United States Patent

[11] **3,598,344**

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Continuation of application Ser. No. 371,715, June 1, 1964, now abandoned.

[54] **MISSILE COMMAND SYSTEM**
4 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** **244/3.11**
[51] **Int. Cl.** **F41g 7/00**
[50] **Field of Search** 244/3.11, 3.13, 3.14

[56] **References Cited**

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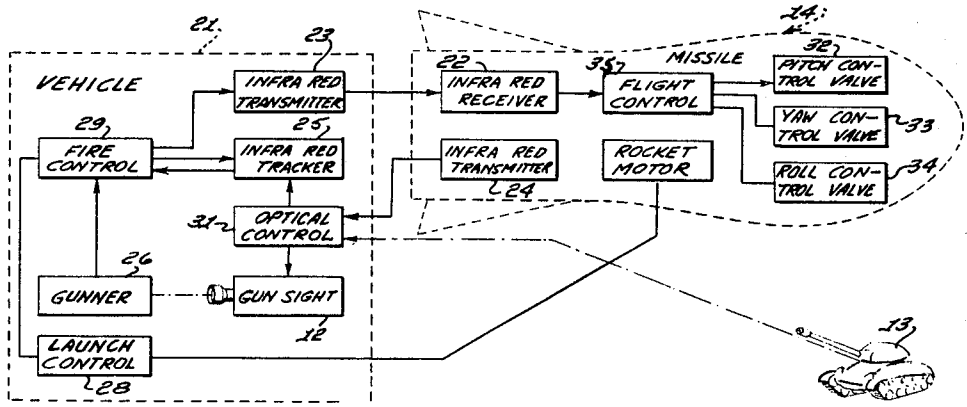
ABSTRACT: A command-type guided missile system wherein a gunner launches a missile and guides it during flight solely by maintaining the cross hairs of his sight reticle trained on the target. A source on the missile emits, rearwardly to the command station, modulated (coded) infrared (IR) light. Visible light from the target and IR light from the source are received at the command station through a common optical system. A beam splitter then sends the visible light to the gunner's sight and sends the IR light through a nutator to a quadrant-type IR detector, which is coupled to the gunner's sight so that the axis of symmetry thereof is always aligned on target. Error signals from the detector indicate the direction of deviation of the image of the source from the axis of the detector and hence the direction of deviation of the missile from the gunner's line of sight to the target. A transmitter, responsive to the error signals, sends modulated IR control signals to the missile to correct its flight path.



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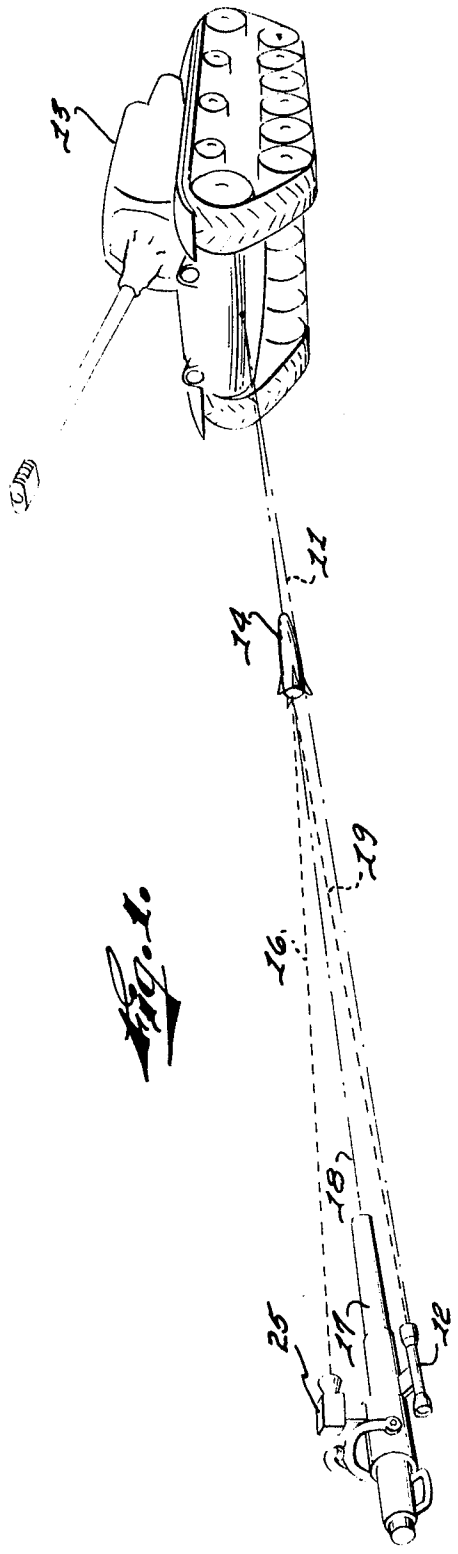

Fig. 1.

