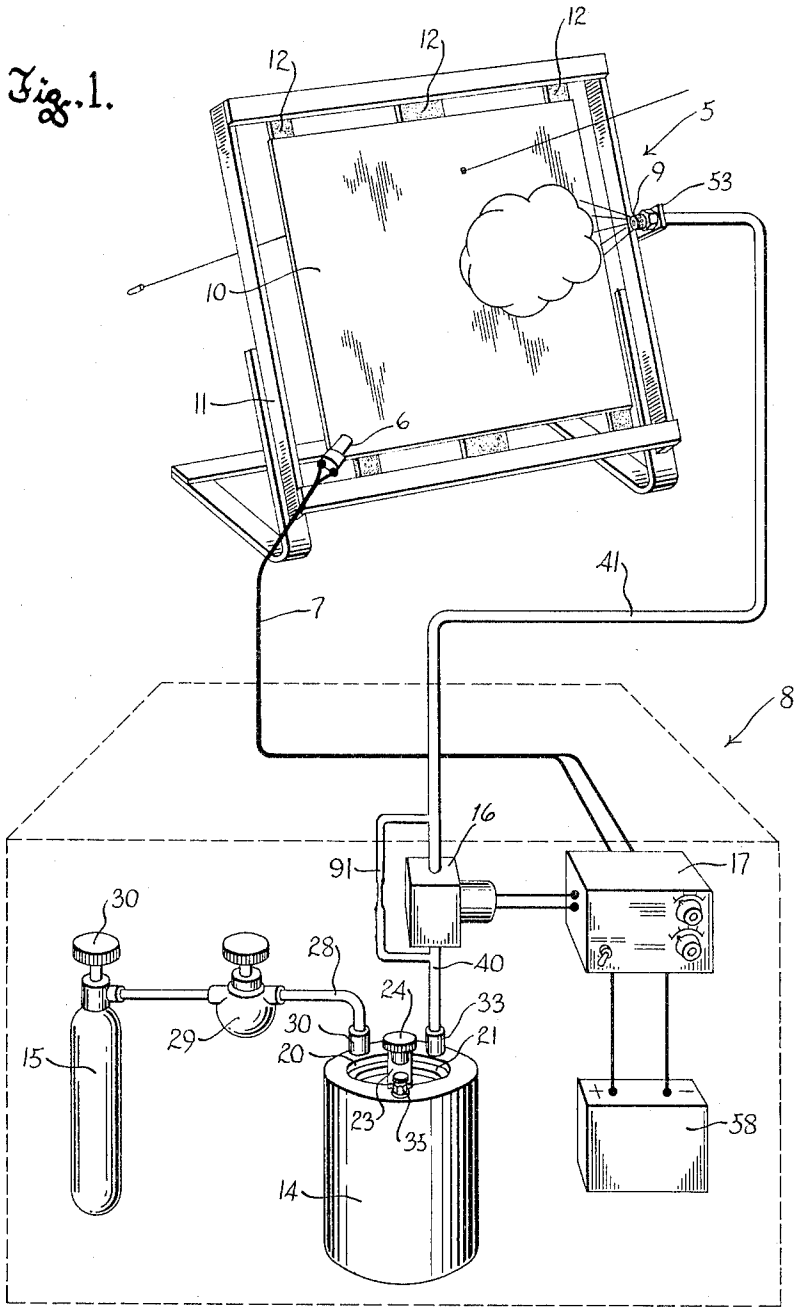
Sept. 13, 1966 J. A. I. OHLUND ETAL 3,272,510

GENERATOR OF SIMULATED SMOKE SIGNALS FOR GUNNERY TARGET PRACTICE

Filed Nov. 19, 1962 4 Sheets-Sheet 1

Fig. 1.



