R. V. MORSE.

TRACER SYSTEM OF FIRE CONTROL.

APPLICATION FILED MAY 10, 1920.

1,355,841.

Patented Oct. 19, 1920.

3 SHEETS—SHEET 1.

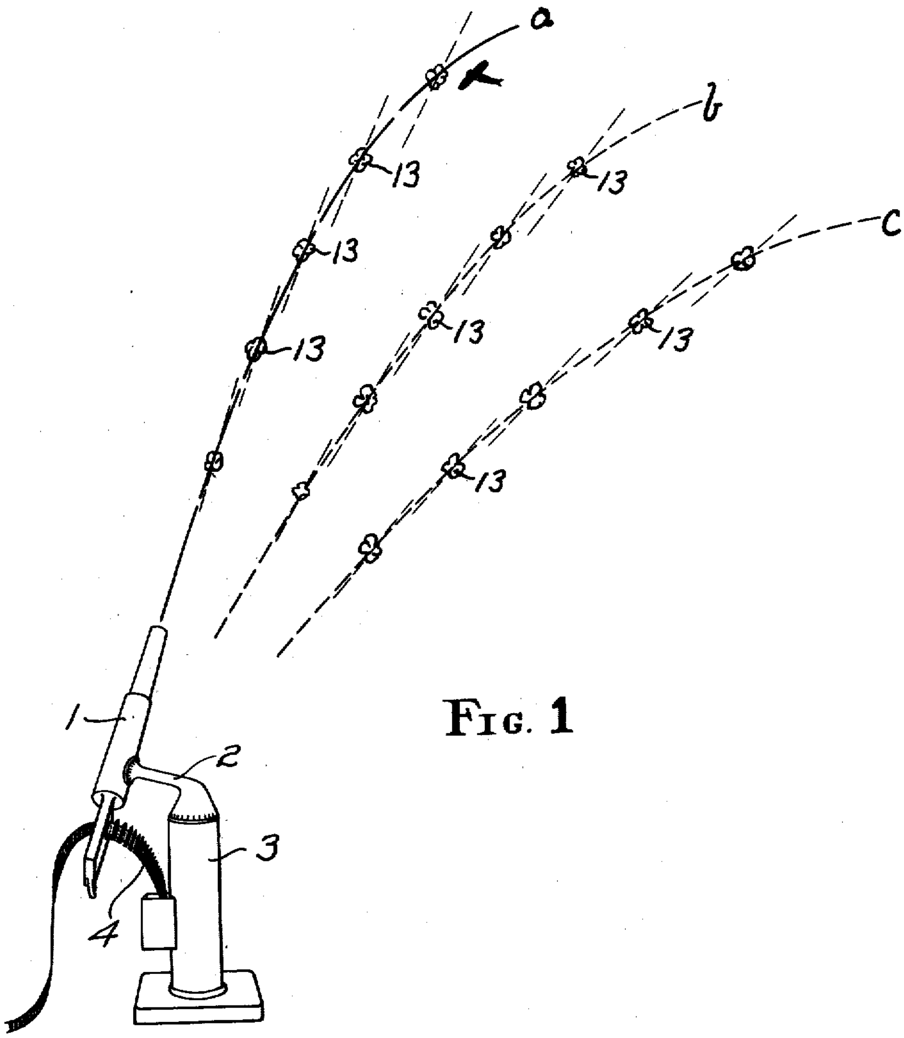


FIG. 1

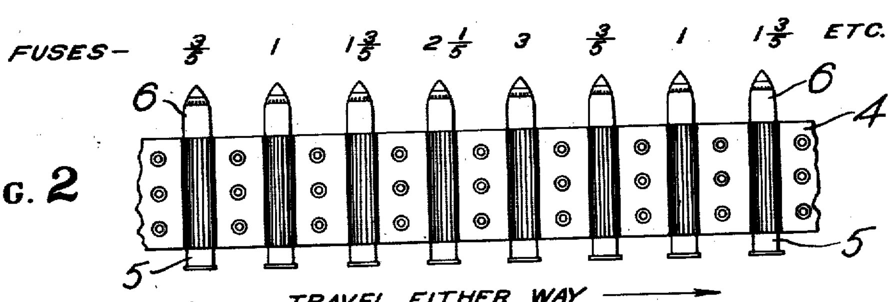


FIG. 2

INVENTOR

Robert V. Morse

R. V. MORSE.

TRACER SYSTEM OF FIRE CONTROL.

