Jan. 9, 1923.

1,441,535

R. V. MORSE.
DIRECT FIRE CONTROL SYSTEM.
FILED MAR. 28, 1921.

2 SHEETS-SHEET 1

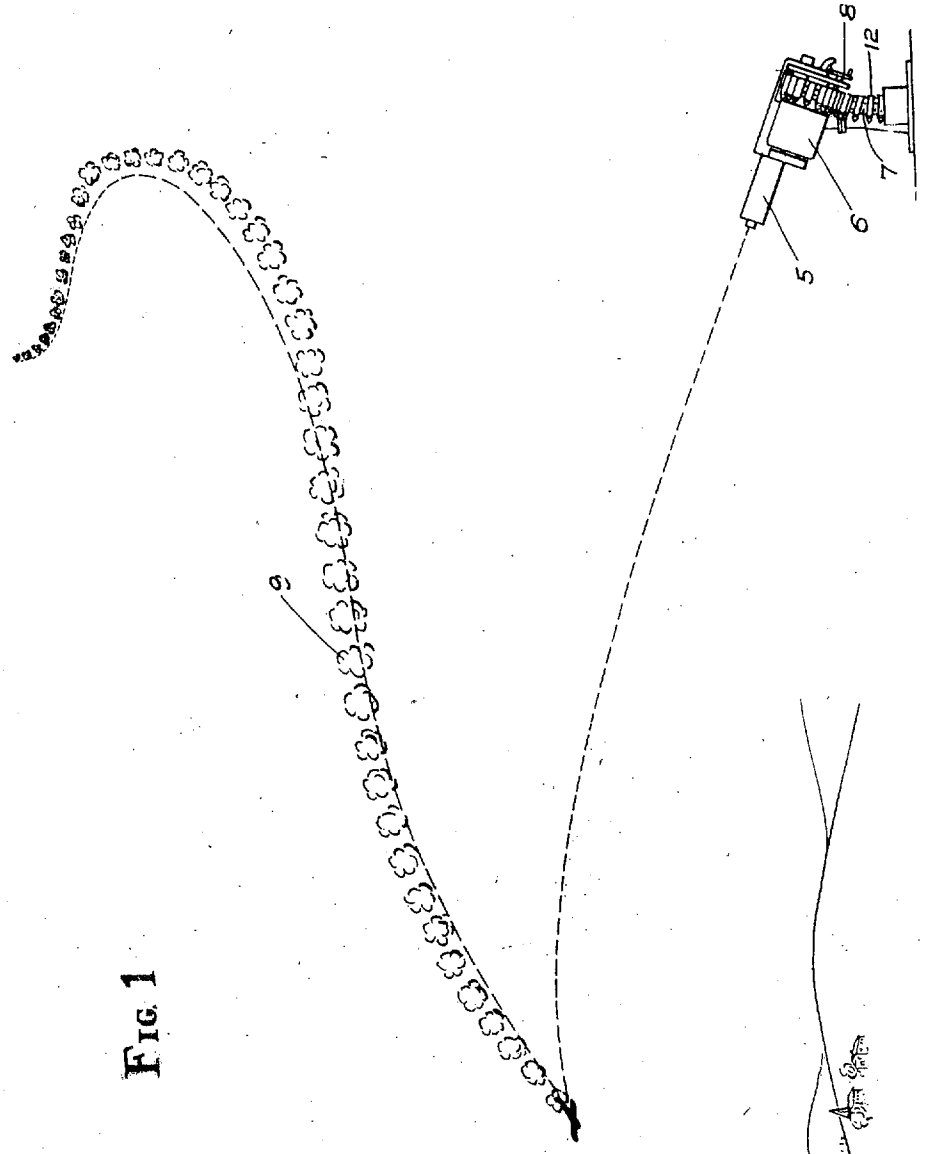


FIG. 1

INVENTOR

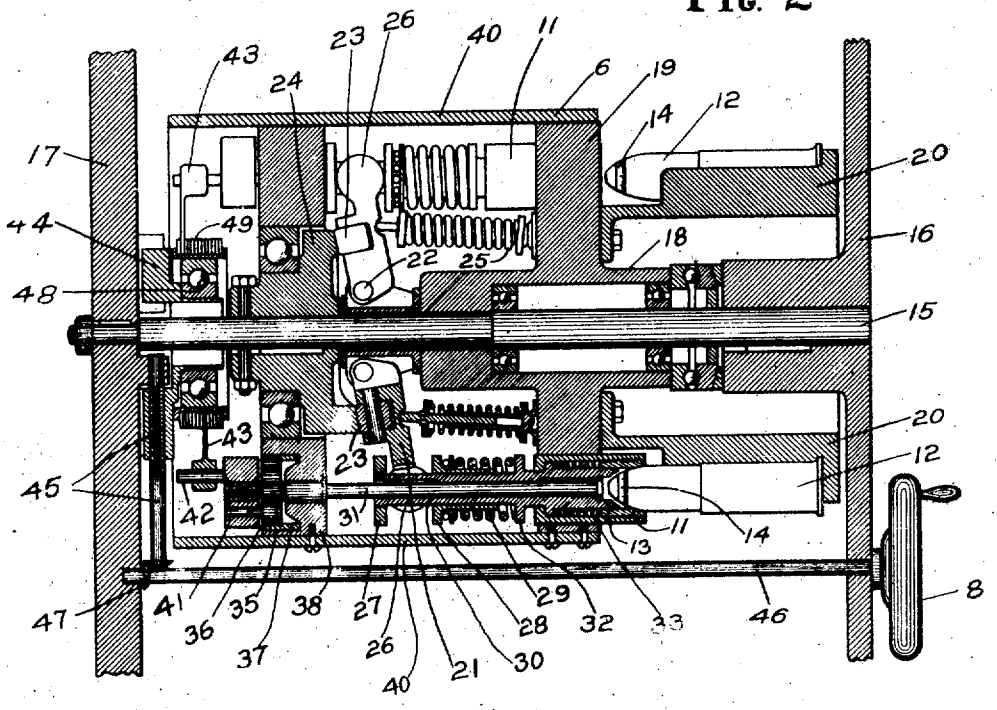
Robert V. Morse

Jan. 9, 1923. 1,441,535

R. V. MORSE.
DIRECT FIRE CONTROL SYSTEM.
FILED MAR. 28, 1921.

2 SHEETS-SHEET 2

FIG. 2



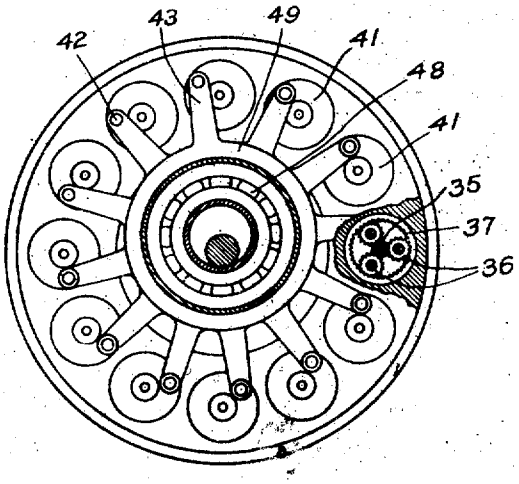
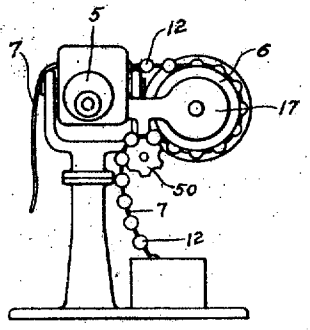


FIG. 3

FIG. 4



INVENTOR
Robert V. Morse

Patented Jan. 9, 1923. 1,441,535

UNITED STATES PATENT OFFICE.

ROBERT V. MORSE, OF ITHACA, NEW YORK.

DIRECT-FIRE-CONTROL SYSTEM.

Application filed March 28, 1921. Serial No. 456,119.

To all whom it may concern:

Be it known that I, ROBERT V. MORSE, a citizen of the United States, residing at Ithaca, in the county of Tompkins and State of New York, have invented a new and useful Direct-Fire-Control System, of which the following, taken with the accompanying drawings is a specification.

