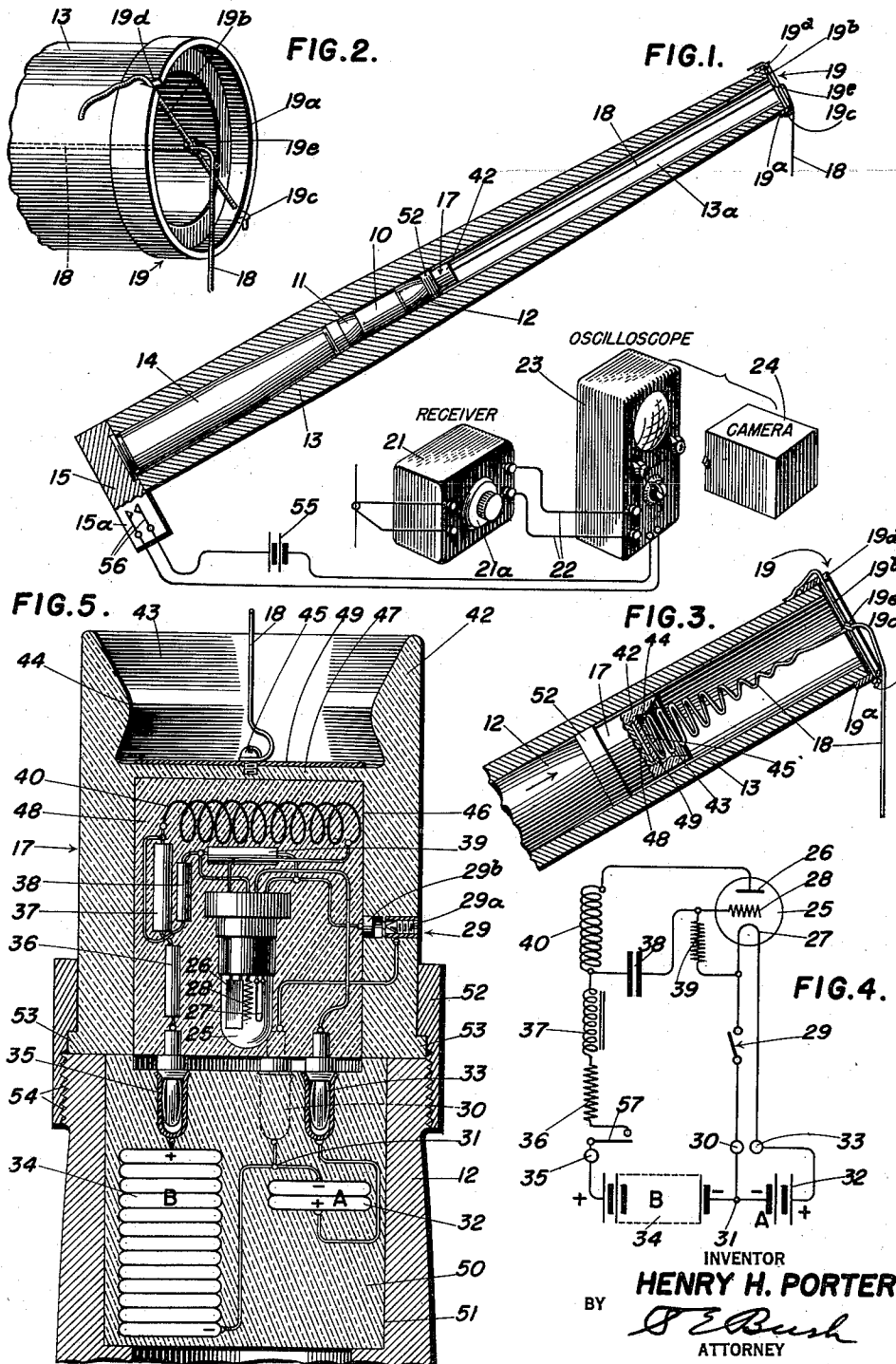


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APPARATUS FOR DETERMINING CONDITIONS
WITHIN A GUN BARREL
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APPARATUS FOR DETERMINING CONDITIONS WITHIN A GUN BARREL

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This invention relates to indicating systems for use in determining the conduct of a projectile in a gun barrel. More particularly, the invention has reference to a novel system of this character comprising a projectile having means disposed in a gun barrel and projecting from the muzzle thereof for transmitting information concerning the conduct of the projectile while passing through the barrel.