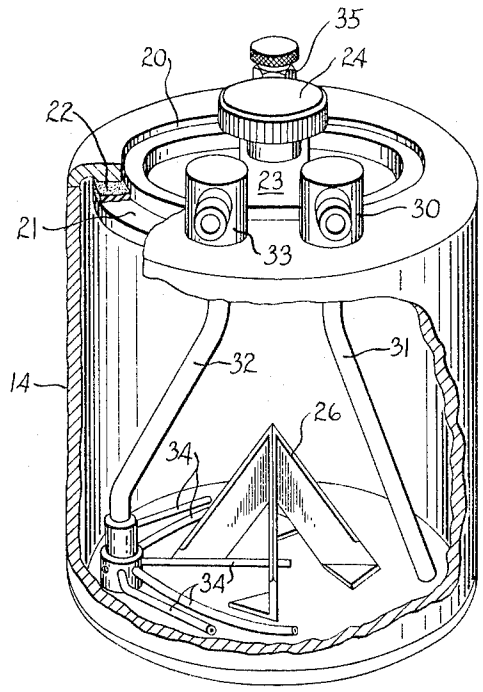
Inventors
John Alex Ingvar Öhlund
Karl Ragnar Andersson
By Dr. Watkin Jones & Gurney

Sept. 13, 1966 J. A. I. OHLUND ETAL 3,272,510

GENERATOR OF SIMULATED SMOKE SIGNALS
FOR GUNNERY TARGET PRACTICE

Filed Nov. 19, 1962 4 Sheets-Sheet 2

Fig. 2.



Inventors
John Alex Ingvar Öhlund
Karl Ragnar Andersson
By Hamilton Jones
Attorneys

Sept. 13, 1966 J. A. I. OHLUND ETAL 3,272,510

GENERATOR OF SIMULATED SMOKE SIGNALS FOR GUNNERY TARGET PRACTICE

Filed Nov. 19, 1962 4 Sheets-Sheet 3

Fig. 3.

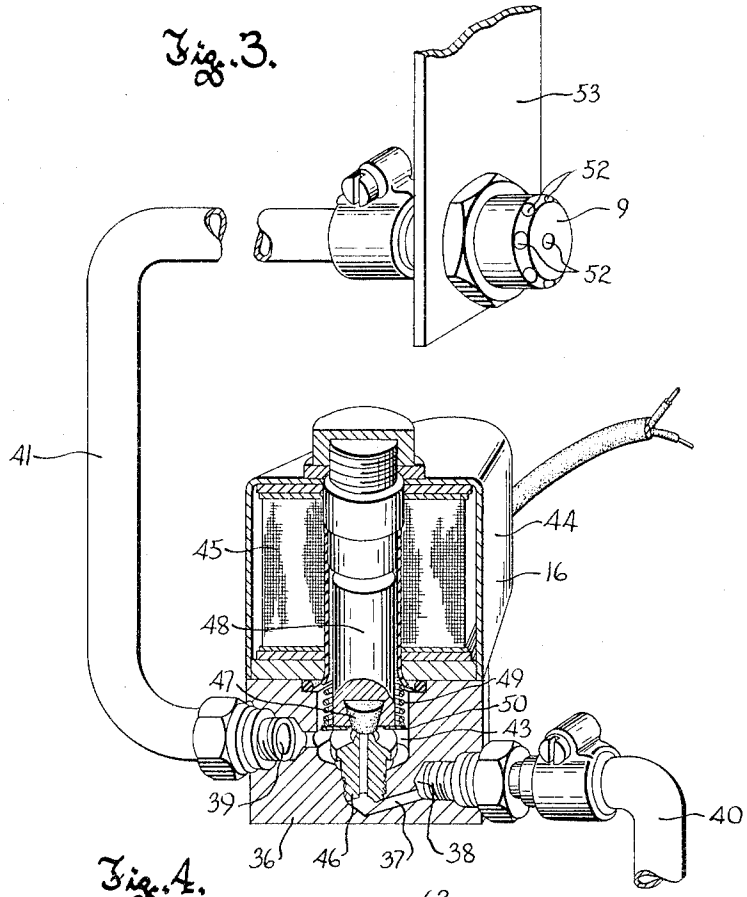
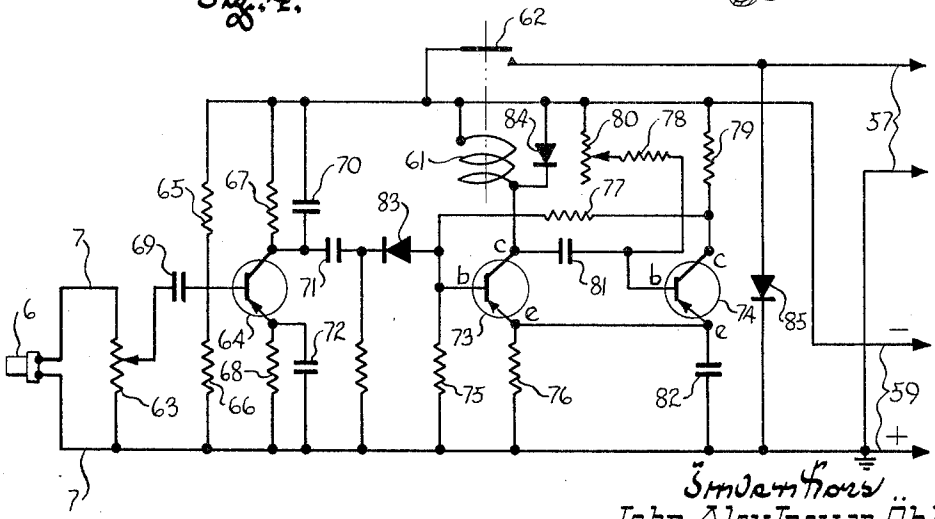


