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Electromagnetic object-tracking-anddestroying method and system

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SUMMARY:

The present invention relates to electric methods and systems, and more particularly to methods and systems for controlling the explosion of shells or other projectile explosives.

An object of the invention is to provide a new and improved radio-locator-and-tracking system.

A further object is to provide a novel radio-controlled firing system.

A further object is to provide for controlling the burst of a shell or other projectile explosive from a point distant from the position of the projectile in motion.

According to present-day techniques, after a projectile, such as a shell or a rocket, has been fired from a projector toward a target object, such as an airplane, the time of its explosion is controlled at the projectile itself. The explosion may, for example, be under the control of a time fuse, a powder-train fuse, a radio-transmitting-and-receiving mechanism, or a photocell fuse in the projectile. The control is such as to assure the explosion of the projectile at the moment of its approach toward the airplane object. If a time fuse or a powder fuse be employed, the target airplane is detected, its line of flight is plotted in order to make possible the prediction of its future position, and the time mechanism in the projectile fuse is set accordingly before firing. In the case of a radio fuse or a photocell fuse, the

explosion of the projectile is effected by the mere fact of its proximity to the target object, and no further control from the ground is necessary. All these prior-art methods are subject to the disadvantage that the projectile may explode at a time or a place where the enemy and may, in fact, damage a 4g plate-supply battery 166.

friend. At the very least, a premature or a too-late or otherwise useless projectile explosion may serve to inform an enemy aircraft that it is under fire. In the case of proximity fuses, furthermore, firing at low-flying aircraft in low quadrants of elevation, for example, will often go is connected from preferably the mid-point of the plate cause premature explosion because of the proximity of the ground to the shell.

Another object of the present invention, therefore, is to explode only those projectiles that are sufficiently near to the airplane or other enemy object to produce lethal 5g and effects.

Still another object is to prevent the explosion of projectiles that have traveled beyond, or have otherwise missed, their mark.

further object still is to provide a fuse mechanism: for flo sistor exploding the projectile accurately, at any desired time during its flight, from the point of its firing, or from any other position remote from the projectile.

Other and further objects will be explained hereinafter, ularly pointed out in the appended gg mence. The oscillating pulses

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claims.

The invention will now be more fully explained in connection with the accompanying drawings, in which Fig. 1 is a diagrammatic view of circuits and apparatus arranged and constructed according to a preferred embodiment thereof; Fig. 2 is a diagrammatic view showing a radioreceiving fuse provided in the projectile, and operable in the various components of the disclosed circuits, Fig. 3 the output stages, Fig. 7 the brightening-pulse output of the multi-

FiS- 8 e gate-pulse output of the multivibrator, the output of the ger pulse, and Fig. 13 the output of the ringing circuit; Figs. 14 and are views of the cathode-ray-tube display, illustrating the sweep, the echoes and other features; Fig.

16 is a diagrammatic view of circuits and apparatus for providing a modified method of operation, to provide for firing any projectile at any position within the lethal range, or at any time when the projectile occupies such position; Fig. 17 is a diagrammatic view of circuits and apparatus as adapted to operation with sound of supersonic energy, illustrating the dropping of a depth bomb Upon a submarine; Fig. 18 is a diagrammatic view illustrating a preferred type of radio-frequency transmitter; Fig. 19 is a similar view of a delay line, such as may be embodied in the system of Fig. 1; and Fig. is a diagrammatic view illustrating a preferred type of variablep|iase multivibrator.

Any well known ultra-high-frequency radio-locator pulse transmitter 1 may be employed. A preferred type is illustrated in Fig. 1

8. Two transmitting triodes 138 and 140 are connected in parallel, with their cathodes 142 and 144 connected together through a grounded tuned radiofrequency circuit 14

6. This tuned circuit may assume any desired form, such as a Lecher line or a tuned cavity (not shown). The anodes 148 and of the tubes 138 and are shown connected together through a tuned circuit comprising a condenser 152 and a coil 154, connected in parallel. The control-grid electrodes 156 and 153 of the tubes 138 and 140 are connected together, through a condenser 166, to a ground 162; and also, through a resister 164, to a grounded As the condenser 160 is thus connected in parallel to the resistor 164 and the battery 166, connected in series, a discharge path for the

condenser is provided through the resistor 164 and the battery 166. A. radio-frequency-choke coil 167 coil 1S4 to the junction of the resistor 164 and the platesupply battery 166, for the purpose of keeping radio frequency out of the supply.

In operation, some disturbance starts the tubes 138 oscillating. The grids 156 and 158 draw electrons from their repective cathodes 142 and 144 to charge the condenser negatively, thereby to stop conduction through the tubes, whereupon the oscillations cease. The condenser 160 thereupon discharges through the reand the plate battery 166. When sufficient negative charge has leaked off the condenser 160, or, from another point of view, when the condenser has become charged sufficiently positive through the resistor 164 and the plate supply 166, the oscillations recom-

Fig. 3), of duration, for example, of a fraction of a microsecond, then produced in the coil 154, are picked up by a coil 168 for transmission to a radio-locator dipole 3 by way of conductors 134, to the antenna dipole 3, appearing as of the coil 168.

The radio energy picked up by the coil 168 of the pulse transmitter I, therefore, travels, by way of the conductors 134, to the antenna dipole 3, appearing as the said transmitted radio-frequency pulse 126, say, of centimeters wavelength.

The dipole antenna 3 is illustrated in Fig. 1 as positioned at the focus of a parabolic or other directive reflector 6. A parasitic reflector 5 may be employed to reflect the radiation emitted from the dipole to the parabolic reflector 6. The parabolic reflector 6 will then direct the energy out towards a target object, such as an airplane 7, and toward a shell or. otherprojectile object 9 that has been fired from a gun (not shown), Upon reaching the objects 7 and 9, the radio pulses thus propagated towards these objects will become scattered and reflected back toward the parabolic reflectoi 6 and the dipole 3, to be transmitted, by the conductors 134 and conductors 102, to a radio-frequency-receiver amplifier 1

1. The received radio-energy shell and target echoes are represented by Fig. 5 as a brief series of radiofrequency oscillations 124 and 128, respectively, between similarly indicated received pulses 123 picked up directly from the oscillatory transmitted pulses 126 (Fig.

3). The amplifier 11 receives and amplifies these refleeted and scattered radio echoes. The energy received by the amplifier 11 may then be detected in a detector 111 to produce direct-current pulses, and then amplified in a video amplifier 130, in well known television fashion.

Suitable apparatus for performing this function may be found described, for example, on page 749 of "Radio Engineering," by F. E. Terman, 1937 edition. Any v/ell known superheterodyne system may also be used as a receiver, such as is described in "Superheterodyne Reception of Micro-Rays," Reeves and Ullrich, Electrical Communications, vol. 16, No. 2, 1937.

The radio-locator transmitter 1, as shown diagrammatically in Fig. 1, is connected by conductors 45 and 174 to an attenuator-and-rectifier 13, the details of which may be as illustrated in Fig.

