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T. B. SLATE.
PNEUMATIC ELECTROMAGNETIC GUN.
APPLICATION FILED JAN. 9, 1918.

Patented Apr. 22, 1919.

2 SHEETS—SHEET 1.

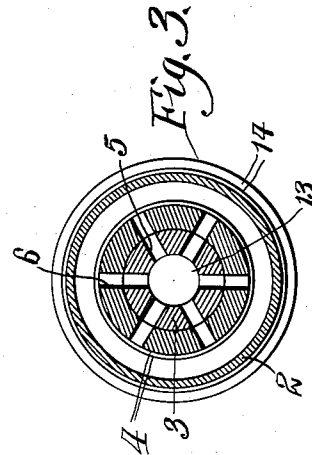
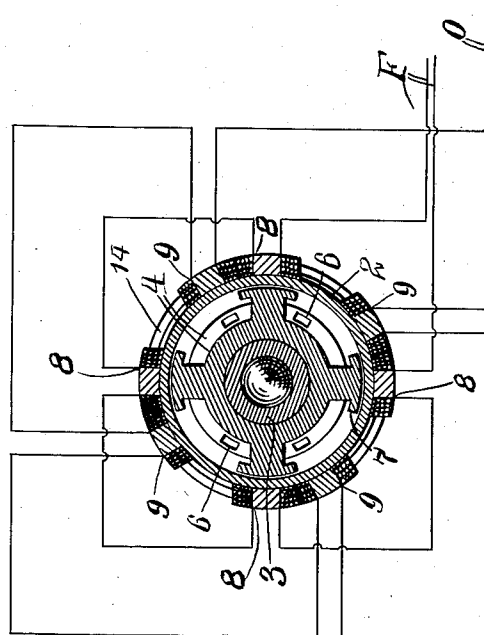
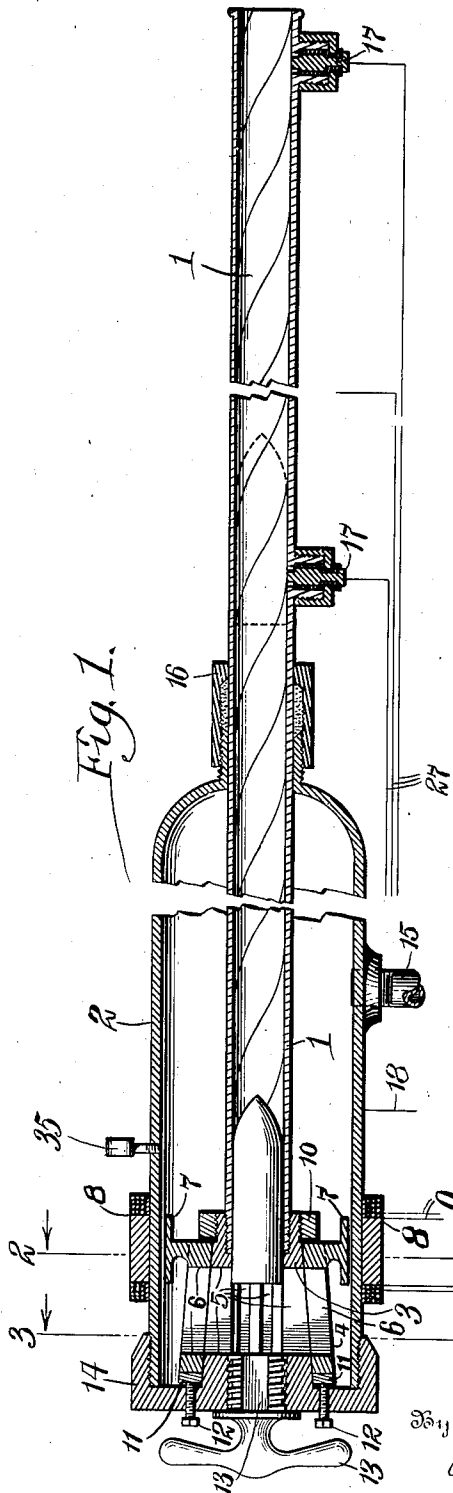


Fig. 2.