Fig. 4.



Inventors
John Alex Ingvar Öhlund
Karl Ragnar Andersson
By Dahlström Jonsson
Attorneys

Fig. 5.

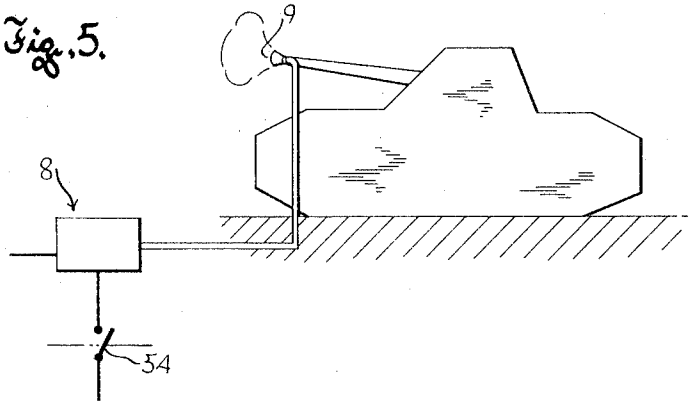


Fig. 6.

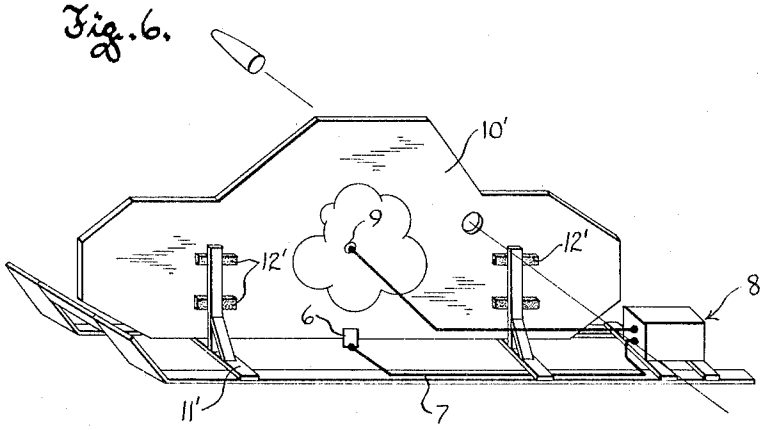
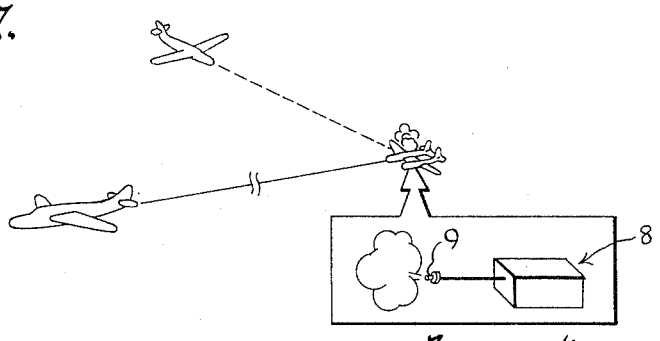


Fig. 7.