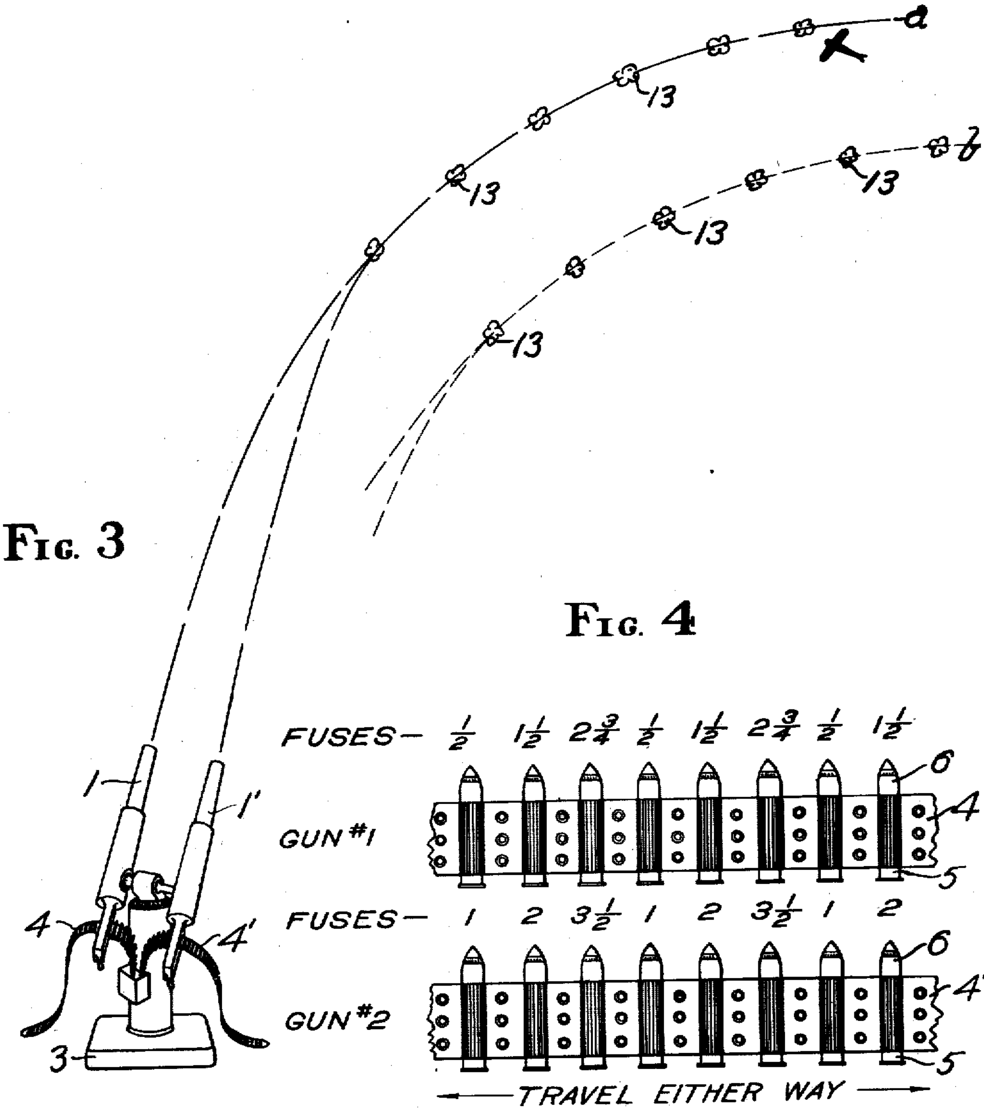
APPLICATION FILED MAY 10, 1920.

1,355,841. Patented Oct. 19, 1920.