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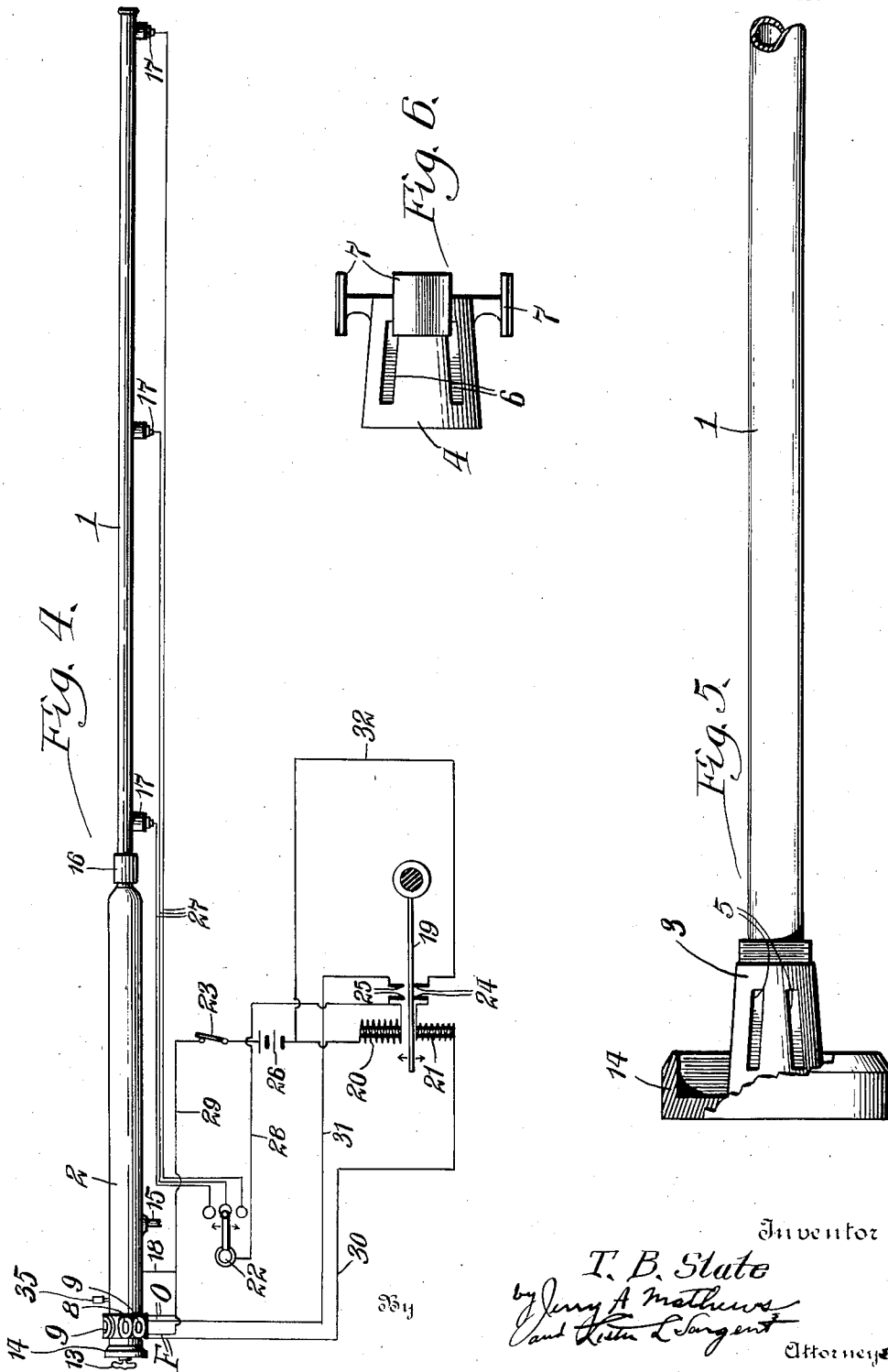
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UNITED STATES PATENT OFFICE.

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PNEUMATIC ELECTROMAGNETIC GUN.

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Specification of Letters Patent.

Patented Apr. 22, 1919.

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To all whom it may concern:

Be it known that I, THOMAS B. SLATE, a citizen of the United States, residing at Washington, in the District of Columbia, have invented a new and useful Pneumatic Electromagnetic Gun, of which the following is a specification.

The object of my invention is to provide a gun for the purpose of shooting or throwing projectiles either of the solid type or of the shell type containing explosives, and more especially for those containing high explosives, as this type of gun will not be nearly so apt to discharge the powder contained within the projectile as would the ordinary type of powder gun.