Inventors
John Alex Ingvar Öhlund
Karl Ragnar Andersson
By Hamilton Jones
Attorneys

United States Patent Office 3,272,510 Patented Sept. 13, 1966

3,272,510

GENERATOR OF SIMULATED SMOKE SIGNALS FOR GUNNERY TARGET PRACTICE

John Alex Ingvar Ohlund, Huskvarna, and Karl Ragnar Andersson, Jonkoping, Sweden, assignors to Saab Aktiebolag, a corporation of Sweden

Filed Nov. 19, 1962, Ser. No. 238—348
5 Claims. (Cl. 273—102.2)

This invention relates to apparatus for gunnery target practice, and refers more particularly to means for generating a visible signal in the nature of a simulated smoke puff to indicate to a gunner engaged in practice shooting at a target that he has placed a shot in a predetermined relationship to the target.

From the standpoint of training efficiency it is desirable that a gunner shooting at a target be apprised of the results that he has achieved as soon as possible after he has fired each shot and while the circumstances of the firing of the shot are still fresh in his mind. This is especially true in aerial gunnery, in which the gunner must take account of many rapidly changing variables in aiming each shot, but in which firing results can be quickly communicated to the gunner only by radio signals or by visible signals which can be seen from a substantial distance so as to be readily perceptible from the gunner's aircraft.

Radio signals are generally unsatisfactory because, among other things, they are somewhat unrealistic in that they do not simulate the conditions that would occur in actual combat firing.

With the foregoing in mind it is a principal object of the present invention to provide apparatus which produces a signal that is visible to the gunner immediately after he has successfully placed a shot in the target and which signal has the appearance of a puff of smoke and is thus readily perceptible at a distance from the target and at the same time affords a realistic simulation of the results that could be expected from successful firing under actual combat conditions.

Another object of this invention is to provide a signalling device of the character described which is particularly well adapted for aerial gunnery target practice, including air-to-air gunnery, in that it comprises means for indicating to an aerial gunner, by a readily perceptible puff of simulated smoke, that he has scored a hit upon a target at which he is shooting, such signal being produced immediately after a projectile strikes the target.

A further object of this invention is to provide simulated smoke generating apparatus of the character described by which a continuous output of simulated smoke can be produced for the purpose of assisting a gunner in locating a target at which he is firing, and by which more intensive puffs of simulated smoke can be released to signify hits on the target, and which can also be employed to simulate return fire from the target.

A more specific object of the present invention is to provide apparatus for gunnery target practice by which a simulated smoke puff is produced to signify each shot that strikes the target, which apparatus comprises transducer means located at the target and which produces an electrical impulse in response to the passage of a missile in a predetermined relationship to the target, and means comprising a solenoid valve and a simulated smoke generator for releasing, through a nozzle outlet located at or near the target, a quantity of powdered material entrained in gas under pressure each time the solenoid valve is opened in response to an electrical impulse from the transducer means.

It is also an object of this invention to provide a simulated smoke generator of the character described which is especially well adapted for cooperation with a target

transducer device of the type described and claimed in the copending application of J. A. I. Ohlund et al., Serial No. 173,636, filed February 16, 1962, for Signalling Device for Scoring Gunnery Target Practice, now Patent No. 3,158,372.

Another specific object of the present invention is to provide, in a simulated smoke generator of the character described, a container wherein a supply of finely powdered material such as soot or talcum powder is stored in contact with gas under pressure, and means for controlledly releasing such gas from the container with the powdered material entrained in the gas to simulate smoke.

A further specific object of the present invention resides in the provision, in a simulated smoke generator of the character described, of a container for finely powdered material and gas under pressure, which container can be charged with powdered material by mere insertion of a bag containing such material downwardly into the container and withdrawal of the empty bag from the container.

The present invention has another of its specific objects the provision of simulated smoke signal generating means for gunnery target practice having electronic means for amplifying the electrical impulse signals produced by a target transducer device of the type hereinabove mentioned, for discriminating against signals from the transducer which are due to causes other than the impacting of a missile against the target, and for producing an output signal having substantial duration as compared with the brief impulse from the transducer means, so that the output of such electronic means can be utilized to effect discharge of a simulated smoke puff of such duration and magnitude as to be readily visible to a gunner at a substantial distance from the target.

With the above and other objects in view which will appear as the description proceeds, this invention resides in the novel construction, combination and arrangement of parts substantially as hereinafter described and more particularly defined by the appended claims, it being understood that such changes in the precise embodiments of the hereindisclosed invention may be made as come within the scope of the claims.