18. A center tap 170 of the coil 168 is there shown connected to the grounded side of the attenuator 176 by the conductor 45, shown grounded. The other side of the attenuator 176 is shown connected by the conductor 174 to one of the terminals of the coil 168. The said one terminal of the coil 168 is shown connected to one side of a rectifier 172 through one side of the attenuator 176. The other side of the rectifier 172 is shown connected, through a radio-frequency-choke coil 178, to the non-grounded output conductor 136, and a load resistor 180 is connected across the output conductors 136.

The radio energy picked up by the coil 168, therefore, travels not only by way of the conductors 134 to energize the dipole antenna 3, but also, by way of the conductors and 174, to the attenuator-and-rectifier 1

3. After passing through the attenuator 176 and the rectifier 172, h the radio-frequency-choke 178, this energy ?&

gt; next trigger pulse appears as direct-current pulses across the resistor 180.

The pulse 182 (Fig. 4) represents that part of the radioenergy pulse that is attenuated and rectified in the attenuator-and-rectifier

13. The pulse 182 will obviously take place at the same instant that the pulse transmitter energizes the antenna 3 to emit the radio-frequency pulse 126, and it is used to trigger the sweep generator The attenuator-and-rectifier 13 is connected to a horizontal-sweep-generator circuit by conductors 136

shown in Fig. 18 connected across the terminals of the resistor 180. The generator 15 may, for example, be of any conventional linear or non-linear type, such, for example, as is illustrated on page of the said "Radio y Terman. This produces a linear or-non-- 7 C-R, is shown in Fig.

linear horizontal-sweep time base between the horizontally spaced, vertically disposed deflector plates 17 and 19 of a cathode-ray oscilloscope 21 for deflecting the electron stream horizontally. The saw-tooth-sweep voltage thus produced between the plates 17 and represented at 62 by Fig.

11. The plate 19 is shown grounded. The video circuits are shown connected to the vetrically spaced horizontally disposed deflector plates 23, by conductors 104 and 105, respectively.

The same trigger voltage from the attenuator-and-reclifter 13 that triggers the horizontal-sweep generator back on . may trigger also a variable-phase oscillator or strobegenerator, such as a multivibrator 29, to produce pulse outputs in any desired phase relationship to the start of the sweep 62 (Fig. 11). This may be effected by connecting the attenuator-and-rectifier 13 to the multivibrator 29 by conductors 137.

The variable-phase multivibrator 29 may, for example, be of the type shown in Fig. 20, where tubes and 301 are shown respectively provided with cathodes 306 and 307, control-grid electrodes 304 and 305, anode plates 302 and 303, and plate-load resistors Rp and Rp. Avariable coupling condenser C and a variable resistor R are connected in series to constitute a coupling circuit CR

from the plate circuit of the tube to the grid or input circuit of the tube 301, the grid of the tube 301 being connected to the junction between the coupling condenser and the resistor R. The grid 304 of the tube is similarly connected to the junction between the variable coupling condenser C and the variable resistor R, coupling the output circuit of the tube 301 to the input circuit of the tube 300. The condenser C may be charged from a battery 309 through the resistor R and the plate resistor Rp. The condenser C may be similarly charged from the battery 309 through the resistor R and the plate resistor Rp.

Let it be assumed that the tube is just cut off. A positive trigger pulse 182 (Fig. 4) is applied to the grid 304 of the tube 300, causing the tube to burst into conduction. The voltage at the plate 302 of the tube drops, and the voltage at the grid of the tube 301 drops also, since it is coupled to the plate 302 by the condenser C. The tube 301, therefore, cuts oft, because of the negative voltage on the grid 30

5. The voltage of the plate 303 of the tube 301 rises, and causes the grid 304 of the tube to rise further, thus increasing the conduction of the tube 300. When no further voltage change occurs at the plate 302, the condenser C becomes charged positively through the resistors R and Rp from the plate-supply battery 309, until the voltage of the grid 305 rises enough, depending upon the values of C and R, to cause the tube 301 to conduct and cut off the tube 300. This point is reached at the leading or left-hand edge of the pulse of Fig.

7. When no further changes in voltage occur at the plate 303, the condenser C charges through the resistor R, the supply battery 309, and the plate load Rp, to restore the grid 304 of the tube to its initial near cut-off condition. The circuit then remains with the tube 301 partially conducting until the causes the tube heavily to con-" duct again. The time that the process of restoring the grid 304 to its initial condition consumes is determined by the settings of the

condenser C and the resistor R, and it is this phenomenon that produces the desired multivibrator-pulse outputs. While the waveform is illustrated as a rectangular pulse, this is, of course, idealized; being, in actual practice, an exponentially dipping spike, as is well known.

A negative pulse 40, Fig. 7, thus appears at the plate 303 and a positive pulse 42, Fig. 8, at the plate 302 of the tube 300. The width of these pulses is controllable, as above explained, by the condenser-resistor control . The time at which these pulses occur, selected and controlled, as above explained, by the phase control as occurring at any desired distance Rs along the sweep.

The pulse (Fig. 7) is fed by conductors 103 between the cathode 60 and the control-grid electrode 61 of the cathode-ray oscilloscope

21. Normally, the elecis 5 trode 61 is biased negatively with respect to the cathode 2,76 9,9 76 by, say, a battery 121, to allow a certain intensity of the electron stream to reach the oscilloscope face

27. A B-battery 119 constitutes a source of supply between the cathode and the anode .

When the brightening pulses arrive between the grid and the cathode 60, the cathode is rendered negative with respect to the grid 61, whereupon the electrons emitted from the cathode 68 are permitted to be accelerated, in the form of -an increased stream, past the control grid 61 and the anode of the oscilloscope 21, to impinge finally on the persistent fluorescent oscilloscope face 27, brightening that part of the sweep starting with a point corresponding to the distance Rs from the start of the sweep, and brightening a predetermined portion of the sweep of length corresponding to the width of the pulse 40.

After rectification, and preferably also amplification, in the detector-and-video amplifier stages 111 and 130, the received direct pulses appear as shown as 63, and the echoes from the shell 9 and the aircraft 7 as shown at and 8, respectively, in Fig. 6. The detected and amplifled video signals are represented by Fig. 6 as they appear at the instant that they are applied to the vertically spaced horizontally disposed deflector plates 23 and to deflect the sweep vertically, as shown in Figs.

15. The deflection 4, representing the echo from the shell 9, and the deflection 8, representing the echo from the aircraft target 7, are shown in Figs. 14 and 15, together with the sweep

2. In these two Figs. 14 and 15, the brightening pulse of Fig. 7 is shown brightening the part 141 of the sweep associated with the echo 8.

A horizontal-sweep time base 2, the time constant of which depends on the range to be covered, is thus produced on the fluorescent screen 27 of the cathode-ray tube 21, with vertical deflections corresponding, in di tance from the start of the time base, to the distances from the antenna 3 of the objects 7 and 9 from which the radio waves are reflected or scattered. In accordance with well known radio-location technique, the radio echo of the shell 9 will be shown at a range Ri from the station and that of the object 7 at a range Rz.