It is a further object of my invention to eliminate the danger of bursting the breech of the gun by the explosion of powder or gases; to eliminate the damage done to the inner walls of the gun barrel directly in front of the powder charge where the heat of explosion is so intense and the tremendous pressure so great at the time of the explosion that the walls are worn away by the hot gases, thereby diminishing the efficiency of the gun; and to eliminate the heat in the gun barrel caused by the explosion of powder or gases, limiting the rapidity of firing according to the size of the gun used, where powder is employed.

It is a further object of my invention to provide a gun which can be manufactured rapidly and economically; and to very materially increase the life of the gun in proportion to the number of shots fired. A further advantage resides in the fact that no explosives other than those contained in projectiles is necessary to be carried with the gun, as it does not use any explosive force for the purpose of throwing or shooting the projectiles. A further advantage is attained by the economic use of energy applied to each projectile as it leaves the gun, making it possible to absolutely gage the distance at which the projectile will fall when the gun is being fired at a high degree of elevation for throwing shells at the greatest possible distance with accuracy.

It is a further object of my invention to provide a gun which can be fired at night without disclosing its position to the enemy.

I attain the objects of my invention by the

mechanism illustrated in the accompanying drawings, in which—

Figure 1 is a longitudinal sectional view of the invention;

Fig. 2 is a transverse section on line 2—2 of Fig. 1;

Fig. 3 is a transverse sectional view on line 3—3 of Fig. 1;

Fig. 4 is a side elevation of the entire gun with the electric apparatus shown in diagram;

Fig. 5 is an elevational view, of member 3, with member 14 shown partly in section; and

Fig. 6 is a side elevation of member 4.

Like characters of reference designate like parts throughout the several views.

Referring to the accompanying drawings, I provide a gun barrel 1 through which projectiles are discharged. Surrounding barrel 1 I provide a compression or storage chamber for storing pneumatic fluid (usually steam) for the purpose of discharging projectiles through barrel 1. I further provide a suitable valve seating member 3 containing the valve-controlled portions or passages 5 through which the energy contained in compression chamber 2 is allowed to pass to the inside of gun barrel 1 for the purpose of discharging projectiles. I further provide a novel electro-magnetically controlled valve 4 mounted on valve seating member 3, for the purpose of opening and closing the valve openings at predetermined times. I provide valve openings 5 in member 3 and valve openings 6 of corresponding shape in member 4, as illustrated in Figs. 1 and 3. Integral with member 4 I provide magnetically attracted arms 7, as illustrated in Figs. 1 and 6. I provide electro-magnets 8 for the purpose of attracting arms 7 to firing position, thus moving valve 4 to open or firing position. I further provide similar electromagnets 9 adjacent members 8, for the purpose of attracting arms 7 to closed or non-firing position to cut off passages 5, and prevent pneumatic fluid from passing from compression chamber 2 to gun barrel 1.

Referring to Fig. 2, I provide two electric circuits, of which O designates the electric circuit which is utilized in operating arms 7 to rotate valve 4 to its "off" or closed

position; while F designates the electric circuit which is utilized in operating arms 7 to move valve 4 to its open or firing position, with the passages 5 and 6 in communication.

5 As shown in Fig. 1 I provide a lock nut 10 to hold valve 4 to its seat; and I also provide a set ring or adjusting collar 11 at the opposite end of valve 4 to prevent it from wedging on member 3 and working too hard to be rotated by electromagnets 8 and 9. I also provide adjusting screws 12 for adjusting member 11 to its proper position. For the purpose of closing the breech of the gun after the projectile has been placed in position for firing, I provide a suitable breech block 13.

As shown in Fig. 5, member 3 is provided with an annular flanged head 14 for the purpose of receiving and securing the end of compression chamber 2. Opening into chamber 2 is a suitable supply pipe leading to any suitable source of pneumatic pressure, steam preferably being employed to operate the gun. A suitable packing gland 16 is provided for the purpose of securing compression chamber 2 to gun barrel 1 and permitting of adjustment for the purpose of allowing for expansion and contraction of metals in either member 1 or 2.

30 I further provide insulated barrel plugs 17 for the purpose of shortening the circuit to magnetic switch 19, as shown in Fig. 4. I provide a suitable ground wire 18 connected to a suitable portion of compression chamber 2, as shown in Fig. 1, this member being the ground wire of the magnetic switch circuit. A magnetic switch 19 is operated by short circuiting the insulated barrel plug with the compression chamber or barrel.