The accompanying drawings illustrate several complete examples of the physical embodiments of the invention constructed according to the best modes so far devised for the practical application of the principles thereof, and in which:

FIGURE 1 is a more or less diagrammatic perspective view of the apparatus of this invention associated with a target to produce a simulated smoke signal at the target when the target is struck by a projectile;

FIGURE 2 is a perspective view of a powdered material container which comprises a part of the apparatus of this invention, portions of the container being cut away to show details of the interior thereof;

FIGURE 3 is a perspective view, with portions cut away and shown in section, of the solenoid and outlet nozzle of the apparatus illustrated in FIGURE 1;

FIGURE 4 is a circuit diagram of the amplifier and release impulse generator of the apparatus of this invention;

FIGURE 5 is a more or less diagrammatic view illustrating the application of the apparatus of this invention to a target having the shape of a tank for the purpose of simulating return fire from the target;

FIGURE 6 is another more or less diagrammatic view showing another application of the apparatus of this invention, in this instance for the purpose of producing smoke signals indicative of hits scored upon a portable target having the shape of a tank; and

FIGURE 7 is a more or less diagrammatic view of the application of the apparatus to an airborne target for

rendering the target readily visible and for indicating hits on the same scored during gunnery practice firing thereat.

Referring now more particularly to the accompanying drawings, the numeral **5** designates generally a target at which gunnery practice firing can be directed. When a projectile makes a hit on the target, a transducer **6** on the target produces an electrical impulse output which is transmitted, by way of conductors **7**, to the simulated smoke generator of this invention, which is generally designated by **8**. In response to such impulse the smoke generator discharges a puff of simulated smoke through a nozzle **9** at the target, thus providing a readily visible and very realistic indication that a hit has been scored.

In general the target **5** and the transducer **6** attached thereto correspond to the apparatus disclosed and claimed in the aforesaid Patent No. 3,158,372. Briefly, the target proper comprises a panel **10** of a relatively dense material such as hardboard, suspended on a frame or stand **11** by means of resilient strips **12** of rubber or the like which substantially insulate the panel from vibrations of the frame. The transducer **6** is attached to one corner of the panel and has its axis of sensitivity lying substantially in the plane of the panel and extending toward the central portion thereof so that the transducer is responsive substantially only to shock impulses that travel edgewise through the panel, such as would be caused by a projectile penetrating the panel. The transducer **6** therefore produces an electrical impulse output only in response to an accurately placed shot, and discriminates against near misses as well as vibrations and shock impulses from other sources.

The simulated smoke signal generator **8** of this invention comprises, in general, a sealed container **14** which is adapted to hold a supply of finely powdered material such as soot or talcum powder, a pressure vessel or bottle **15** for holding a supply of compressed air, carbon dioxide, or other inert gas under pressure, and which is normally in constant communication with the interior of the container **14**, a solenoid valve **16** which controls discharge of powder entrained in pressurized gas from the interior of the container **14** through the nozzle **9**, and an amplifier **17** connected between the transducer **6** and the solenoid valve **16**.

As best seen in FIGURE 2, the container **14** is preferably cylindrical and has a large opening **20** in its upper end wall that can be closed by a removable cover **21** which engages under the inner surface of the top wall, around the marginal edge portion of the opening **20**. Preferably the opening **20** is elliptical or otherwise noncircular, and the cover has a corresponding shape so as to be readily insertable through the opening although it is larger than the opening. A gasket **22** at the underside of the top wall of the container, all around the opening **20**, insures that the cover makes a good seal. The cover is drawn up into compressive engagement with the gasket by means of a cross bar **23** which has its end portions overlying the top of the container and which is secured by a screw **24** threaded into the center of the cover.

To facilitate charging the container with powdered material it is provided with sharp edged knife means **26** projecting upwardly from its bottom wall and which in the present case is shown as four pyramidally arranged sheet metal strips with sharp edges. It is thus possible to package the powdered material in standard bags of, e.g., plastic film. As such a bag is inserted downwardly into the container **14** through the opening **20** therein, the knife means **26** cuts open the bottom of the bag so that the bag can be emptied into the container as it is withdrawn therefrom.