One object of the invention resides in the provision of a novel system for indicating the conduct of a projectile passing through a gun barrel, which comprises a wire connected to the projectile and designed to extend through the barrel and out the muzzle of the gun for carrying a signal from the projectile when the latter is fired from the gun.

Another object of the invention is to provide a system of the character described in which the projectile is provided with an antenna or wire electrically coupled to a signal producing means in the projectile for transmitting a signal along the gun bore to operate an oscilloscope, or the like, through a suitable receiver. In accordance with one form of the invention, the projectile contains a source of electrical energy and an oscillating circuit designed to be energized by the source. The antenna or wire is coupled to the oscillating circuit in the projectile and extends along the bore of the gun and out of the muzzle, preferably from the nose of the projectile. The antenna or wire is held out of contact with the gun, as by means of a suitable support on the muzzle, and when the gun is fired, the antenna or wire is collected in the nose portion of the projectile as it moves through the barrel.

Another object of the invention resides in the provision of a novel projectile having apparatus for use in determining the conduct of the projectile in the bore of a gun. In one form of the invention, the projectile includes an insulating member in the nose portion of the projectile having a recess from which an antenna extends through the bore of the gun, whereby the antenna is collected in the recess as the projectile moves through the gun barrel. The recess has a metal bottom to provide continuous contact with the antenna during collection thereof and to provide a coupling of constant capacitance between the antenna and the radiating means. Within the projectile to the rear of the antenna collector is a block which is insulated from the projectile body and carries the parts of the oscillating circuit. The oscillator parts, is desired, may be embedded in the block so that they are ade-

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quately supported and protected against damage do to the shock in firing the projectile in the gun. The source of electricity for energizing the oscillating circuit is preferably included in another block insulated from the casing and mounted in the projectile adjacent the block containing the oscillating circuit, the two blocks having releasable electrical connections between them to supply electricity to the oscillator and permit ready assembly and disassembly of the projectile.

The specific object of the invention is to provide a process and means for observing and recording the impulse vibrations of a projectile, due to firing of the gun, while said projectile is still within the gun barrel.

Other objects and many of the attendant advantages of this invention will be appreciated readily as the same becomes understood by reference to the following detailed description, when considered in connection with the accompanying drawings, wherein:

Fig. 1 is a diagrammatic view of one form of the new indicating system;

Fig. 2 is an enlarged detail view of the muzzle portion of the gun shown in Fig. 1;

Fig. 3 is a longitudinal sectional view of the muzzle portion of the gun showing the projectile as it moves through the barrel;

Fig. 4 is a wiring diagram of the oscillating circuit, and

Fig. 5 is an enlarged longitudinal sectional view of the nose portion of the projectile.

Referring to the drawing, the system there shown comprises a projectile having a casing 10 of any suitable form, a rotating band 11 near the tail end of the projectile, and a nose portion 12 which may be secured to the casing by the usual threaded connection. The projectile is loaded in a gun 13 having a bore 13a provided with the usual rifling (not shown), the main body of the projectile being disposed in the bore with the rotating band 11 in the gun chamber to the rear of the rifling. As shown, the projectile is of the fixed ammunition type and is held at its tail end in a cartridge case 14 containing a firing charge, although it will be understood that the firing charge may be contained in bags in the gun chamber so as to eliminate the cartridge case. A breech mechanism 15 is mounted on the gun at its rear end and includes a suitable device 15a for exploding the firing charge in the cartridge case.

In the nose portion of the projectile is a radio transmitter 17 having an oscillating circuit, to

be described in detail presently, and an antenna 18 electrically coupled to the oscillating circuit. The antenna, which may be coiled, extends from the projectile through the bore of the gun to a support 19 at the muzzle. The support comprises an insulating ring 19a which fits over the muzzle portion of the gun and carries a supporting strand 19b made of silk or other insulating material. The strand extends diametrically across the ring and is secured at one end by a knot 19c, the opposite end of the strand being held in a notch 19d in the ring. Intermediate its ends, the strand 19b is connected to the antenna 18, as by means of a knot 19e, so as to hold the antenna out of contact with the gun barrel. From the strand 19b a short length of the antenna hangs downwardly from the gun muzzle.

The electromagnetic waves radiated from the antenna 18 are received by a radio receiver 21 which is tuned, as by means of a dial 21a, to the frequency of the oscillating circuit in the transmitter 17. The output end of the receiver 21 is connected through wires 22 to a suitable indicator, such as a cathode ray oscilloscope 23. Preferably, a camera 24 is provided adjacent the oscilloscope for recording the readings thereof. If desired, a suitable recorder (not shown) may be operated by the output from the receiver 21.