Referring further to Fig. 4 I provide a larger electric switch magnet or solenoid 20 and an opposed smaller solenoid 21 for operating switch 19. That member normally is in contact with solenoid 20 when the gun is in non-firing position. I provide a suitable 3-way switch 22 for the purpose of selecting the proper cut-off point of valve 4 through plug 17. Member 23 is a main switch for shutting off current from the circuit.

Referring to Fig. 4, I provide firing switch contacts 24 for magnetic switch 19; and opposed "off" switch contacts 25. A suitable generator or battery 26 is provided in the circuit. Extending from contact plug 17 to switch 22 are wires 27. Switch 22 may be arranged for any suitable number of wires, varying with the size and uses of the gun. A wire 28 is provided, extending from switch 22 to the "off" contacts 25. A wire 29 is provided, extending from main switch 23 to contacts 25. A wire 30 is provided extending from the smaller solenoid 21 to electromagnet 9, and to contacts 24.

31 designates a wire extending from "off" contacts 25 to electromagnets 9; and 32 designates a wire from firing contact 24 to battery 26. Operatively connected with compression chamber 2 I provide a suitable pressure gage 35 as indicated in Figs. 1 and 4.

The operation of my gun is as follows: Beginning with main switch 23 in "off" position, the operator moves switch 22 to its proper position according to the distance it is desired to throw the projectile, as governed by the position of the particular plug 17, which is to be utilized in completing the electric circuit as the missile passes through the gun barrel. The operator also moves switch 19 toward solenoid 20 to connect contact points 25. The switch 23 is then moved to its "on" position, connecting up the main circuit. Breech block 13 is turned to removing position and removed from the end of gun barrel. The projectile is inserted in the barrel and breech block 13 replaced and locked. After noting whether the pressure shown by pressure gage 25 is sufficient to throw the projectile the desired distance, taking into consideration the position of switch 22, the operator moves switch 19 to its firing position. By so doing the current is thrown on to the wires of the "F" circuit (reference being had to Fig. 2) and valve arms 7 are attracted to electromagnets 8, putting the compression chamber into communication with the gun barrel through the openings 5 and 6 of the valve and valve seating member, for supplying steam at the rear of the projectile. The energy of the pneumatic fluid (ordinarily steam) in chamber 2, causes the discharge of the projectile through barrel 1 with the exertion of the full amount of pressure stored in chamber 2 until the projectile reaches the insulated barrel plug which is in circuit through switch 22. The insulated member of plug 17 touching the projectile, (as indicated in Fig. 1 by dotted lines), and the projectile being in direct contact with barrel 1, makes a short circuit through ground wire 18 to solenoid 20. Solenoid 20 (which is the stronger of the two solenoids) thereupon attracts switch 19, from solenoid 21 and closing contacts 25, thereby exciting electromagnets 9 and thus causing the rotation of valve 4 to its original or "off" position, cutting off the supply of energy from compression chamber 2 to barrel 1. In this way use is made of the expansion of energy at the rear end of barrel 1 for the expulsion of the missile. The operation is repeated for the next projectile, except that switch 23 is left closed. The operator moves switch 19 back to its firing position, when the energy lost by firing the projectile is restored to chamber 2 through supply pipe 15.

The electromagnets 8 and 9 are placed exterior to compression chamber 2, as shown

in Figs. 1 and 2, and operate the valve by electromagnetic force exerted through the walls of compression chamber 2 without having any direct connection through openings or otherwise through the casing of the compression chamber.

It will be readily understood that the energy supplied to a projectile from this gun does not come with an explosion or sudden jar, but is exerted evenly and keeps up almost its maximum pressure until the projectile reaches that portion of the barrel where the supply of steam is cut off as controlled by the making of an electric circuit from a barrel plug to the barrel of the gun, thereby starting and moving the projectile by means of a gradual pneumatic pressure constantly supplied at the rear of the projectile, and if desired almost at constant pressure until it leaves the muzzle of the gun. If it is desired to throw the projectile to the greatest possible range, this is accomplished by using plug or cut-off nearest the muzzle end of the gun barrel. This method of discharging a projectile from the gun makes it possible to use the highest explosive in projectiles with safety, and also makes it possible to use a much cheaper shell to contain explosives, because of the fact that the shell does not have to stand the shock of a sudden explosion supplied to it by a charge of powder or explosive gases but is propelled by the substantially uniform impulse of steam pressure.

