguards to assure that the device will not function inadvertently, for in many of the uses of cartridge actuation such unintentional firing might cause death, personal injury or enormous property losses. The main explosive or "work" charge is not likely to be set off except by action of the initiator. The types of initiators mentioned, electric, percussion and combination, are susceptible to several types of energy, it being possible to specify and hold a certain range of sensitivity during manufacture. Of course it is not possible to specify the environment to which the ultimate user will transport the device.

Percussion initiators are particularly sensitive to friction, shock and heat. The energy levels needed are relatively high and would probably appear only during abnormal conditions such as a crash landing or a fire. However, even under such conditions it is desirable to prevent unintentional firing.

The hazards associated with electric ignition are more difficult to evade. The energy levels specified for purposeful initiation are comparatively low in order that the device will respond without lag to a weak firing signal. The principal sources of extraneous electricity which could supply the firing current are lightning, static, galvanic action and radio-frequency transmitters. Very little can be done about lightning, but careful design can largely circumvent danger from static and galvanic action. The problem of radio-frequency energy is severe, particularly because it can be transmitted without a physical connection. The situation can be improved to some extend by shielding but some danger remains.

Combination initiators exhibit the characteristics of both percussion and electric types. When properly used all types of initiators are comparatively safe but occasionally an unintentional discharge may occur.

In consideration of the aforementioned difficulties the

principal object of this invention is to provide a safety system which will divert the gas from an unintentional explosion in a cartridge actuated device to prevent the gas from working the system.

Another object is to provide a safety system which can be interlocked with an ignition control system without impairing the fast response characteristic which is desired in most cartridge actuated devices.

Another object is to provide a safety system which will provide protection without depending on a power supply.

Still another object is to provide a safety system by which gas pressure from an unintentional discharge may be vented to a place where it can do no harm.

Other advantages and objects of the invention will be apparent from the detailed description hereinafter set forth and from the drawing made a part thereof. FIGURE 1 shows in section a cartridge power unit into which has been incorporated a safety system which embodies the principle of this invention.

Referring to the drawing, 1 designates generally the receiver of a cartridge actuated device having a chamber 3 adapted to receive an electric-primed cartridge 5. A removable breech plug 7 closes one end of chamber 3, while at the other end are two branches 9 and 11, designated the work branch and the vent branch respectively. In this embodiment the vent branch is shown leading to the atmosphere but if necessary it could lead to a disposal container.

At the vicinity where branches 9 and 11 diverge there is placed a ball check 13 made of some material having high magnetic permeability. Ball check 13 is of such a size that it may block one or the other passage, but not both. Ring seals 15 and 17 of some elastic material are fitted against buttresses 19 and 21 in the mouths of the branches to accommodate ball check 13 and effect a gas-tight closure.

Surrounding work branch 9 is a hollow, cylindrical permanent magnet 23. At 25 is indicated a portion of a pressure conduit provided to carry the gas to a driven device. It is not intended to limit this invention to any particular arrangement. The principle disclosed herein may readily be applied to many types of powder actuated devices.

Surrounding vent branch 11 is coil 27, composed of insulated wire and forming a solenoid. The ends of coil 27 are connected to a pair of conductors, indicated by numerals 29 and 31. Conductor 31, which is shown grounded at 33, leads directly to a source of electric current 35. Conductor 29 also leads to the source of current but it may be interrupted at switch 37.

Also from switch 37 there leads conductor 39 which is adapted to carrying the firing current to cartridge 5. Conductor 39 passes through insulator 41 which is inserted into a hole in breech plug 7 and terminates in a suitable contact (not shown) which is capable of passing the current to the initiator to be fired. The circuit back to the current source 35 is completed by ground connection 43. (The internal circuit of the typical cartridge is well-known and need not be detailed here.)

Switch 37 may be of the type known as a sequence switch in which a single operation closes several circuits in succession, in a pre-determined order. In this case the pair of contacts labeled A would close first, followed by the pair labeled B.

Operation: This invention is based on the "fail-safe" principle. Assuming that there will always be some chance of unintentional firing brought about by extraneous energy, an arrangement such as that shown in FIGURE 1 permits the discharge to be ineffective as far as the normal work of the device is concerned. When the device is in the safe status, magnet 23 is holding ball

check **13** against seal **15** in the mouth of work branch **9**, and at the same time chamber **3** communicates freely with the atmosphere via vent branch **11**. If a discharge occurs while the unit is in the safe status the powder gases would merely be expelled to the atmosphere.

On the other hand, when the operator desires to fire the device he closes sequence switch **37**. This first energizes coil **27** via contact pair A thus exerting a tractive force on ball check **13** greater than the attraction of permanent magnet **23**. Ball check **13** moves to the alternate position indicated by broken circle **45**, where it rests against seal **17** to close off the vent. This movement of the ball by solenoid action takes place very quickly.

The sequence switch now closes the gap between contact pair B thus completing the firing circuit. The cartridge being ignited, gas pressure travels through work branch **9** and conduit **25** to perform its usual work. It will be noted that in either position of the ball gas pressure will tend to seat it forcibly against one of the seals.

An important consideration is the speed with which the device can be prepared to fire intentionally when it is resting in a safe status. By adjusting the relative strengths of the magnets the time lag (which is the elapsed time for the ball to change positions) can be reduced to an insignificant period. The reflex time of an average operator would be more significant.

The energy required to move the ball can be adjusted relative to the energy needed to fire a cartridge in order to provide a suitable safety factor. If venting to the atmosphere is undesirable the vent branch may be connected to some suitable container. In percussion fired devices a movable, permanent magnet may be mechanically interlocked with the firing trigger to position the ball or other check. The embodiment disclosed herein is not intended to be limiting as the principle can be applied to numerous other arrangements.

What I claim is:

1. In an explosive-powered prime mover in combination: a firing chamber with closing means and igniting means; a first passage from said chamber in gas communication with a driven device, said first passage being substantially circular in cross-section where it meets said chamber; a second passage for venting gas pressure from said chamber, said second passage being substantially circular in cross-section where it meets said chamber; a magnetically permeable ball; a permanent magnet positionally disposed to retain said ball at a first position blocking said first passage; and an electromagnet positionally disposed to attract said ball from said first position to a second position blocking said second passage.

2. The combination claimed in claim 1 further characterized by said igniting means and said magnetic selective positioning means being interlocked in a time sequence.

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