Since the control electrode 61 is biased negatively with respect to the cathode 60, however, this horizontal sweep will not be very bright on the oscilloscope face 27. At such times as the brightening pulse is applied to the cathode 60 and the grid 61, by way of the conductors 103, from the multivibrator 29, the cathode becomes negative with respect to the control-grid electrode 61.

The effect of the said pulse, therefore, as previously described, is to brighten the sweep during the duration of the pulse 40.

When an operator has detected a target appearing as a deflection 8 (Figs. 14 and 15), he may adjust the variable-phase multivibrator 29 to bring the edge of the brightening section on to the deflection 8, leaving, therefore, a

selected predetermined portion of the sweep brightened before the. deflection 8, as shown at 141.

The left-hand edge of the portion 141 represents a future position of the projectile which is traveling towards the target. By suitable design of the time constants of the multivibrator 29, this brightened portion 141 may be made to correspond in v/idth or range to the lethal distance or range of the projectile. As previously explained, the. constants CR of Fig. 20 control the width of the ulse and, therefore, the width of the brightened 05 phase pulse section 1

41. If the lethal area of the projectile is yards, for example, the product of the values of the capacitance C and.the resistance R may be adjusted to produce a time constant of approximately one microsecond. As shown in Figs. .6 and 14, the echo the object 9 has not yet reached its selected future position and .has not yet entered the lethal area, shown as the horizontal region 141. Any explosion of the projectile would therefore be ineffective at this time.

The instant that the projectile enters within the lethal distance or range, its echo will enter the brightened sec-, tion 141, as shown by Figs. 9 and 15. The projectile should be exploded at this time. The method of exploding the projectile at such a time will now be explained.

The gate-pulse output 42 of the multivibrator 29, as shown in Fig. 8, taken, for example, from the plate circuit of the first tube of the multivibrator by the conductors 101, may be fed between the screen grid and the cathode 12 of a gating tube 1

4. Because of the properties of multivibrators, as previously explained, the timing and the pulse width of the output 42 will be identical with the timing and the pulse width of the output 40, taken from the second tube 301 of the multivibrator, though the pulse 42 is positive as compared with the negative pulse

40. The screen grid may be biased by the battery 16, so as to prevent the tube 14 from conducting except during the application of the positive variable-phase gating pulse 42.

The video output of the receiver, as shown in Fig. 6, may be fed by the conductors 104, 106 and 105, 107 between the control electrode 18 and the cathode 12 of the gating tube 14 to cause the tube 14 to tend to conduct only during the application of the video pulses, such as the pulses 4 and 8. The same video output shown in Fig.

and 25 6 may be fed by the conductors 104, 106, and 105, 107, 109 to a delay circuit of any convenient and well known type, such as an artificial transmission line, a time-constant circuit, or supersonic cell 59, Fig. 19.

From the delay circuit, the video output is fed, by conductors 112 and 113 (Fig. 1), between a suppressor electrode 22 and the cathode 12 of the gating tube

14. The suppressor electrode 22 is shown negatively biased by a battery 114. The delay mechanism should be adjusted to delay any video signals by an amount of time ii5 corresponding to the pulse width of the gating pulse 42. that is, to the lethal range of the burst of the projectile

9. For example, a supersonic cell 59 may be used, as shown in Fig. 19, of material and length such that the video signals, fed to an exciter at one end, such as a piezo-electric crystal 57, and propagated through the cell 59, shall be delayed by a length of time corresponding to the pulse width of the pulse 42, and then sent to the suppressor electrode 22 by a receiver piezoelectric crystal 58 at the other end of the cell 59. The echo 4 from the projectile 9 and the echo 8 from the object 7, as shown in Fig. 10, will therefore arrive at the suppressor electrode 22 of the gating tube 14 after a period of time displaced from their respective positions in Fig. 10 by approximately the duration of the variablephase pulse output or 42.

In Fig. 10, for illustrative purposes, the echo 4 from the shell 9 is indicated as arriving at the suppressor grid at the same time that the echo 8 from the object 7, as shown in Fig. 9, arrives at the control grid 18 of the gating tube 14, and also during the continued application of the gating pulse 42 from the multivibrator, as shown in Fig. 8, at the screen grid

of the gating tube 14.

At approximately the instant of time that the shell 9 enters the lethal area, therefore, the gating tube 14 is opened up by the application of the gating pulse 42 to the screen grid 10, the object pulse 8 to the control grid 18. and the delayed pulse 4 to the suppressor grid 22.

The actual instant is somewhat later, after a time corresponding approximately to the width of the variableor

42. At that instant of time, the gating tube 14 conducts heavily, thus causing less current to flow through a relay coil 24 (Fig. 1) that is connected, .by conductors 115, in parallel with the plate or output circuit of the gating tube 14. This diminution of current from 70 through the relay coil 24 results in the closing of a relay switch 26, disposed in the plate or output supply of a radio-frequency trigger transmitter

28. The transmitter 28 is connected, by conductors 116, to energize a further dipole antenna system 30, shown as a directional system moving together or in synchronism with the reflector 6, The transmitter 28, which is normally ineffective to transmit a signal, will thus be rendered effective to send a further and special directional radio signal 46 by way of the antenna system 30, of a different frequency, for example, than the frequency of the transmitter 1, as illustrated by Fig. 12, toward the projectile 9, to explode the projectile.

A receiving-mechanism fuse provided in the shellprojectile 9 will therefore cause the projectile 9 to explode almost immediately. This receiving mechanism may comprise a receiving antenna or antennas. Two dipoles of dimensions resonant to the trigger-signal frequency are shown at 31 and 64, preferably mounted externally to the fuse 55, as shown in Fig. 2. The antenna or antennas feed into the fuse to energize a lighttransparent radio-frequency cavity resonator 33 of dimen-

sions resonant to the radio waves transmitted by the trigger transmitter 28 (Fig. 1). The radio-frequency resonant cavity 33 may, for example, be constituted of polystyrene or any other similar light-transparent material that serves as a conductor of high-frequency waves. The resonator may be filled with an illuminating agent; for example, the rare gas neon.

The antennas 31 and 64 are shown connected to the resonant cavity 33 by coaxial lines 47 and 48, respectively. The radio-frequency energy thus fed into the gas in the cavity resonator 33 results in ionizing the gas therein, which therefore becomes illuminated. The illumination may be focused by a lens upon a photocell 37, connected in series with a source of voltage, such as a battery 49 and an igniting mechanism 39, such as a charge, as of powder, for exploding the explosive mixture of the shell or the projectile. When the trigger transmitter 28 sends a radio signal that is received by the antennas and energizes the cavity 33, therefore, the light from the ionization of the cavity resonator causes current to flow in the light-sensitive circuit of the photocell 37. upon which the light is focused, thereby causing a sufficiently large current to flow through the charge 39 to ignite the charge 39 and to explode the shell.

If desired, the light-transparent radio-cavity resonator may be maintained periodically ionized by a striking potential from an energy source 50, as shown in Fig. 2.

When the radio energy from the trigger transmitter 23 conveyed into the cavity resonator, the gas will become 4g mechanism further ionized, producing an increased intensity of light discharges and a greater current in the photocell circuit for setting off the mechanism 39.