Gas is normally maintained under substantially constant pressure in the interior of the container **14**, in contact with the powdered material therein, and to this end the inside of the container is communicated, by way of a duct **28** that comprises a manually controllable pressure reducing valve **29**, with the compressed gas vessel **15**. A conventional manual valve **30** on the compressed gas bottle **15** permits the same to be cut off from the container **14** when the apparatus is not in use or when the bottle is to be changed. The reducing valve **29** insures that the pressure of gas in the container **14** will be maintained at a substantially constant value.

The duct **28** leading from the bottle **15** is connected with an inlet fitting **30** on the container **14** from which an inlet tube **31** extends down into the interior of the container with its mouth near the bottom thereof. Gas, with powder entrained therein, is expelled from the container through an outlet duct **32** which extends downwardly into the container from an outlet fitting **33** on the top thereof and which terminates at its bottom in a plurality of branches **34** that open to different parts of the bottom portion of the container. The arrangement of the branch ducts **34** permits powdered material to be expelled from the container even when the supply of such material in the container is very low. By means of a manually controllable vent nipple **35** on the top of the container gas can be released from the container without discharge of powder, so that the cover can be removed for recharging of the container.

As best seen in FIGURE 3, the solenoid valve **16** which controls discharge from the container **14** comprises a valve body **36** through which a passage **37** extends from an inlet port **38** at one side of the body to an outlet port **39** at the other side thereof. The inlet port **38** is connected, by means of a duct **40**, with the outlet fitting **33** on the container **14**, while another duct **41** communicates the outlet port **39** with the discharge nozzle **9**. The medial portion of the passage **37** is enlarged to provide a valve chamber **43** which opens to the top of the body **36** and which is closed by a housing **44** that is secured to the top of the body and wherein an annular winding **45** is housed. A substantially tubular sleeve member **46**, threaded into the lower portion of the valve chamber, defines a valve seat in the passage **37**. The valve element **47** that cooperates with this valve seat is formed on the bottom of a magnetically responsive plunger **48** which is coaxially slidable in the winding **45** and which projects down into the upper portion of the valve chamber. Also housed in the valve chamber is a coiled compression spring **49** that surrounds the lower portion of the plunger and reacts between the underside of the housing **44** and a washer **50** secured on the lower end of the plunger. The spring **49** thus biases the plunger downwardly toward a seated position of the valve element **47** thereon, but it will be apparent that the plunger will be drawn upwardly by magnetic attraction when the solenoid winding **45** is energized by an electric current, thus carrying the valve element **47** off of its seat to permit gas having powder entrained therein to flow out of the container **14** and to the nozzle **9** by way of the ducts **40** and **41** and the passage **37** in the solenoid valve body **36**.

To keep powdered material away from the plunger **48**, the spring **49** and the winding **45** a diaphragm can be inserted between the lower part of the plunger and the valve body.

Preferably the discharge nozzle **9** has a plurality of outlet orifices **52** therein which open in generally radially outward directions so that the simulated smoke is dispersed over the face of the target in a manner which realistically simulates the impact of a projectile. Obviously the nozzle could be made interchangeable with others that would provide for other patterns of dispersal of the simulated smoke signal. A suitable bracket **53** provides for securement of the nozzle **9** to the target frame **11**.

As suggested by FIGURE 5, the solenoid valve could be controlled by a manually operated switch **54**, or could be replaced by a manually operated valve element, so that an operator could, in either case, produce the appearance of bursts of smoke simulating return fire from a target on which the discharge nozzle is installed. Also, as suggested by FIGURE 7, a suitable by-pass **91** (see FIGURE 1)

around the solenoid valve can be provided whereby a constant but relatively light stream of simulated smoke can be made to emanate from the target to facilitate location and identification of the target, impacts on the target then being signalled by larger outputs of smoke produced in consequence of opening of the solenoid valve for a brief period after each hit is scored.

In the apparatus illustrated in FIGURE 6 the target simulates the appearance of a tank, and the target proper comprises a panel **10'** of hardboard or the like in the shape of a tank, secured to a frame or stand **11'** by means of resilient mounting elements **12'**. The nozzle **9** is preferably located near the center of the panel for discharge through the same to the front thereof. As with the embodiment of the invention illustrated in FIGURE 1, simulated smoke is dispersed whenever a hit on the target panel is detected by a transducer **6**.