3 SHEETS—SHEET 2.

FIG. 3

FIG. 4



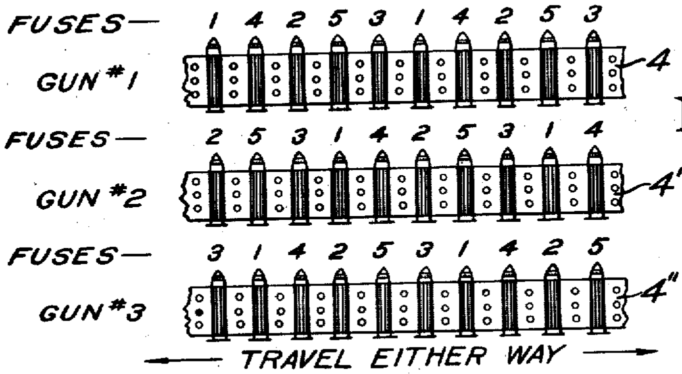


FIG. 5

INVENTOR

Robert V. Morse

R. V. MORSE.

TRACER SYSTEM OF FIRE CONTROL.

APPLICATION FILED MAY 10, 1920.

1,355,841. **Patented Oct. 19, 1920.**

3 SHEETS—SHEET 3.

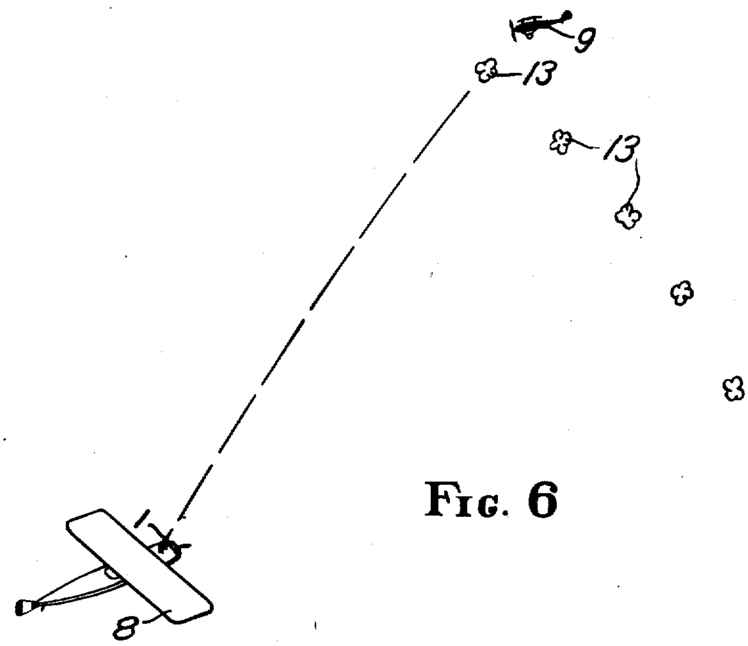


FIG. 6

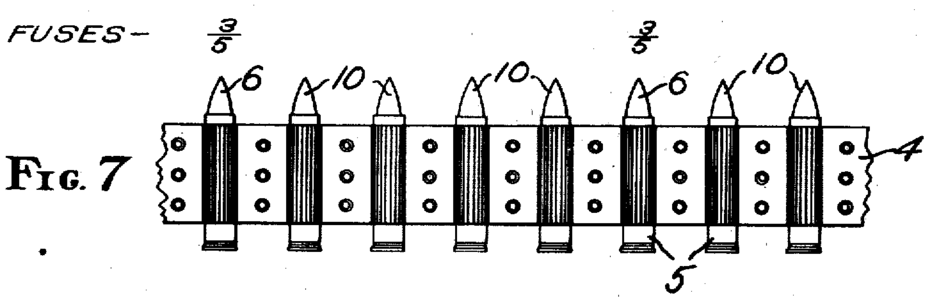


FIG. 7

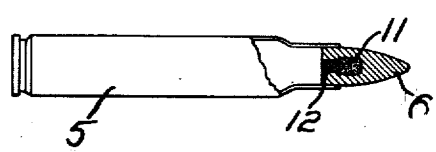


FIG. 8

INVENTOR

Robert V. Morse

UNITED STATES PATENT OFFICE.