To prevent premature operation, thereby further to control the explosion of the projectile at any desired time, or when it occupies any desired position, from any desired remote point, an arming device, such as an arming propeller screw 41, may be provided to maintain the photocell circuit open, by holding down a switch 43, for example, until such time as the projectile has travelled g5 transmitter energizes the cavity 233, therefore, the light a desired length of time. At the end of this time, the arming propeller 41 will have unscrewed itself from the fuse nose in flight, thereby releasing the switch 43, and cpmpleting the photocell circuit in the fuse for operation upon the receipt of the energizing

radio-trigger signal from the remote point.

It may be desired to insure that the shell 9 shall fire at any given time after it shall get within lethal range, or when it occupies any desired position within the lethal range. Such an occasion may arise, for example, in the event that the radio-locator antenna system 3, 6 should happen not. to pick iip the signal from the shell 9 or the target 7 until after the shell shall have already entered thelethal area.

To the attainment of this end, the video output of the receiver may also be fed by conductors 104, ringing or a poorly damped high-frequency oscillating circuit 108, as shown in Fig.

16. Each video signal, therefore, will produce a train of oscillations, the half-period of which will be much less than the width of the pulses of the radio-frequency transmitter 1. As shown in Fig.

whole trains of positive and negative oscillations may thus be produced by each video pulse, a train 51 corresponding to the echo 4, as shown in Fig. 9, and a train corresponding to the echo 8. These trains of oscillations may be fed by conductors 122 (Fig. 16) between the screen grid 32 and the cathode 38 of another gating tube 34, in order to lift the bias thereon provided by, say, a biasing battery 120.

The variable-phase gating pulse output 42 of the multivibrator 29 may also be fed by the conductors 101, not only between the screen grid and the cathode 12 of the first gating tube 14, as previously described, but also between the control electrode 36 and the cathode 38 of the second gating tube 34, as shown in Fig. 16. This may be effected simultaneously with the application of the trains of oscillations 51 and 52 to the screen grid

32. The tube will therefore open up to conduct each positive oscillation for the duration of the gating pulse 42. The output of the tube 34 may be inverted in any well known video amplifier 53, so that a series of closely spaced positive pulses shall be available for application to the suppressor grid 22 of the main gating tube 14. The delay circuit 20, of course, will be disconnected from the suppressor grid 22 during this mode of operation.

Since the half-period of the oscillations 51, 52 is small compared with the width of the video signals 4 and 8, the main gating tube 14 will open up on the application of a video signal 4 from a projectile 9 at essentially any time during the gating period of the output 42 and, therefore, at essentially any time after the projectile 9 enters within the lethal area of the object 7.

The circuits and apparatus of Fig. 17 may be identical with those shown in Fig. 1, except that a supersonic transmitter 201 may replace the radio-locator-transmitter system 1, 6, a supersonic receiver 211 may replace the radio-frequency amplifier 11, and a supersonic trigger transmitter 228 may replace the radio-frequency trigger transmitter 28. These are all shown carried by a ship 2

19. A depth bomb projectile 209 may be equipped with sound receivers, such as quartz crystals 56, that may be connected in similar fashion to the connections of the antennas 31 and 64 of Fig. 2, and that may be connected into a cavity 233, resonant to the electric oscillations of the trigger supersonic transmitter 228, inside a fuse on or within the depth bomb. The cavity 233 may be of the same nature as the gas-filled, lighttransparent cavity resonator 33 illustrated in Fig. 2.

The electric oscillations produced by the crystals 56 in response to the ultrasonic waves from the transmitter 228. and thus fed into the gas in the cavity resonator 233, wni ionize this gas, which will therefore become illuminated. The effect, of the illumination is manifested in a photo-cell circuit connected in series with a battery amj an igniting charge. When the ultrasonic trigger produced in the cavity responsive to the ionization of the g, as therein causes current to flow in.the light-sensitive photo-cell circuit. This results in igniting the charge and exploding the "ash-can" in a manner similar to that described in connection with the cavity resonator 33 and the photo-cell circuit of Fig. 2.

Employing this invention, a submarine 207 would not be aierted by. the explosion of depth-charges or bombs that

mlght miss mark; but would be subjected to injury by those deptn tombs that would become exploded without notice when they are within lethal range of the submarine.

The supersonic transmitters and receivers mentioned or exampie be maghetostrictive or piezoelectric, to. a 70 according to weU known technique. The supersonic Pulse transrmtter 201 and the supersonic receiver 211 for example, may be of the type described m Umted States Letters Patent 2,084,845, issued June 22, 1937, to Edward L. Holmes. The trigger transmitter 228 may, for 5 example, be of any well known piezo-electric type.

Other and further modifications will occur to persons skilled in the art, and all such are considered to fall within the spirit and scope of the invention, as defined in the appended claims.

What is claimed is:

1. An electric system having, in combination, means for detecting an explodable object and producing a voltage signal corresponding to the same, means for producing a voltage signal indicative of the occupation by the object of a predetermined position, and means separate from the detecting means for thereupon in response to the said voltage signals automatically exploding the object during the continued detecting of the object.

2. An electric system having, in combination, a radio locator for detecting, producing voltage signals indicative of and indicating the track of objects one of which is provided with explcdable means, voltage-producing means for continuously selecting along the indicated track a future position of the explodable object within a preselected range of another of the objects, and means separate from the radio locator and response to the voltage of the selecting means and to the said voltage signals of the radio locator for automatically energizing the explodable means to explode the explodable object when it approaches within the preselected range during the continued detection by the radio locator.

3. An electric system having, in combination, radiolocating means for detecting, producing voltage signals indicative of and indicating the track of an object provided with explodable means, voltage-producing means for continuously selecting along the indicated track a future position of the explodable object, and radio controlled means separate from the radio-locating means responsive to the voltage of the selecting means and to the said voltage signals of the radio-locating means for automatically energizing the explodable means to explode the object when it reaches the future position during the continued detection by the radio-locating means.

4. An electric system having, in combination, a radiolocator system for detecting an object and an explodable projectile traveling towards the object and provided with explodable means, a cathode-ray tube, means for displaying upon the cathode-ray tube a voltage signal received from the object by the radio-locator system, voltageproducing means for selecting an area upon the cathoderay tube in the proximity of the object detected by the radio-locator system as displayed on the cathode-ray tube, and means separate from the radio-locator system responsive to the said voltage signal of the radio-locator system and to the voltage of the selecting means for automatacally energizing the explodable means to explode the explodable projectile when it enters the said proximity during the continued detection by the radio-locator system.

5. In an electric system having means for propagating radio waves toward objects in space, radio-receiving means for receiving radio waves from both a target in space and an explodable projectile traveling toward the target, provided with energy-receiving means and means connected with the radio-receiving means for exploding the projectile in response to an energy signal received by the energyreceiving means, normally ineffective means separate from the radio-wave propagating means for transmitting an energy signal to the energy-receiving means, a display, means controlled in accordance with the radio waves received from both the target and the projectile for produ ing indications of the distance between the target and the projectile upon the display, means for continuously selecting-a predetermined value of distance between the target and the projectile upon the display, and means responsive to the selecting means and to the received radio waves and operable when the distance between the target and the projectile becomes less than the predetermined value to render the transmitting means effective to transmit the energy signal to the energy-receiving

means, thereby to effect the explosion of the projectile during the continued radio-wave propagation by the propagating means.