This invention relates to anti-aircraft ordnance, and in particular to means for directing and controlling the fire of machine guns capable of firing shells having adjustable time fuses, such as the so-called "pom-pom" one pounder type of machine gun. In Patent No. 1,355,841, Tracer system of fire control, issued to me October 19, 1920, the problem of tracing such fire by direct observation is analyzed, and a means for making visible the apparent stream of fire, (as distinguished from the individual trajectories), is described. This invention is a development or improvement of the system described in that patent, and consists in general in maintaining a continuous visible bursting point whose location in space is under the complete control of the gunner, who can move it up or down, right or left, and nearer or farther in range, at will. No sights, range determinations, deflection settings or computations of any kind are required,—the manipulation of the gun being a direct reflex from observation of the continuous bursting point, as is necessary where an engagement is a matter of seconds or at most a few minutes.

Referring now to the drawings, Fig. 1 illustrates in a somewhat diagrammatic manner the method of fire control embodied in this invention; Fig. 2 is a longitudinal view partly in cross-section showing one form of the continuous fuse-setting mechanism; Fig. 3 is a view from the left end of the rotating drum. Fig. 4 is a front end elevation of a machine gun equipped with the continuous fuse-setter, showing the cartridge belt as fed thru the mechanism.

In Fig. 1 the machine gun 5 is of a type such as the one-pounder for example capable of firing a projectile sufficiently large to be equipped with an adjustable time fuse, the gun 5 being mounted in the usual trunnions on a revolving base so that it can be freely pointed in any direction in the usual manner. Combined with the gun 5 is an automatic fuse-setting mechanism 6 which sets the fuses of the shells in the cartridge belt 7 just before they are fired,—the cartridge belt 7 feeding continuously thru the setting mechanism 6 and gun 5 when the gun is in operation. The amount of the fuse setting given by the mechanism 6 is controlled by a lever or wheel 8, by means of which the gunner can directly control the range of the bursting point as easily and promptly as he can control the direction. The location of the bursting point does not of course respond instantaneously to the will of the gunner, as an interval of time must elapse while the projectile is travelling thru the air. For this reason the bursting point cannot always be laid immediately upon the airplane, and the trail of bursts 9 will generally not respond immediately to a sharp turn in the course of the airplane. However, the errors generally inherent in the burning of time fuses cause a certain amount of diffusion in the bursts, so that the trail of bursts 9 is generally not so precise and narrow as indicated in Fig. 1, so that it covers to a certain extent ordinary changes in the course of the airplane. When the gun 5 is pointed by the use of a stock or handle, the same man may both point the gun and control the range of its bursting point. When elevating and traversing wheels are used to point the gun, different men may be employed for the pointing and for controlling the range or distance.

An essential element in a fire control system such as has been above described is of course a fuse-setting mechanism operating in combination with a machine gun of the type mentioned. This mechanism sets the fuses in succession in the belt just before they are fired from the gun, and must continuously make these settings with a rapidity corresponding to the rate of fire of the gun,—several shots a second,—in order to maintain a continuous bursting point and a continuous stream of fire. One illustrative form of such setting mechanism is shown in detail in Figs. 2, 3, and 4.

Referring now especially to Fig. 2, the heart of the fuse-setting mechanism consists of a clutch 11 which at the proper time grips the main body of the shell or cartridge 12 so as to grasp it firmly and hold it from rotation, and a second clutch 13 which can slide and turn freely within the clutch 11 and which grips the fuse-ring 14 on the nose of the shell and then proceeds to turn

the fuse-ring around thru an amount determined by the setting which has been given the mechanism by the control wheel or lever 8. The same action of course may be obtained by holding the fuse-ring stationary and turning the body of the shell. When the fuse-ring 14 has been turned the desired amount, the clutch 13 is pulled back to release its grip on the fuse-ring, and the body of the shell or cartridge is then also released by the clutch 12,—the shell thus set being then carried on by the machine gun mechanism and fired in the usual manner. It will be understood that before a belt of cartridges is fed into the setting mechanism all the fuse-rings in the belt are carefully set at precisely the same value, such as zero or safety, so that the ultimate fuse settings resulting from the action of the mechanism will all correspond to the amount by which the ring 14 was turned by the clutch 13.