ROBERT V. MORSE, OF ITHACA, NEW YORK.

TRACER SYSTEM OF FIRE CONTROL.

1,355,841. Specification of Letters Patent. Patented Oct. 19, 1920.

Application filed May 10, 1920. Serial No. 380,259.

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 Tracer System of Fire Control, of which the following, taken with the accompanying drawings, is a specification.

This invention relates to anti-aircraft artillery and in particular to a means for tracing the fire of machine guns of the pom-pom type or in general any type of machine gun firing an explosive projectile. It has heretofore been customary to trace the fire by inserting in the machine gun belts bullets or projectiles containing a smoke emitting compound which was ignited by the discharge of the gun and left a trail of smoke behind the projectile as it passed through the air, thus tracing the trajectory of the projectile. With such tracers it is difficult to get sufficient visibility when using small caliber bullets, especially at fairly long ranges; and the method was also open to the difficulty that when the target was rapidly moving the smoke trails did not give a definite path or stream line, like water emitted from a moving hose, but gave instead a fan shaped aggregation of smoke trails. This was due to the fact that the smoke trails had a certain permanence, and that each trail traced the path of an individual bullet, without regard to the instantaneous relative locations of the other bullets in the stream.

It is a somewhat wide-spread popular fallacy that as a stream of water from a hose is swung sidewise, the individual particles of water follow the laterally curved path of the stream, in other words, that the path of the particles is the path of the stream. On analysis it will be seen however that the path of such a stream at each instant is determined by the relative locations of the various particles, each of which is following a different individual path. It will thus be seen that the path of the stream is different from the path of the individual bullets, when directed against a moving target. Owing to the time intervals involved, it is the path of the stream, not the paths of the bullets, which we really desire to know in order to direct the bullets on a moving target.

By this invention there is periodically presented to the eye the instantaneous relative locations of a number of projectiles in a stream, in other words the true curvature of the stream is shown by the substantially simultaneous indication of a number of points.

Referring now to the drawings, Figure 1 shows the general operation of the system,—the heavy broken line following the stream, and portions of the individual trajectories being indicated by the lighter broken cross-lines. Fig. 2 shows the ammunition belt for Fig. 1. Fig. 3 shows a modification in which more than one gun is used. Fig. 4 shows the ammunition belts for a two gun set. Fig. 5 shows the ammunition belts for a three gun set. Fig. 6 shows a modification for short range combat work of airplanes. Fig. 7 shows the ammunition belt for Fig. 6; and Fig. 8 shows a type of projectile which may be employed.

In Fig. 1 of the drawings, the machine gun 1 is pivotally mounted on the arm 2, which in turn is rotatably mounted on the pedestal 3. The machine gun 1 is of the pom-pom or other suitable type capable of shooting explosive projectiles having time fuses. The gun 1 is fed by the ammunition belt 4, one form of which is illustrated on a larger scale in Fig. 2, where the belt 4 is shown carrying the cartridges 5, having the explosive shells 6 for example. These shells 6 are set with various fuse lengths repeating periodically in a definite manner,—for example, as shown in Fig. 2, beginning we will say with a fuse setting of 3 and coming down in five successive steps to a setting of $\frac{3}{5}$ths, and repeating the same group of five successively over and over again throughout the length of the belt; or the steps can be run in the other direction, beginning with $\frac{3}{5}$ths for example, and following with settings of 1, $1\frac{3}{5}$, $2\frac{1}{5}$, 3, and then starting again with $\frac{3}{5}$ths, 1, $1\frac{3}{5}$, and so on: these values are illustrative by way of example,—the general principle being that the length of the group should be adapted to the rate of fire of the gun, or rate of travel of the belt 4, in such a manner that a group will feed through the gun in a period of time about equal to the longest fuse setting. This assures that successive groups shall appear to the eye distinct from each other.