6. In an electric system having means for propagating radio waves toward objects in space, radio-receiving means for receiving radio waves from both a target in space and a projectile traveling toward the target provided with energy-receiving means, normally ineffective means separate from the radio-wave propagating means for transmilling an energy signal to the energy-receiving means, a display, means controlled in accordance with the radio waves received from both the target and the projectile for producing indications of the distance between the target and the projectile upon the display, means for continuously selecting a predetermined value of distance between the target and the projectile upon the display, and means responsive to the selecting means and to the received radio waves and operable when the distance between the target and the projectile becomes less than the predetermined value to render the transmitting means effective to transmit the energy signal to the projectile energy-receiving means during the continued radio-wave propagation by the propagating means.

7. An electric system having, in combination, means for propagating pulses of radio waves towards both a target and an explodable projectile traveling toward the target provided with energy-receiving means and means connected with the receiving means for exploding the projectile in response to an energy signal received by the energy-receiving means, radio-receiving means for receiving the pulses of radio waves after reflection and scatter from the target and the projectile, normally ineffective means separate from the radio-wave propagating means for transmitting an energy signal to the energy-receiving means, a cathode-ray-tube display, means synchronized with the propagating means for producing a time base upon the cathode-ray-tube display, means controlled by the radio-receiving means for indicating the instants of reception of the reflected and scattered radio waves from the target and from the projectile upon the time base, thereby to indicate the relative distances of the target and of the projectile, means for continuously selecting a portion of the time base corresponding to a predetermined value of distance from the target, and means responsive to the selecting means and to the received radio waves an(j operable when the distance between the target and the projectile becomes less than the predetermined value to render the transmitting means effective to transmit the energy signal to the energy-receiving means, thereby to effect the explosion of the projectile during the continued radio-wave propagation by the propagating means.

8. An electric system having, in combination, a radiolocator system for detecting and indicating the track of relatively movable objects one of which is provided with energy-receiving means and producing voltages indicative of trie relative positions of the detected objects, means comprising a further voltage-producing selecting means for producing a further voltage correlated with respect to the said voltage indicative of another of said objects , and continuously corresponding to a selected assumed future position of the said one object within a preselected range of the said another of the objects, a normally ineffectiye electric circuit that can be rendered effective only upon the substantially simultaneous application thereto of the said voltages indicative of the said one arid the C5 said other objects detected by the radio-locator system and the said further .voltage produced by the selecting means at the time when the said one object approaches within the said preselected range, means for feeding the said voltages produced by the radio-locator system and the said further voltage produced by the selecting means to the normally ineffective electric circuit, thereby automatically to render the electric circuit effective at the said time, and means responsive to the rendering effective of the electric circuit for thereupon transmitting an energy signal to the said energy-receiving means of the said one object.

9. An electric system having, in combination, a radiolocator system for detecting and indicating the track of relatively movable objects one of which is provided with radio-receiving means and producing voltages indicative of the relative positions of the detected objects, means comprising a further voltage-producing selecting means for producing a further voltage correlated with respect to the said voltage indicative of another of the said objects and continuously corresponding to a selected assumed future position of the said one object within a preselected range of the said another of the objects, a normally ineffective electric circuit that can be rendered effective only upon the substantially simultaneous application thereto of the said voltages indicative of the said one and the said other objects detected by the radio-locator system and the said further voltage produced by the selecting means at.

the time when the said one object approaches within the said preselected range, means for feeding the said voltages produced by the radio-locator system and the said further voltage produced by the selecting means to the normally ineffective electric circuit, thereby automatically to render the electric circuit effective at the said time, and means responsive to the rendering effective of the electric circuit for thereupon transmitting a radio signal to the said radio-receiving means of the said one object.

10. An electric system having, in combination, a radiolocator system for detecting and indicating the track of relatively movable objects one of which is explodable and producing voltages indicative of the relative positions of the detected objects, means comprising a further voltageproducing selecting means for producing a further voltage correlated with respect to the said voltage indicative of another of the said objects and continuously corresponding to a selected assumed future position of the said one object within a preselected range of the said another of the objects, a normally ineffective electric circuit that can be rendered effective only upon the substantially simultaneous application thereto of the said voltages indicative of the said one and the said other objects detected by the radio-locator system and the said further voltage produced by the selecting means at the time when the said one object approaches within the said preselected range, means for feeding the said voltages produced by the radio-locator system and the said further voltage produced by the selecting means to the normally ineffective electric circut, thereby automatically to render the electric circuit effective at the said time, and means responsive - to the rendering effective of the electric circuit for explo ing the said one object.

11. An electric system having, in combination, a radiolocator system for detecting and indicating the track _of relatively movable objects one of which is provided with radio-receiving-means and for producing voltages i dicative of the relative positions of the detected objects, means comprising a further voltage-producing selecting means for producing a further voltage correlated with respect to the said voltage indicative of another of the _ ject locator system provided with means for directionally ding to a selected ou transmitting energy to and receiving energy assumed future position of the .said one object within a preselected range of the said another of the objects, means for producing voltages corresponding to but delayed from the said voltages produced by the radiolooator system an mterva o.tune corresponding substantially to the said preselected range, a normally ineffective electric circuit that can be rendered effective only upon the substantially .simultaneous application thereto of the said voltage indicative of the said other, object detected by the radio-locator system, the delayed voltage indicative of the said one object and the said further voltage produced by the selecting means, means for feeding the said voltage produced by the radio-locator systern, the said delayed voltage and the said further voltage .

produced by the selecting means to the normally ine fective electric circuit, thereby automatically to render the electric circuit effective at the time when the said one object approaches within the said preselected range, and means responsive to the rendering effective of the electric circuit for thereupon transmitting a radio signal to the said radio-receiving means of the said one object.

12. An electric system having, in combination, a radioenergy locator system provided with means for propagating pulses of radio energy toward and receiving the pulses of sound energy after reflection and scatter from relatively movable objects one of which is provided with sound-energy-receiving means and means for producing pulse voltages from the pulses of radio energy received from the objects, thereby to indicate the track and measure the range of the relative positions of the objects, means comprising a further voltage-producing selecting means for producing a further voltage correlated with respect to the said voltage indicative of another of the said objects and continuously corresponding to a selected assumed future position of the said one object within a preselected range of the said another of the .objects, means for producing pulse voltages corresponding to but delayed from the said pulse voltages produced by the radio-energy-locator system an interval of tune correspending substantially to the said preselected range, a normally, ineffective electric circuit that can be rendered effective only upon the substantially simultaneous application thereto of the said pulse voltage indicative of the said other object produced by the radio-energy-locator System, the delayed pulse voltage indicative of the said one object and the said further voltage produced by the selecting means, means for feeding the said pulse voltages produced by the radio-energy-locator system, the said delayed pulse voltage and the said further voltage produced by the selecting means to the normally ineffective electric circuit, thereby to

render the electric circuit.

effective at the time when the said one object approaches within the said preselected range, and means responsive to the rendering effective of the electric circuit for there-

Upon transmitting a radio-energy signal to the said one object for reception in the said radio-energy-receiving means.