Such a mechanism may be linked directly mechanically to the recoil or gas operated elements of the machine gun mechanism, so that every time a shot was fired the next shell in line would be seized and set by the clutch, but this would necessitate performing the seizing and setting operations with extreme rapidity,—completing the whole setting operation in a fraction of a second,—increasing the tendency of the mechanism to jam, and increasing the liability to errors in setting. Consequently in the preferred form of mechanism selected for illustration herein, I have combined a number of individual setting units into a multiple machine,—each unit in its own time carrying thru the same cycle of operations, but arranged so that when one unit is releasing a completely set shell, the next unit back is just completing the setting of its shell, those farther back are in the process of setting, and other units are just seizing the shell, and so on through the cycle. By performing simultaneously different operations on the shells in the belt, the time allowed to complete the cycle with any particular shell is extended over a much longer interval, so that while the mechanism can send out completely set shells with great rapidity, the individual operations within the mechanism are performed at a more moderate rate of speed, giving greater precision and freedom from jamming.

In the form shown in Figs. 2 and 3, the individual setting units are arranged radially around a central shaft 15, and rotate bodily around that shaft as a center when the mechanism is in operation. The shaft 15 is normally stationary and is fixed in the frame or brackets 16 and 17, which are secured to the body or case of the machine gun 5 as shown in Fig. 4. A hub 18 is rotatably mounted on suitable bearings on the fixed shaft 15, and is carried out into a disk or plate 19 having holes or sockets arranged equidistantly around near its periphery, in each of which sockets a tubular clutch 11, of the cone faced type, can slide but cannot turn. A cartridge belt wheel 20 is bolted to the plate 19, and is provided with suitable indentations to accommodate the cartridges in the belt. The wheel 20 is arranged so that each cartridge 12 falls into place with its nose directly opposite a clutch 11 in a corresponding socket in the plate 19. In the upper part of Fig. 2 the clutch 11 is shown retracted, as after a setting has been completed, or before a setting has been begun. In the lower part of Fig. 2 the clutch 11 is shown forced out gripping the shell 12 preparatory to beginning the operation of turning the fuse-ring 14. The clutch mechanisms are forced thus in and out by levers or fingers 21 which are pivoted at the points 22,—the pivots 22 being assembled on a rotatable bushing which turns with the hub 18 around the fixed shaft 15. A roller 23 is mounted in each finger 21, and rolls on an annular cam face 24, the cam 24 being securely fixed to the stationary shaft 15. As the fingers 21 rotate bodily around the shaft 15 and the rollers 23 engage high portions of the cam 24, the fingers 21 are swung to the right, as shown in the lower part of Fig. 2; while on other portions of the cam the fingers 21 swing to the left as shown in the upper part of Fig. 2. Follower springs 25 maintain the rollers 23 in contact with the cam 24 at all times. The outer extremities of the fingers 21 terminate in round headed yokes 26 which engage flanges 27 and 28, through which the reciprocating motion is transmitted to the clutch mechanisms 11 and 13.

In order that the required yielding quality be given to the mechanical force behind the clutches, the force when engaging is transmitted thru suitable springs 29. This is not necessary when moving in the opposite direction to disengage the clutch, since in that direction the reciprocating parts are not forced against any solid obstacle,—nor would it be necessary if magnetic clutches were employed. Taking up the yielding spring arrangement more in detail, the flange 27 is solidly attached to a long tubular bushing 30 which terminates at the other end in the inner clutch face 13, opposite the fuse-ring 14. The bushing 30 can slide longitudinally on an interior shaft 31. The flange 28 is arranged to slide freely on the bushing 30, and transmits its force to the bushing 30 thru a spring 29 which bars against a flange 32,—the latter flange being integral on the bushing 30. The force is further transmitted to the clutch 11 thru another interposed spring 33 arranged interiorly of the clutch 11, between the clutch