In Fig. 3 two machine guns 1 and 1′ are shown connected together so as to operate as a single firing unit. The feeding mechanisms are geared together so as to run in synchronism, and the cartridge belts are arranged as shown for example in Fig. 4, in which two belts 4 and 4′ are used to repeat the periodic groups; thus a given group can be fired more rapidly, or conversely, the groups can be made longer, giving a greater number of different settings in a group. The same principle may be extended of course to three or more machine guns working as a unit, as shown for example in Fig. 5, and it will be noted that the groups need not necessarily always begin on the same belt,—sometimes beginning on the belt 4, sometimes on the belt 4′, and sometimes on the belt 4″.

In combats at very close range, such as between the fighting airplanes 8 and 9, in Fig. 6, a single indicating point may be used instead of a string of points. In that case the cartridge belt 4 as shown in Fig. 7 is equipped with small shells, (that is, explosive bullets having time fuses), only at intervals in the belt, with groups of ordinary bullets 10 between.

In Fig. 8 there is shown, partly in cross-section, a cartridge 5 having a shell or explosive bullet 6, containing an explosive charge 11, and equipped with a short fuse 12, which is ignited by the propelling charge of the cartridge. The length of the fuse 12 is made according to the burning time desired. This simple type of fuse can be used with small caliber projectiles, where it is difficult to construct a satisfactory adjustable fuse. With larger projectiles, such as the one pound shell fired by the pom-pom type of gun, adjustable fuses may be employed.

The operation is as follows: the cartridges 5 having shells 6 equipped with time fuses are arranged in advance in the machine gun belts 4 in the manner described,—with the fuse settings arranged to give a fairly simultaneous string of bursts, and the groups or strings arranged in proper relation to the normal rate of fire of the gun 1 so that the successive strings will appear distinct to the eye. When the gun is trained on a fixed target and fire opened, the trajectory of the shells is shown by a string of bursts, continually renewed. If the fuse settings have been carefully determined with regard to the intervals at which the gun fires, the bursts of a whole group or string can be made to occur simultaneously, the farthermost shells having had time to travel to their point of burst while the ones with shorter fuse settings are being fed through the gun. If the belt is arranged with the fuse settings occurring in the reverse order the bursts are more irregular, so that the string is not so clear and definite, though the periodic repetition facilitates the fire control to a certain extent. The clearest indication is generally given when the fuses are so timed as to make the bursts of a string occur substantially simultaneously, or with only such slight variations from simultaneous action as will make the string of bursts apparently ripple out from the gun, or ripple back toward the gun beginning at the farthermost burst—as perfectly definite strings then periodically meet the eye.

In fire against a moving target, such as an airplane, the gun should be moved steadily and evenly in the endeavor to direct the string of bursts through the target. It is important that the motion be steady and even, or else the curvature of successive strings will vary so widely as to afford but little aid in the pointing of the gun. It is like trying to touch a moving object with a long and very flexible pole, where the tip does not respond immediately to the motion of the butt. Owing to the motion of the target during the time of flight of the bullet, we are in fact trying to aim at the point which the moving target will reach at the time the bullet gets there,—which operation necessarily involves a prediction of the future motion of the target; and in order to make such a prediction, by any optical or mechanical means, a certain steadiness of motion is necessary. Under this invention we create the optical illusion of a stream of shells in order to guide the gun pointers in directing the fire through the advance point of aim. It will be noted that, with the fire on a moving target, the string of bursts does not indicate a trajectory, that is, the individual shells do not follow the path indicated by string of bursts. What is indicated is the relative locations of successive shells, as affected by their relative time of burst and the motion of the gun; this gives the illusion of a stream of projectiles following a fairly definite form of path, and as a practical matter when an apparent stream can be placed through the target, the target will be hit by the projectiles. Each projectile follows its own trajectory, as indicated by the dotted cross-lines, Fig. 1, crossing the line indicated by the string of bursts 13, 13,—the successive strings being indicated by the letters *a*, *b*, and *c*. The curvature of an apparent stream *a* varies not only with the rate of motion of the gun as it sweeps around, but also varies according as the bursts of a string are simultaneous or non-simultaneous. If simultaneous, the illusion is analogous to that presented by a stream of water from a hose swung laterally,—where the relative locations of the particles are presented simultaneously to the eye. But if the bursts at one portion of the string occur at slightly different time from other bursts of that string, the apparent curvature presented to the eye is different. We are in fact dealing with an optical illusion, so far as a stream of successive shells following a definite path is concerned,—except where the target is stationary. But regardless of how the curvature is distorted or modified by the relative time intervals in which the bursts in a string occur, the fact that similarly curved strings are periodically presented enables the device to function as an instrument for directing a projectile at the proper point of aim for a moving target,—since when any apparent stream, regardless of its curvature, is located on the target, the proper lead will have been arrived at, and the moving target will be hit.