Steam pressure is preferred as probably the most practical fluid for supplying energy, and it permits of lubrication of the gun barrel in the same manner as the piston in a steam cylinder is lubricated. In consequence wear on the walls of the gun barrel and rifling is practically eliminated, thus making it possible to throw hundreds of thousands or millions of projectiles from one gun barrel without any appreciable wear, there being no dry heat or extremely hot gases to wear away the metal of the gun barrel at the breech, and there being no undue strain on the breech of the gun. My construction also eliminates the necessity of relining the gun barrel, and there is no possible danger of bursting the gun at the breech, since the energy is supplied equally throughout the length of the barrel or to the point of the cut-off or plug in circuit with switch 22.

One of the principal advantages of compression chamber 2 is that it maintains an even temperature of gun barrel 1 during the first period of expulsion of the projectile and prevents condensation of steam following the projectile until after it passes the end of the compression chamber.

This gun may be used most economically at the highest degree of elevation for the greatest possible range, as it is possible to

absolutely determine the distance a projectile will be thrown by the pounds per square inch of pressure supplied behind the projectile while within the gun barrel. This, with the difference between the cost of powder and that of fuel for generating steam, or the cost of other pneumatic, such as compressed air, very materially reduces the cost of throwing a projectile a given distance. This is very clearly illustrated by the fact that the first explosive engine was operated by the explosion of gunpowder, but very readily gave way to the milder operation of gas and steam actuated engines, because of the economy in the use of the latter and the less severity of the force or energy supplied.

My gun may be continuously fired for an indefinite period up to the extreme life of the gun as it will not become unduly heated from the process of firing. This is also true of guns of this type of small bore and rapid fire. It is within the contemplation of my invention to supply any suitable automatic feed for rapid firing purposes, so that the gun may be fired at any desired degree of rapidity up to three thousand shots per minute.

What I claim is:

1. In a pneumatic electro-magnetic gun, the combination of a gun barrel, an electromagnetically controlled valve for controlling the inflow of pneumatic fluid, a compression chamber to contain the pneumatic fluid, a magnetic switch electrically connected with the gun, an insulated short circuiting plug mounted in the barrel of the gun to control the electric circuit and consequently the supply of fluid pressure which discharges the projectile.

2. In a pneumatic electro-magnetic gun, the process of supplying a pneumatic fluid under pressure at the rear of a projectile continuously to drive the projectile from the barrel; lubricating the barrel by the pneumatic fluid flowing therethrough; and automatically cutting off the supply of pneumatic fluid when the projectile has passed a given point in the barrel, substantially as set forth.

3. In a gun, the combination of a barrel, a cylindrical encircling storage chamber containing a pneumatic fluid, a valve controlling the admission of the fluid to the gun barrel, electro-magnetic means controlling the operation of the valve, and electro-magnetic means for automatically reversing the operation of the valve by the completion of an electric circuit.

4. In a pneumatic electro-magnetic gun, a gun barrel, an energy storage chamber communicable therewith, an electromagnetically controlled valve regulating the flow of pneumatic fluid from storage chamber to gun barrel, and electro-magnetic

means for automatically closing the valve at a predetermined time, governed by the position of the projectile in the barrel in consequence of its relation to an electric contact plug projecting into the barrel and insulated therefrom.

5 5. In a pneumatic electro-magnetic gun, the combination of a gun barrel, a pneumatic energy storage tank communicable therewith, an electro-magnetically controlled valve for regulating the flow of pneumatic fluid under pressure into the rear of the gun barrel to discharge a projectile, and means for shutting off the inflow of pneumatic fluid at a predetermined time governed by the closing of an electric circuit as the missile passes through the barrel, and thereby reversing the operation of the above described electro-magnetically controlled valve

whereby the distance to which the projectile will be thrown may be gaged.

6. In a pneumatic electro-magnetic gun, the combination of a gun barrel, a steam chamber encircling the rear portion of the gun barrel, a rotatable valve having openings therein communicable with corresponding openings in a valve seating member, a valve seating member connected with the gun barrel, a plurality of electromagnets arranged to control the operation of the valve, one or more insulated plugs projecting into the gun barrel, and an electric circuit arranged to be completed when the projectile passes over a particular plug, said circuit causing a reversal of the action of the valve and thereby shutting off the inflow of steam behind the projectile.

THOMAS B. SLATE.