tubes 11 and 13. As force toward the right is applied to the flange 28, the spring 29 transmits it to the bushing 30, which in turn transmits it to the clutch 11 thru the spring 33,—the clutches 11 and 13 in the initial stages thus moving bodily to the right. When the clutch 11 meets the body of the shell 12 and grips it, it can go no farther, as the cartridge is backed by the solid rim of the cartridge wheel 20; consequently the spring 33 then begins to yield, until the clutch 13 meets and engages the fuse-ring 14 of the shell. Thereafter neither the clutch 11 nor the clutch 13 can advance any further to the right; but the motion of the finger 21 continues to force the flange 28 to the right for some distance, thus further compressing the spring 29 and increasing the pressure on the cone clutch 13 until the grip on the fuse-ring 14 is sufficiently firm. When the finger 21 swings back to the left, the motion is transmitted thru the flange 27 directly to the bushing 30, thus first retracting the clutch 13, and finally carrying the clutch 11 also bodily back with it.

It remains to describe the manner in which the clutch 13 is given the desired rotation after it has gripped the fuse-ring 14. A feather key is arranged between the shaft 31 and the bushing 30, so that while the bushing is free to slide longitudinally on the shaft 31, as has been described, the bushing 30, (and consequently the clutch 13), can be rotated by turning the shaft 31. The shaft 31 terminates at the left, as shown in Fig. 2, in a small gear 35 which forms the center of a planetary system,—as also shown in Fig. 3 in the partially sectioned portion. Surrounding the gear 35 are planetary gears 36 which engage internal teeth in the casing 37, which fits in a socket in the main frame or ring 38 which extends around the fixed pivot shaft 15 and surrounds the cam 24. This frame or ring 38 has a series of sockets for the casings 37 spaced in the same manner as the sockets for the clutches 11 in the disk 19. Suitable bearings are interposed between the frame 38 and the fixed cam 24 so that the frame 38 can rotate with the disk 19,—the disk 19 and frame 38 being secured together by a drum shaped casing 40 which surrounds and rotates with the principal mechanism. The stub shafts upon which the planetary gears 36 are mounted are not fixed to the frame 38, but are mounted in a collar 41 which itself can rotate or oscillate around an extension of the shaft 31. A crank pin 42 extends from the collar 41. When the crank pin 42 is oscillated the planetary gears 36 roll around within the casing 37, and transmit a much multiplied oscillation or rotation to the shaft 31. For example, with suitably proportioned planetary gears, a motion of say a quarter of a revolution imparted to the crank pin 42 and gears 36 will produce a complete revolution of the shaft 31,—amply sufficient to give any desired fuse setting.

In order to give the desired motion to the crank pins 42 the following mechanism is provided. Each pin 42 is linked by a connecting rod 43 to a central crank shaft having a variable throw, so that as the various setting mechanisms rotate bodily around the central shaft the pins 42 are moved according to the amount the central crank shaft is off center. In Figs. 2 and 3 this central crank shaft is shown built up of an inner bracket 44 which can be moved up and down by the screw 45 operated by the control wheel 8 thru the shaft 46 and bevel gears 47. This bracket 44 can thus be thrown off center to any desired amount,—a hollow space thru the center of the bracket 44 permitting such motion relative to the fixed central shaft 15. In Fig. 2 the bracket 44 is shown as concentric with the shaft 15, and in Fig. 3 the bracket 44 is shown displaced to its extreme amount relative to the central shaft 15. A large ball bearing 48 is carried on an extension of the bracket 44, and also of coarse surrounds the shaft 15. This bearing 48 is in turn surrounded by the pivot bearings of the inner end of the connecting rods 43, which are here expanded to large thin rings of metal 49 in order to encompass the enlarged hollow crank shaft described. It will be noted that though there is a slight relative motion between the various rings 49, the chief motion of rotation is taken by the ball bearing 48, so that there is little wear or friction.