13. An electric system having, in combination, an electromagnetic-wave pulse-energy locator system for detecting an object and a projectile traveling towards the object, a cathode-ray tube, means for displaying upon the cathode-ray tube a voltage pulse corresponding to a signal received from the object by the locator systern, means -for producing a gate voltage pulse of du5U ration greater than that of the signal voltage pulse and for controlling the gate pulse to select a region upon the cathode-ray Mbe corresponding to a region in the proximity of the object, and a transmitter responsive to the voltages of the signal and gate voltage pulses for 5o automatically transmitting a further signal to the projectile when it is detected by the locator system, as having entered the said proximity.

14. An electric system having, in combination, an obfrom an object in space and producing voltage signals indicative -of tlle position of tbe obiect in space, means for producin a fwther ycl -corresponding to an assumed future -,?,, r ,- & lt; ,, ;

and Proyided wnh means for directionally transmitting a SI.gcal when effective, means for causing, the signalhngsystem-directional-transrmttmg means-to be directed toward the same object located by the object locator systern, and means responsive to the voltage signals produced by the locator system and to the further voltage for rendering the signalling system effective at a time when the object has entered the said assumed future positiori, thereby to thereupon transmit a signal to the object during the continued object location by the locator system, 15. An electric system having, in combination, an object radio locator system, provided with means for directionally transmitting radio energy to and receiving radio energy from an object in space and producing voltage signals indicative of the position of the object in space, means for producing a further voltage corresponding to an assumed future position of the object in space, a normally ineffective object radio signalling system separate from the locator system and provided with means for directionally transmitting a radio signal when effective, -means for causing .the signalling-systemdirectional-transmitting means to be directed toward the same object located by the object locator system, and means responsive to the voltage signals produced by the locator system and to the further voltage for rendering the signalling system effective at a time when the object has entered the said assumed future position, thereby to thereupon transmit a radio signal to the object during the continued object location by the locator system.

16. An electric system having, in combination, a pulseenergy locator system for detecting an object in space and a projectile traveling towards the object and producing pulse voltage signals indicative of the positions in space of the object and the projectile, means for producing a gate voltage pulse of duration greater than that of the pulse voltage signals, means for controlling the gate pulse to correlate its position with respect to the said pulse voltage signal indicative of the position in space of the object in order to correspond to an assumed future position of the projectile, and a transmitter responsive to the voltages of the pulse voltage signals and the gate pulse for automatically transmitting a further signal to the projectile when it is detected by the locator system as having reached the said future position.

17. An electric system having, in combination, an electromagnetic pulse-energy locator system for detecting an object in space and a projectile traveling towards the object and producing pulse voltage signals indicative of the positions in space of the object and the projectile, means for producing a gate voltage pulse of duration greater than that of the pulse voltage signals, means for controlling the gate pulse to correlate its position with respect to the said pulse voltage signal indicative of the position in space of the object in order to correspond to an assumed future position of the projectile, and an electromagnetic transmitter responsive to the voltages of the pulse voltage signals and the gate pulse for automatically transmitting a further electromagnetic gg means connected to and operated by the activation of said signal to the projectile when it is detected by the locator system as having reached the said future position.

18. An electric system having, in combination, radiolocating means comprising means for detecting, means for producing voltage signals indicative of and means for indicating the track of an object provided with energyreceiving means, voltage-producing means for continuously selecting along the indicated track a. future position of the object, and radio-controlled means .separate from the radio-locating means responsive to the voltage of the selecting means and to the said voltage signals of the radio-locating means for energizing the object energyreceiving means when the object reaches the future position during the continued detection by the radiolocatine means 19. In electric system having, in combination means !, , - -

for detecting an object provided with energy-receiving means, means connected witn the detecting means for producing a voltage signal corresponding to the object, means for producing a .voltage signal indicative of the occupation by the object of a predetermined position, and means separate from the detecting means for thereupon in response to the said voltage signals of the occupation by the object of a predetermined position energizing the object energy-receiving means during the continned detecting of the object.

20. In a radio object location system in which transmitted pulses of radio frequency energy are reflected from a missile to be received as echo pulses by said system and indicate the distance therefrom of said missile, the cornbination of means for producing pulses corresponding to pulses transmitted by the said system, the produced pulses being delayed with respect to the corresponding transmitted pulses by a given interval of time corresponding to a predetermined target range, normally deactivated gating switch means receptive of said echo pulses received by said system and also .receptive of the delayed pulses from said producing means, said gating switch means being activated by a coincidence between the delayed pulses and the echo pulses, control means connected to and operated by the activation of said gating switch means for producing a predetermined signal, and means in said missile responsive to the said signal for detonating said missile.

21. In a radio object location system in which transmitted pulses of radio frequency energy are reflected from a missile to be received as echo pulses by said system and indicate the distance therefrom of said missile, the combination of means for producing pulses delayed from corresponding pulses transmitted by the said system by a given interval of time corresponding to a predetermined target range, normally deactivated gating switch means receptive of said echo pulses received by said system and also receptive of the delayed pulses from said producing means, said gating switch means being activated by a coincidence between the delayed pulses and the echo pulses, control means connected to and operated by the activation of said gating switch means for producing a predetermined signal, and means in said missile responsive to the said signal.

22. In a radio object location system for detecting at least one missile by means of transmitted pulses of radio frequency energy which are reflected from said missile to be received as echo pulses by said system and indicate the distance therefrom of said missile, the combination of means for producing pulses delayed from corresponding pulses transmitted by the said system by a given interval of time corresponding to a predetermined target range, normally deactivated gating switch means receptive of said echo pulses received by said system and also receptive of the delayed pulses from said producing means, said gating switch means being activated by a coincidence between the delayed pulses and the echo pulses, control gating switch means for transmitting a predetermined radio-frequency signal, and means in said missile responsive to the said transmitted signal for detonating said missile,

23. In a radio object location system for detecting at least one missile by means of transmitted pulses of radio frequency energy which are reflected from said missile . to be received as echo pulses by said system and indicate the distance therefrom of said missile, the combination of means for producing.pulses delayed from corresponding pulses transmitted by the said system for a given interval of tlme corresponding to a predetermined target range, normally deactivated gating switch means receptive of said echo pulses received by said system and also receptive fl delayed pulses from said producing means, said & witf , meaHns bf activated by a coincidence between the delayed pulses and the echo pulses control means o d J. c gating switch means for transmitti predetermined radio-frequency signal, and means in said missile responsive to the said transmitted signal.

24. An electric System having, in combination, an enei-gy locator for detecting objects one of which is provided with explodable means, voltage-producing means for continuously selecting a future position of the explodable object within a preselected range of another of the objects to be destroyed by the explodable object, and means separate from the energy locator operable at a remote point and responsive to the voltage of the selecting means and to the energy locator for automatically energizing the explodable means to explode the explodable object when it approaches within the preselected range during the continued detecting of the objects by the energy locator.