The transmitter 17 may be of any desired form. As shown in Fig. 4, it comprises an electron discharge tube 25 having a plate 26, a filament 27 and a grid 28. One side of the filament 27 is connected through a switch 29 and a releasable plug-and-socket connection 30 to a terminal 31 at the negative side of an A battery 32. The other side of the filament 27 is connected through a releasable plug-and-socket connection 33 to the opposite side of battery 32. The negative side of a B battery 34 is connected to the terminal 31, and the positive side of the B battery is connected through a releasable plug-and-socket connection 35 to a resistor 36. The resistor is connected through a radio frequency choke coil 37 and a capacitor 38 to the grid 28 of the tube. A grid bias resistor 39 is connected between the filament and grid circuits. The plate 26 of the tube is connected to one terminal of a tank coil 40, the opposite terminal of which is connected between the capacitor 38 and the choke coil 37.

The transmitter is contained in the projectile in two sections, one of which comprises a member 42 made of insulating material, such as Lucite, mounted at the nose of the projectile. In the nose end of the member 42 is a generally cup-shaped recess 43, the open end of which faces the muzzle of the gun. The side walls of recess 43 converge from the nose end of the member to a restricted portion 44 and then diverge to the bottom of the recess. A terminal screw 45 is threaded in the bottom of the recess 43 for connection to the antenna 18. In the rear end of the member 42 is a generally cup-shaped recess 46 having its open end facing to the rear, the recesses 43 and 46 being separated by a partition 47. Fitted closely in the recess 46 is a block 48 made of an insulating compound, such as Lucite, in which the parts of the oscillating circuit are embedded. If desired, the block 48 may be molded around the parts of the oscillating circuit, including the tube, the resistors 36 and 39, the capacitor 38, and the coils 37 and 40. Also, one element of each of the plug-and-socket connections 30, 33 and 35 is embedded in the block 48. A metal plate 49 is held against the bottom of recess 43 adjacent the tank coil 40 and has

the screw 45 threaded into it, the plate serving as a coupling of substantially constant capacitance between the oscillator and the antenna. The plate 49 also serves as a contact means for maintaining continuous electrical contact with the antenna during collection thereof, even though the inner end of the antenna should become detached from screw 45. The switch 29 in the filament circuit may conveniently take the form of a contact screw 29a threaded in the side wall of member 42 and engageable with a coating contact 29b adjacent its inner end. Normally, the screw 29a is withdrawn out of engagement with contact 29b so as to open the filament circuit.

The other section of the transmitter comprises a block 50 of insulating material disposed in a recess 51 in the metal nose portion 12 of the projectile. The block 50 has mounted in it the A and B batteries 32 and 34 and the other elements of the plug-and-socket connections 30, 33 and 35.

The member 42 may be connected to the nose portion 12 of the projectile in any suitable manner. As shown, the member 42 is provided with a ring 52 extending around the outside of the member at its rear end over an annulus 53 for securing the ring and member against relative axial movement. The ring projects rearwardly from the member 42 and its projecting portion is provided with internal threads 54 which mate with similar threads on the nose 12. Thus, in the assembly of the projectile, the block 50 is inserted in the nose recess 51, the member 42 is placed over the nose end of block 50 with the plug-and-socket connections 30, 33 and 35 engaged, and the ring 52 is screwed over the threads on the nose 12 so as to clamp the parts firmly together.

The oscilloscope 23 is provided with a sweep circuit including a pair of terminals connected with a source 55 of electricity and a switch 56 associated with the firing device 15a. The switch 56 and the source 55 cooperate to produce a trigger circuit for initiating an impulse in the sweep circuit in the oscilloscope 23 when the gun is fired. The receiver 21 is provided with an antenna (not shown) for receiving waves radiated from the antenna 18. The output of the receiver is connected with the vertical deflection terminals of the oscilloscope by the wires 22 for modulating the sweep voltage initiated by the trigger circuit previously described.

In operation, the switch 29 in the filament circuit of oscillator tube 25 is closed by tightening screw 29a, and the projectile is loaded into the gun for firing, with the antenna 18 extending out through the bore, as shown in Fig. 1. It will be understood that when switch 29 is closed, the oscillating circuit is energized by the source of electricity in block 50, so that electromagnetic waves are emitted from the antenna 18. The radio-receiver 21 is tuned to the frequency of the waves emitted from the oscillator; the shutter of the oscilloscope camera 24 is opened, and, if a sound recorder is employed, the recorder cutting head is set down on the record. The firing device 15a in the breech of the gun is then actuated so as to fire the projectile and close the switch 56, the receiver 21 being thus energized from the source 55. Upon firing of the gun, the projectile passes through the bore 13a, and, as shown in Fig. 3, the antenna collapses and is received in the recess 43 in the nose of the projectile. The outer portion of the side walls of

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recess 43 serves to direct the antenna to the bottom of the recess where it is held against plate 49 by the constricted portion 44.