When the bracket 44 with its attached bearing 48 and rings 49,—in other words, the central crank shaft,—is concentric with the fixed shaft 15, the bodily rotation of the main mechanism around the shaft 15 will not cause any motion or oscillation of the pins 42 relative to the shafts 31,—and consequently no setting would be given the fuse-ring 14 by the clutch 13. But when the rings 49 are displaced eccentrically as shown for example in Fig. 3, the bodily rotation of the mechanism around the shaft 15 results in the pins 42 being given a corresponding amount of oscillation, turning the planetary gears 36 in one direction for half a revolution of the drum 40, and in the opposite direction for the other half of the revolution. The multiplying action of the gears 36, as described above, results in the shaft 31 and clutch 13 being turned thru the desired amount during one-half a bodily rotation of the main mechanism or drum 40,—the clutch 13 returning to its initial position by the completion of the rotation of the main mechanism. In the form shown in Fig. 4 the main mechanism is rotated by the pull of the cartridge belt 7 which is drawn into the gun by the operation of the

gun's feeding mechanism in the usual manner. Any other means of rotating the setting mechanism could of course be used. The cartridge belt 7 is fed into the mechanism over an idler wheel 50 as shown in Fig. 4, so that the shell has been firmly gripped by the clutches 11 and 13 by the time the pin 42 and clutch 13 are at one extreme of their oscillation. Then as the movement progresses the clutch 13 and fuse-ring 14 are turned gradually by an amount corresponding to the eccentricity which has been given the rings 49 by the control wheel 8. Half a cycle after this motion is begun the other end of the oscillation is reached, the motion being given the fuse-ring 14 comes to a stop, and at this instant the action of the cam 24 on the fingers 21 withdraws the clutches 11 and 13 and releases the shell, now set, which passes on to the gun and is fired.

It will be obvious to those skilled in the art that the invention is not limited to the particular form of mechanical setting mechanism which has been described by way of illustration; and that various modifications and adaptations may be made in the mechanical arrangements of various designs without departing from the scope of the invention as defined by the following claims.

I claim—

1. In an automatic fuse-setting mechanism for machine guns, the combination of means for gripping the body of the shell whose fuse is to be set, a clutch adapted to grip the fuse-ring of the shell, and mechanical means for causing the first mentioned means to act prior to the action of the clutch.

2. In an automatic fuse-setting mechanism for machine guns, the combination of a clutch member adapted to engage the fuse-ring of a shell, a second clutch member adapted to keep the body of the shell from twisting, means for forcing said clutches into action, a spring interposed between the first mentioned clutch member and the second clutch member, and a spring interposed between said forcing means and the first mentioned clutch member.

3. In an automatic fuse-setting mechanism for machine guns, the combination of a clutch member adapted to engage the fuse ring of a shell, a second clutch member arranged to keep the body of the shell from twisting, means for forcing said clutches into action, a shaft arranged to turn the first mentioned clutch member, and mechanical means arranged to periodically turn said shaft so as to give the desired fuse settings.

4. In an automatic fuse-setting mechanism for machine guns, means for causing a periodic motion corresponding to the fuse-setting desired, means for modifying said motion so as to give the amplitude required for the setting of the fuse, a clutch, and means for rotating said clutch according to said modified motion.

5. In an automatic fuse-setting mechanism for machine guns, the combination of a clutch, means operated by the action of the machine gun for causing said clutch to oscillate, means controlling the amplitude thru which said clutch oscillates, and means for causing said clutch to engage when at one end of its oscillation and disengage when at the other end of its oscillation, whereby the clutch will engage and disengage at times of minimum oscillatory motion.

6. In an automatic fuse-setting mechanism for machine guns, the combination of a central shaft, a frame carried on suitable bearings so that it can rotate around said shaft, a number of fuse-setting units mounted in said frame and arranged so as to rotate with said frame around the central shaft, and a cam on said shaft arranged to drive said fuse-setting units so as to carry them successively thru their cycle of operations as they rotate around the central shaft, whereby the operation of fuse-setting may be completed on successive shells with greater rapidity than the time required to carry thru a single setting, and means for varying the amount of the fuse-setting.

7. In an automatic fuse-setting mechanism for machine guns, the combination of a rotatable frame adapted to receive a number of cartridges, clutches arranged around said frame, a cam mechanism arranged to operate the clutches successively as the frame rotates, a yieldable drive connection between the cam mechanism and the clutches, means for turning the clutches, a central crank, connectors extending from the central crank to the turning means for the several clutches, a central shaft, and means for varying the eccentricity of the central crank relative to the central shaft, whereby the amount of the fuse-settings may be controlled.

In witness whereof I have hereunto set my hand this 22nd day of March, 1921.

ROBERT V. MORSE.