The electrical impulse signal produced by transducer **6** in response to a hit upon the target is both relatively weak and of relatively very brief duration. It is therefore necessary to amplify such signals, to produce currents of sufficient magnitude to actuate the solenoid valve, and to increase the effective duration of such currents so that the solenoid valve will be held open for a long enough period of time after each hit to produce a simulated smoke puff of sufficient size and density to be readily visible to the gunner. These two functions of amplification and increasing the duration of the solenoid energizing current are performed by the amplifier **17**, the circuit of which is diagrammatically illustrated in FIGURE 4.

The conductors **7** that carry the output of the transducer **6** are connected with the opposite ends of a potentiometer **63**, which can be adjusted to discriminate against relatively weak signals from the transducer, produced by causes other than a direct hit on the target panel. The wiper of potentiometer **63** is connected with an amplifier-filter circuit comprising a transistor **64** and a resistance-capacitance network consisting of resistors **65**, **66**, **67** and **68** and capacitors **69**, **70**, **71** and **72**. Capacitors **69** and **71**, which determine the low frequency limits of the circuit, are so chosen as to discriminate against frequencies below about 1000 c.p.s., corresponding to noises due to wind sough and the like. Capacitor **70**, which determines the upper frequency limit of the amplifier, is of such value as to discriminate against frequencies above 3000 c.p.s., so that the amplifier passes signals within the band of 1000–3000 c.p.s., containing the frequencies of vibrations of the panel due to hits thereon.

The amplifier-filter circuit thus cooperates with the transducer **6** and potentiometer **63** in rejecting spurious signals due to jerks on the cable of a towed target, bow wave shocks from projectiles passing near the target without striking it, and other causes. The potentiometer **63** also makes it possible to so adjust the apparatus that it will pass only the relatively strong signals caused by impact upon the target of projectiles from large bore weapons, and will reject the weaker signals due to hits from small bore weapons such as rifles. Such adjustment for projectile size is particularly useful where the apparatus is used with a tank target like that illustrated in FIGURE 6.

The output of the amplifier comprising the transistor **64** is fed, through a diode **84**, to a monostable flip-flop circuit comprising a pair of transistors **73** and **74**, by which the effective duration of the signals from the amplifier is effectively increased so that the solenoid valve is energized for long enough periods to provide readily visible discharges from the nozzle. In addition to transistors **73** and **74**, the flip-flop circuit comprises resistors **75**, **76**, **77**, **78** and **79**, a potentiometer **80**, a pair of capacitors **81** and **82**, and a pair of diodes **84** and **85**. The amplifier and its associated flip-flop circuit are powered by a battery **58** or other D.C. source, connected with the electronic circuit by means of conductors **59**. The output terminals of the amplifier unit are connected with the winding **45** of the solenoid valve by means of conductors **57**, energization of which is controlled by a switch element **62** actuated by a relay winding **61**.

When no signal is received from the transducer, the flip-flop circuit is in a stable condition, in which transistor **74** is conducting current and its collector **74***c* is at a low potential, e.g., 1.5 v. The value of resistor **76**, which is in series with the emitters of the two transistors, is so chosen that the voltage drop across it under these conditions will be about 1.0 v. If the voltage divider formed by resistor **76** is suitably dimensioned, the base **73***b* of transistor **73** will then be at such potential in relation to the emitter **73***e* thereof that said transistor will be at cut-off. The relay winding **61** is connected in series with the collector **73***c* of transistor **73**, and hence when transistor **73** is at cut off, only a negligible current will flow through relay winding **61**, insufficient to close switch element **62**.

If a signal current is now supplied from the amplifier to the base **73***b* of transistor **73**, by way of diode **83**, the pre-voltage across resistor **76** is neutralized and transistor **73** is rendered conductive, with the result that the potential on its collector **73***c* decreases. Current then flows through the transistor and the relay winding **61** in series therewith, thus effecting closure of switch element **62** and consequent energization of winding **45** to open the solenoid valve. Such current flow through transistor **73** also charges capacitor **81**, which is connected with the collector **73***c* of transistor **73** in parallel with winding **61**. Through its connection with that capacitor, the potential of the base **74***b* of transistor **74** is decreased to the point where that transistor is rendered non-conductive. The condenser **81** discharges through resistor **78** and potentiometer **80**, which are connected in series with it, and hence the duration of the unstable condition, in which current flows in winding **61**, depends upon the capacitance of condenser **81** and the combined resistance of circuit components **78** and **80**. Preferably the circuit constants are so chosen that potentiometer **80** can be adjusted to provide a duration of 0.5 to 1.5 seconds for target practice signalling work, and to provide longer intervals in cases where the apparatus is used to simulate return fire from a target or the like.