25. An electric system having, in combination, energylocating means for detecting an object provided with explodable means, voltage-producing means for continuously selecting a future position of the explodable object, and energy-controlled means separate from the energylocating means responsive to the voltage of the selecting means and to the energy-locating means for automatically energizing the explodable means to explode the object when it reaches the future position during the continued detecting of the object by the energy-locating means.

26. An electric system having, in combination, energyreceiving means for receiving energy waves from both a target and a projectile traveling toward the target provided with energy-receiving means, normally ineffective means for transmitting an energy signal of an entirely different character than the energy waves received by the energy receiving means to the energy receiving means, a display, means controlled in accordance with the energy waves received from both the target and the projectile for producing indications of the distance between the target and the projectile upon the display, voltage-producing means for continuously selecting a predetermined value of distance between the target and the projectile upon the display, and means responsive to the voltage of the selecting means and to the received energy waves and operable when the distance between the target and the projectile becomes less than the predetermined value to render the transmitting means effective to transmit the energy signal to the projectile energy-receiving means.

27. An electric system having, in combination, means for propagating pulses of energy waves towards both a target and an explodable projectile traveling toward the target provided with energy-receiving means and means connected with the receiving means for exploding the projectile in response to an energy signal received by the energy-receiving means, energy-receiving means for receiving the pulses of energy waves after reflection and & Propagating means for producing a time base upon the scatter from the target and the projectile, normally ineffective means separate from the propagating means for transmitting an energy signal to the energy-receiving means, a cathode-ray-tube display, means synchronized with the propagating means for producing a time base d indicate the relative distances of the target and of the upon the cathode-ray-tube display, means controlled by the energy-receiving means for indicating the instants of reception of the reflected and scattered energy waves from the target and from the projectile upon the time base, thereby to indicate the relative distances of the t and to target and of the projectile, voltage-producing means for continuously selecting a portion of the time base corresponding to a predetermined value of distance from the target, and means responsive to the voltage of the selecting means and to the received energy waves and operable when the distance between the target and the projectile becomes less than the predetermined value to render the transmitting means effective to transmit the energy signal to the energy-receiving means, thereby to effect the explosion of the projectile during the continued propagation and reception of the energy waves.

28. An electric system having, in combination, a radio locator for detecting objects one of which is provided with explodable means, voltage-producing means for continuously selecting a future position of the explodable object within a preselected range of another of the objects to be destroyed by the explodable object, and means separate from the radio locator operable at a remote point and responsive to the voltage of the selecting means and to the radio locator for automatically energizing the e plodable means to explode the explodable object when it approaches within the preselected range during the continued detecting of the objects by the radio locator.

29. An electric system having, in combination, radiolocating means for detecting an object provided with explodable means, voltage-producing means for contimiously selecting a future position of the explodable object, and radio-controlled means separate from the radio-loeating means responsive to the voltage of the selecting means and to the radio-locating means for automatically energizing the explodable means to explode the object when it reaches the future position during the continued detecting of the object by the radio-locating means.

30. An electric system having, in combination, radioreceiving means for receiving radio waves from both a target and a projectile traveling toward the target provided with radio-receiving means, normally ineffective means for transmitting a radio signal of an entirely different character than the radio waves received by the radio receiving means to the radio receiving means, a display, means controlled in accordance with the radio waves received from both the target and the projectile for producing indications of the distance between the tar8et and the projectile upon the display, voltage-producing means for continuously selecting a predetermined value of distance between the target and the projectile upon the display, and means responsive to the voltage of the selectin means and to the received radio waves and operable when the distance between the target and the projectile becomes less than the predetermined value to render the transmitting means effective to transmit the energy signal to the Projectile energy-receiving means.

31. An electric system having, in combination, means for propagating pulses of radio waves towards both a taret and an explodable projectile traveling toward the target Provided with radio-receiving means and means connected with the receiving means for exploding the Projectile in response to a radio signal received by the A radio-receiving means, radio-receiving means for receivln& the Pulses of radio waves after reflection and scatter from the tar et and ? projectile, normally ineffective means seParate from e propagating means for transmitting an energy signal to the radio-receiving means a cathode-ray-tube display, means synchronized with the cathode-ray-tube display, means controlled by the radioreceiving means_for indicating the instants of reception of the, rf ected and sca tered enertf Wayes, fr m e targf and from the projectile upon the time base, thereby to Projectile, voltage-producing means for continuously selecting a portion of the time base corresponding to a predetermined value of distance from the target, and means responsive to tip voltage of the selecting means received radio waves and operable when the distance en the target and the projectile becomes less than the predetermined value to render the transrmttln|. mean.s .effective to; transmit the radio signal to the radio-receiving means thereby to effect the explosion of e projectile during the continued propagation and reception of the radio waves. . -.--

An electee system having m combination, an e erf lo??tor .for Detecting objects one of which is pro-

Vlded Wlth signal-receiving means voltage-producing means for continuously selecting a future position of the sald ne object within a preselected range of another of e ects& gt; and means opwabte at a point remote from the objects and responsive to the voltage of the selecting mean? and to the locat?r for automatically sending a signal to the signal-receiving means of the said one object when Jt approaches the preselected range.

33. An electric system having, m combination, energylocating means for detecting an object provided with signal-receiving means, voltage-producing means for con-

T5 tinuously selecting a iuture position of the said object, and signal-controlled means responsive to the voltage of the selecting means and to the energy-locating means for automatically energizing the cbject-signal-receiving means when the object reaches the future position.

34. An electric system having, in combination, an energy locator for detecting objects one of which is provided with explodable means, voltage-producing means for continuously selecting a future position of the exjilodable object within a preselected range of another of the objects to be destroyed by the explodable object, and means separate from the energy locator operable at a point remote from the explodable object and responsive to the voltage of the selecting means and to the energy locator for automatically causing the explodable means to explode the explodable object when it approaches within the preselected range during the continued detecting of the object by the energy locator.

35. An electric system having, in combination, a radio locator for detecting objects one of which is provided with explodable means, voltage-producing means for co tinuously selecting a future position of the explodable object within a preselected range of another of the objects to be destroyed by the explodable object, and means separate from the radio locator operable at a point remote from the said one object and responsive to the voltage of the selecting means and to the radio locator for automatically causing the explodable means to explode the explodable object when it approaches within the preselected range during the continued detecting of the objects by the radio locator.

36. An electric system having, in combination, radiolocating means for detecting an object provided with explodable means, voltage-producing means for continuously selecting a future position of the explodable object, and radio-wave transmitting means normally occupying one of two conditions of energization, the radio-wave transmitting means being separate from the radio-locating means and responsive to the voltage of the selecting means and to the radio-locating means for automatically occupying its other condition of energization to cause the explodable means to explode the object when it reaches the future position during the continued detecting of the object by the radio-locating means.