The operation of the modifications illustrated in Figs. 3, 4, and 5 is similar to that of Fig. 1, the only difference being that by employing a group of machine guns as a firing unit the number of bursts in a single string can be increased, since a group of cartridges can be discharged faster. In the modification shown in Fig. 6 there is no illusion of a stream of bursts, the gunner's eye and the single point of burst 13 determining the line of aim; these single points are presented in rapid succession, and have the advantage of good visibility.

It will be understood that the fuse settings and groupings mentioned in the foregoing are merely by way of example, and that they may have various values according to the type of gun, and ammunition, as well as the characteristics desired in the periodic apparent streams. Many other variations and adaptations within the scope of the invention as covered by the following claims will be apparent to those skilled in the art:

1. In an automatic aiming mechanism for ordnance, the combination of a machine gun capable of firing projectiles in rapid succession, means for presenting in space the relative locations of a group of successive projectiles according to a certain time relation, said relative locations being presented sufficiently simultaneously to appear to the eye as a definite group, and means for rapidly and periodically repeating said group, the same said time relation being maintained within the repeating groups, whereby the gun may be directed on the proper line of fire through observation of the streams of fire apparently indicated by the strings of points comprising the periodic groups.

2. In an automatic aiming mechanism for ordnance, the combination of a machine gun, an ammunition belt for said gun, cartridges in said belt, explosive projectiles in said belt having time fuses of various settings arranged in successive groups in which the time fuse settings are repeated, the time fuses in each group being set with regard to the rate of fire of the gun and the times at which the various projectiles of the group will burst so that the group will burst sufficiently simultaneously in the air to have their relative locations of burst observed, whereby there may be presented to the eye the successive locations of apparently definite streams of fire, to aid in the pointing of the gun.

3. In an automatic aiming apparatus for ordnance, the combination of a machine gun, an ammunition belt for said gun, cartridges in said belt, explosive projectiles in the cartridges, time fuses set for various lengths in the projectiles, the settings being fixed in the same definite order in successive repeating groups in the belt, whereby the fire can be observed by means of periodic rapidly repeating strings of bursts having the same relative time intervals between the individual bursts in each string.

4. In an automatic aiming apparatus for ordnance, the combination of a machine gun, an ammunition belt for said gun, cartridges in said belt, explosive projectiles in the cartridges, time fuses set for various lengths in the projectiles, the settings being fixed in the same definite order in successive repeating groups in the belt, and the length of each group being proportioned to the rate of fire of the gun so that a group will feed through the gun in a period of time approximately equal to the longest fuse setting of the group, whereby the fire can be observed by means of definite rapidly repeating periodic strings of bursts having the same relative time intervals between the individual bursts in each string.

5. In an automatic aiming apparatus for ordnance, the combination of a machine gun, an ammunition belt for said gun, cartridges in said belt, explosive projectiles arranged at intervals in the belt, time fuses in said projectiles, said fuses having such values that the same fuse timing will be repeated periodically when the gun is fired, whereby the line of fire can be judged by rapidly repeating periodic bursts.

6. In an automatic aiming apparatus for ordnance, the combination of a machine gun, an ammunition belt for said gun, cartridges in said belt, explosive projectiles in said cartridges, fixed timing fuses of various lengths arranged in the projectiles in a definite periodic order in the belt, whereby definite strings of bursts will be periodically presented to the eye when the gun is fired.

In witness whereof I have hereunto set my hand this 7th day of May, 1920.

ROBERT V. MORSE.

Witnesses:

MARGARET SUMNER MORTES,

EPSIE B. MORSE.