Diode **74** is connected across relay winding **61** and diode **85** is connected across the switch element **62** to prevent detrimental voltage peaks that might develop upon disconnection of the inductive loads presented by the relay and the solenoid valve.

From the foregoing description taken together with the accompanying drawings it will be apparent that this invention provides means for producing a visible signal, in the nature of a simulated smoke puff, for indicating to a gunner engaged in target practice that he has scored a hit on the target. It will also be apparent that the apparatus of this invention is capable of producing such a signal immediately after the hit is scored, and can also be employed to produce simulated smoke puffs and clouds for other purposes such as providing a smoke trace that assists a gunner in locating a target and producing an appearance of return fire from a target.

What is claimed as our invention is:

1. Apparatus for providing to a gunner at a distance from a target a visual indication that he has scored a hit upon the target, in the form of a simulated smoke signal produced immediately after the target is hit, said apparatus comprising:

(A) a container adapted to hold a supply of finely powdered material in contact with gas under pressure and having

(1) a gas-tight closure,

(2) an outlet near its bottom and

(3) an inlet for gas under pressure;

(B) means for connecting said inlet with a source of gas under substantially constant pressure;

(C) a solenoid valve having inlet and outlet ports;
(D) duct means connecting the outlet of the container with the inlet port of the solenoid valve so that the valve can control release from the container of powdered material entrained in gas under pressure;
(E) nozzle means located at the target and connected with the outlet of the solenoid valve, through which gas and entrained powdered material are expelled into the air when the valve is open, to produce the appearance of smoke;
(F) transducer means at the target for producing an electrical impulse in consequence of passage of a projectile in a predetermined relationship to the target; and
(G) amplifier means having
(1) input terminals connected with the transducer means and
(2) output terminals connected with the solenoid valve,

said amplifier means comprising time delay holding means for delivering a current of relatively long duration to said output terminals, to open the solenoid valve for a sufficient time to produce a distinctly visible simulated smoke puff in response to the brief electrical impulse delivered to said input terminals from the transducer means.

2. The apparatus of claim **1**, further characterized by the fact that said outlet comprises a plurality of branch tubes, each having one end connected to an outlet duct which is common to the several branch tubes, the other ends of the several branch tubes being in different locations near the bottom of the container to insure that powdered material will be entrained in gas released from the container even when only a small amount of powdered material is present in the container.

3. The apparatus of claim **1**, further characterized by the fact that said amplifier comprises: an amplifier having a resistance capacitance filter network for amplifying impulse signals within a range of frequencies corresponding to those caused by the impact of a projectile upon the target and for rejecting signals of other frequencies.

4. The apparatus of claim **1** wherein said gas tight closure for the container comprises a removable top thereof, further characterized by: knife means in the bottom of the container having an upwardly projecting cutting edge by which the bottom of a bag filled with powdered material can be cut in consequence of downward insertion of the bag into the container, to thus effect release of the powdered material into the container upon withdrawal of the bag from the container.

5. The apparatus of claim **1**, further characterized by: duct means for connecting the outlet of the container to the nozzle means in by-pass relation to the solenoid valve to provide for the emission of a constant but relatively light stream of simulated smoke.

References Cited by the Examiner

UNITED STATES PATENTS

609,970	8/1898	Lochmann	222—399
1,287,767	12/1918	Schanschieff	46—9
2,148,438	2/1939	Crain et al.	273—102.1
2,608,025	8/1952	Miller	46—9
2,788,607	4/1957	Ward	46—9
2,932,126	4/1960	Howell	46—9 X
3,022,076	2/1962	Zito	273—102.2

FOREIGN PATENTS

552,189	1/1923	France.

DELBERT B. LOWE, *Primary Examiner.*

RICHARD C. PINKHAM, *Examiner.*