Electromagnetic waves from the antenna 18 are received by the receiver 21 as the projectile moves through the gun barrel, and the output of the receiver is recorded by camera 24 focused on the oscilloscope 23, or by a suitable sound recorder (not shown), or by both. Forces incident to movement of the projectile through the gun barrel tend to affect the oscillations in the oscillator 17, with the result that the signals received by the receiver 21 are correspondingly affected, as indicated by the oscilloscope or the sound recorder. It should be understood that the emitted signal is modulated by suitable means, such as a switch 57 which is opened and closed by any suitable means and shown diagrammatically in Figure 4, a crystal, a flexible capacitor, or other electrical component. It should be understood that the switch 57 can be any one of a number of well known intermittently operable types; for example said switch can be of the thermal element type, such as has well known use with blinker systems. The sole purpose of the switch is to provide modulation so that the signal emitted from the transmitter may be easily identified. Other forms of modulation can be used, if space therefor is available, for example, a small audio oscillator could be employed. The inventor has found in experiments carried out with the new system that signals from the transmitter 17 may be heard in the receiver 21 while the projectile is in the gun barrel, and that valuable data concerning the conduct of the projectile in the gun barrel can be obtained from the signals. More specifically, data obtained from the oscilloscope 23 and from a sound recording device associated with the receiver show that oscillation in the projectile does not cease until the projectile is well out of the gun barrel. Also, such data provide a basis for determining the vibration of the tube filament 27 in the gun barrel, and also provide information in regard to acceleration of the projectile throughout its movement in the barrel. Additionally, the system may be used to obtain a record of the impulse vibrations in the gun.

The new system may be assembled readily and is easy to operate. Since the component parts of the transmitter 17 are embedded in the insulating blocks 48 and 50, they are capable of withstanding the heavy shocks incident to firing the projectile in the gun. Also, by mounting the parts of the transmitter 17 in two separate units 48 and 50 and providing detachable electrical connections 30, 33 and 35 between the units, the projectile may be readily assembled and disassembled.

The provision of an antenna positioned in a gun barrel to project therefrom for the purpose of emitting a signal generated in a projectile in the barrel, is merely one possible arrangement. Although the transmitter 17 has been disclosed in the form of an oscillator unit, it will be understood that other means may be employed for producing a signal or impulse to be received by the receiver 21. Also, if desired, the parts of the transmitter 17 may be mounted in a single unit instead of the two detachable units 48 and 50, or they may be mounted in three or more units designed to be received in the projectile.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be

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understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. An indicating apparatus for use in determining the conduct of a projectile in a gun barrel, which comprises a radio transmitter in the projectile, an antenna electrically coupled to the transmitter and extending from the projectile along the bore of the gun, and a receiver remote from the projectile and tuned to the frequency of the transmitter for receiving signals emitted from the antenna.

2. In combination, a projectile to be loaded into a gun for firing, a radio transmitter in the projectile, means electrically coupled with the transmitter for radiating energy from adjacent the muzzle of the gun, and a radio receiver tuned to the frequency of the transmitter for receiving signals from said radiating means.

3. An apparatus for determining the conduct of a projectile in a gun barrel, which comprises an electrical oscillator unit in the projectile, a source of electrical energy in the projectile for energizing the oscillator unit, means electrically coupled with the oscillator unit and extending along the bore of the gun for radiating energy from adjacent the muzzle of the gun, and a radio receiver tuned to the frequency of the oscillator unit for receiving signals from said radiating means during the passage of the projectile through the barrel.

4. An apparatus for determining the conduct of a projectile in a gun barrel, which comprises an oscillator unit in the projectile, a source of electrical energy in the projectile for energizing the oscillator unit, a manually operable switch in the projectile for electrically connecting said source to the oscillator unit, means electrically coupled with the oscillator unit and extending along the bore of the gun for radiating energy from adjacent the muzzle of the gun, and a radio receiver tuned to the frequency of the oscillator unit for receiving signals from said radiating means as the projectile moves along the gun barrel.