37. An electric system having, in combination, energylocating means for detecting an object provided with signal-receiving means, voltage-producing means for continuously selecting a future position of the said object, and signal-transmitting means for signaling the signalreceiving means and normally occupying one of two conditions of energization, the signal-transmitting means go feeding the said voltages produced by the energy-locator being responsive to the voltage of the selecting means and to the energy-locating means for automatically occupying the other condition of energization to produce an indication at the object-signal-receiving means when the object reaches the future position.

38. An electric system having, in combination, an energy-locator system for detecting relatively movable objects one of which is provided with energy-receiving means and producing voltages indicative of the relative positions of the detected objects, means comprising a further voltage-producing selecting means for producing a further voltage correlated with respect to the said voltage indicative of another of the said objects and continuously corresponding to a selected assumed future position of the said one object within a preselected range of the said another of the objects, a normally ineffective electric circuit that can be rendered effective only upon the substantially simultaneous application thereto of the said voltages indicative of the said one and the said other objects detected by the energy-locator system and the said further voltage produced by the selecting means at the time when the said one object approaches within the said preselected range, means for feeding the said voltages produced by the energy-locator system and the said further voltage produced by the selecting means to the normally ineffective electric circuit, thereby automatically to render the electric circuit effective at the said time, and means responsive to the rendering effective of the electric circuit for thereupon transmitting an energy signal to the said energy-receiving means of the said one object.

39. An electric system having, in combination, an energy-locator system for detecting relatively movable objects one of which is provided with energy-receiving means and producing voltages indicative of the relative positions of the detected objects, means comprising a further voltage-producing selecting means for producing a further voltage correlated with respect to the said voltage indicative of another of the said objects and continuously corresponding to a selected assumed future position of the said one object within a preselected range of the said another of the objects, a normally ineffective vacuumtube gating electric circuit that can be rendered effective only upon the substantially simultaneous application 2o thereto of the said voltages indicative of the said one and the said other objects detected by the energy-locator system and the said further voltage produced by the selecting means at the time when the said one object approaches within the said preselected range, means for feeding the said voltages produced by the energy-locator system and the said further voltage produced by the selecting means to the normally ineffective electric circuit, thereby automatically to render the electric circuit effective at the said time, and means responsive to the rendering effective of the electric circuit for thereupon transmitting an energy signal to the said energy-receiving means of the said one object.

40. An electric system having, in combination, an energy-locator system for detecting relatively movable objects one of which is explodable and producing voltages indicative of the relative positions of the detected objects, means comprising a further voltage-producing selecting means for producing a further voltage correlated with respect to the said voltage indicative of another of the said objects and continuously corresponding to a selected assumed future position of the said one object within a preselected range of the said another of the objects, a normally ineffective electric circuit that can be rendered effective only upon the substantially simultaneous application thereto of the said voltages indicative of the said one and the said other objects detected by the energylocator system and the said further voltage produced by the selecting means at the time when the said one object approaches within the said preselected range, means for system and the said further voltage produced by the selecting means to the normally ineffective

electric circuit, thereby automatically to render the electric circuit effective at the said time, and means responsive to the rendering effective of the electric circuit for exploding the said one object.

41. An electric system having, in combination, an energy-locator system for detecting relatively movable objects one of which is provided with energy-receiving means and for producing voltages indicative of the relative positions of the detected objects, means comprising a further voltage-producing selecting means for producing a further voltage correlated with respect to the said voltage indicative of another of the said objects and continuously corresponding to a selected assumed future position of the said one object within a preselected range of the said another of the objects, means for producing voltages corresponding to but delayed from the said voltages produced by the energy-locator system an interval of time corresponding substantially to the said preselected range, a normally ineffective electric circuit that can be rendered effective only upon the substantially simultaneous application thereto of the said voltage indicative of the said other object detected by the energylocator system, the delayed voltage indicative of the said one object and the said further voltage produced by the selecting means, means for feeding the said voltage produced by the energy-locator system, the said delayed voltage and the said further voltage produced by the selecting means to the normally ineffective electric ci cuit, thereby automatically to render the electric circuit effective at the time when the said one object approaches within the said preselected range, and means responsive to the rendering effective of the electric circuit for thereupon transmitting an energy signal to the said energyreceiving means of the said one object.

42. An electric system having, in combination, an energy-locator system for detecting relatively movable objects one of which is explodable and for producing voltages indicative of the relative positions of the detected objects, means comprising a further voltage-producing selecting means for producing a further voltage correlated with respect to the said voltage indicative of another of the said objects and continuously corresponding to a selected assumed future position of the said one object within a preselected range of the said another of the objects, means for producing voltages corresponding to but delayed from the said voltages produced by the energylocator system an interval of time corresponding substantially to the said preselected range, a normally ineffective electric circuit that can be rendered effective only upon the substantially simultaneous application thereto of the said voltage indicative of the said other object detected by the energy-locator system, the delayed voltage indicative of the said one object and the said further voltage produced by the selecting means, means for feeding the said voltage produced by the energy-locator system, the said delayed voltage and the said further voltage produced by the selecting means to the normally ineffective electric circuit, thereby automatically to render the electric circuit effective at the time when the said one object approaches within the said preselected range, and means responsive to the rendering effective of the electric circuit for thereupon exploding the said one object.

43. An electric system having, in combination, an 40 236l,177 energy4ocator system provided with means for propagating pulses of energy toward and receiving the pulses of energy after reflection and scatter from relatively movable objects one of which is provided with energy-receiving means and means for producing pulse voltages from 45 2411788 the pulses of energy received from the objects, thereby to measure the range of the relative positions of the objects, means comprising a further voltage-producing selecting means for producing a further voltage corwith respect to the said voltage indicative of an- 50 2,463,233 other of the said objects and continuously corresponding to a selected assumed future position of the said one ob-

l i f j.t J A f ,1 ject within a preselected range of the said another of the objects, means for producing pulse voltages corresponding to but delayed from the said pulse voltages produced by the energy-locator system an interval of time correspending substantially to the said preselected range, a normally ineffective electric circuit that can be rendered effective only upon the substantially simultaneous application thereto of the said pulse voltage indicative of the said other object produced by the energy-locator g system, the delayed pulse voltage indicative of the said one object and the said further voltage produced by the selecting means, means for feeding the said pulse voltages produced by the energy-locator system, the said delayed pulse voltage and the said further voltage produced by the selecting means to the normally ineffective electric circuit, thereby to render the electric circuit effective at the time when the said one object appreaches within the said preselected range, and means responsive to the rendering effective of the electric circuit for thereupon transmitting an energy signal to the said one object for reception in the said energy-receiving

means.

44. An electric system having, in combination, a pulse-energy locator system for detecting an object and a projectile traveling towards the object, a cathode-ray tube, means for displaying upon the cathode-ray tube a voltage pulse corresponding to a signal received from the object by the locator system, means for producing a gate voltage pulse of duration greater than that of the signal voltage pulse and for controlling the gate pulse to select a region upon the cathode-ray tube corresponding to a region in the proximity of the object, and a transmitter responsive to the voltages of the signal and gate voltage pulses for automatically transmiting a furher signal to the projecile when it is detected by the locator system as having entered the said proximity.

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