5. In combination, a projectile to be loaded into a gun for firing, a radio transmitter in the projectile, an antenna electrically coupled to the transmitter and extending from the projectile along the gun barrel for radiating energy from adjacent the muzzle of the gun, a radio receiver tuned to the frequency of the transmitter, and an oscilloscope electrically connected to the output end of the receiver.

6. In combination, a projectile to be loaded into a gun for firing, a radio transmitter in the projectile, an antenna electrically coupled to the transmitter and extending from the projectile along the bore of the gun for radiating energy from adjacent the muzzle of the gun, a radio receiver tuned to the frequency of the transmitter, and means for indicating the output of the receiver.

7. In combination, a projectile to be loaded into a gun for co-action with its firing mechanism, a radio transmitter in the projectile, an antenna electrically coupled to the transmitter for radiating energy from adjacent the muzzle of the gun, a radio receiver tuned to the frequency of the transmitter, and an energizing circuit for the receiver including a switch operable by said firing mechanism.

8. In combination, a projectile to be loaded into a gun for firing, a radio transmitter in the

projectile, an antenna electrically coupled with the transmitter and extending from the projectile along the bore of the gun for radiating energy from adjacent the muzzle of the gun, a collector unit on the nose portion of the projectile for receiving the antenna as the projectile moves through the gun barrel, and a radio receiver tuned to the frequency of the transmitter for receiving signals from the antenna.

9. In combination, a projectile to be loaded into a gun for firing, a transmitter in the projectile, an antenna electrically coupled to the transmitter and extending along the bore of the gun for radiating energy from adjacent the muzzle of the gun, insulating means mounted on the muzzle of the gun for supporting the antenna to maintain the antenna out of contact with the gun, and a receiver tuned to the frequency of the transmitter for receiving signals from the antenna.

10. In a projectile, a radio transmitter for use in determining the conduct of the projectile in a gun barrel, which comprises electrical operating elements, electrical connections between said elements, insulating means in which said elements and connections are embedded, means for securing said insulating means to the projectile body, and an antenna electrically coupled to said operating elements and extending from the nose of the projectile.

11. In a projectile, a radio transmitter for use in determining the conduct of the projectile in a gun barrel, which comprises an electrical oscillator unit including operating elements and electrical connections between the elements, an insulating block in which said elements and connections are embedded, a source of electrical energy, a second insulating block in which said source is embedded, releasable electrical connections between said blocks for conducting current from the source to said first electrical connections, and means for securing said blocks to the projectile body.

12. In a projectile, a radio transmitter for use in determining the conduct of the projectile in a gun barrel, which comprises a member at the nose of the projectile insulated from the projectile body, said member having a generally cup-shaped recess in its nose end, insulating means in the rear end portion of the member, an oscillator unit embedded in the insulating means, means for securing said member to the projectile body, means in the projectile body for energizing the oscillator, and an antenna electrically coupled to the oscillator and having one end disposed in said recess in the nose end of the member, whereby the antenna is adapted to be collected in said recess as the projectile moves through the gun barrel.

13. In a projectile, a radio transmitter for use in determining the conduct of the projectile in a gun barrel, which comprises a member at the nose portion of the projectile insulated from the projectile body, insulating means in said member, an oscillator unit embedded in said insulating means and including an oscillator tube having a filament, a manual switch in the side wall of said member for closing the energizing circuit of said filament, means for securing said member to the body of the projectile, and means in the projectile body for energizing the oscillator unit.

14. In a projectile, a radio transmitter for use in determining the conduct of the projectile in a gun barrel, which comprises a member at the nose of the projectile insulated from the projectile body, insulating material in said member, an oscillator unit embedded in said material, releasable means for connecting said member to the projectile body, an insulating block disposed in a recess in the nose portion of the projectile body to the rear of said first block, energizing means embedded in said block, and releasable electrical connections between said blocks for conducting current from the energizing means to the oscillator unit.

15. In combination a projectile to be loaded into and fired from a gun, an indicating apparatus for determining the conduct of the projectile in the gun barrel, which comprises signal producing means in the projectile, a wire coupled to said means and extending from the projectile along the bore of the gun, and a receiver remote from the projectile for receiving from said means a signal transmitted along the wire.

16. In combination a projectile to be loaded into and fired from a gun, an indicating apparatus for determining the conduct of the projectile in the gun barrel, which comprises means in the projectile for producing an electrical signal, a wire electrically coupled to said means and extending from the projectile along the gun bore and out of the muzzle, and a receiver remote from the projectile for receiving the signal from said wire.

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