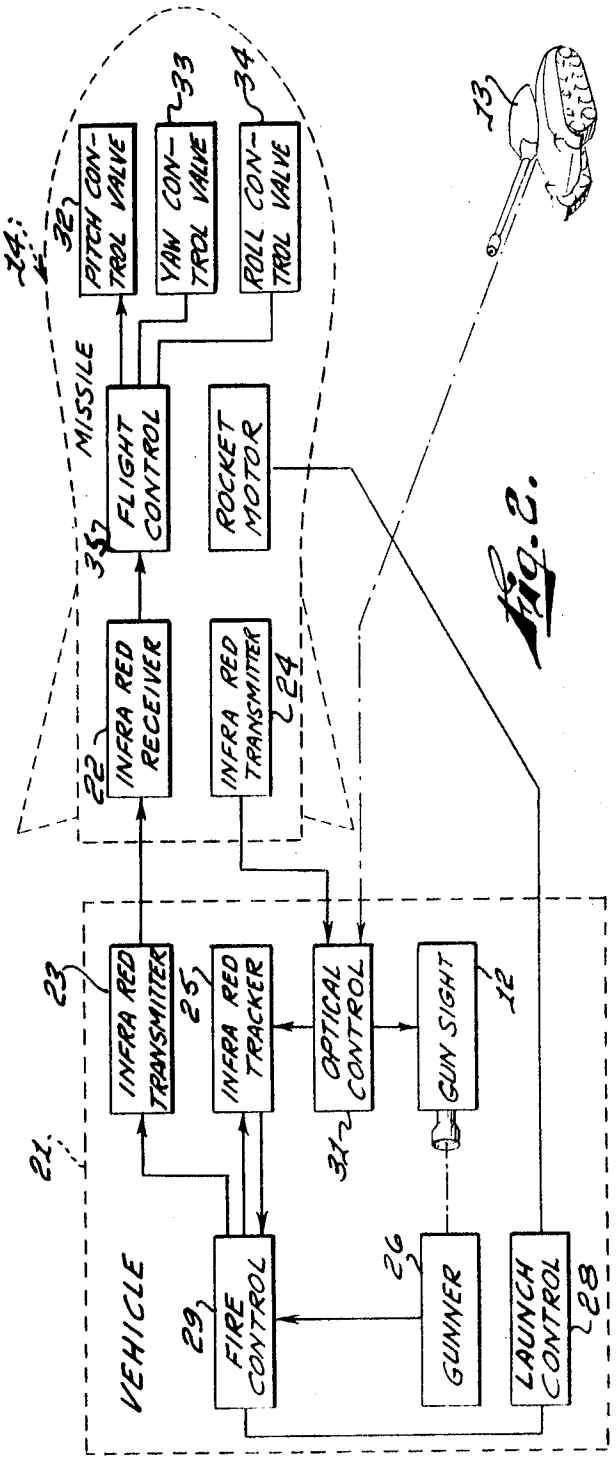

Fig. 2.

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Fig. 3.

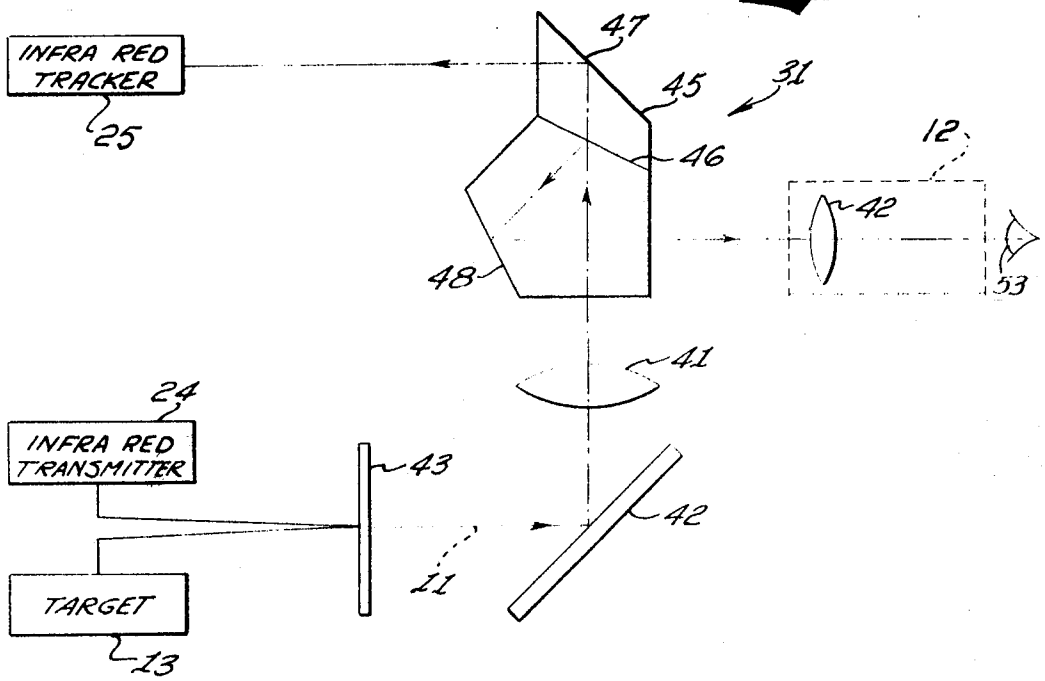
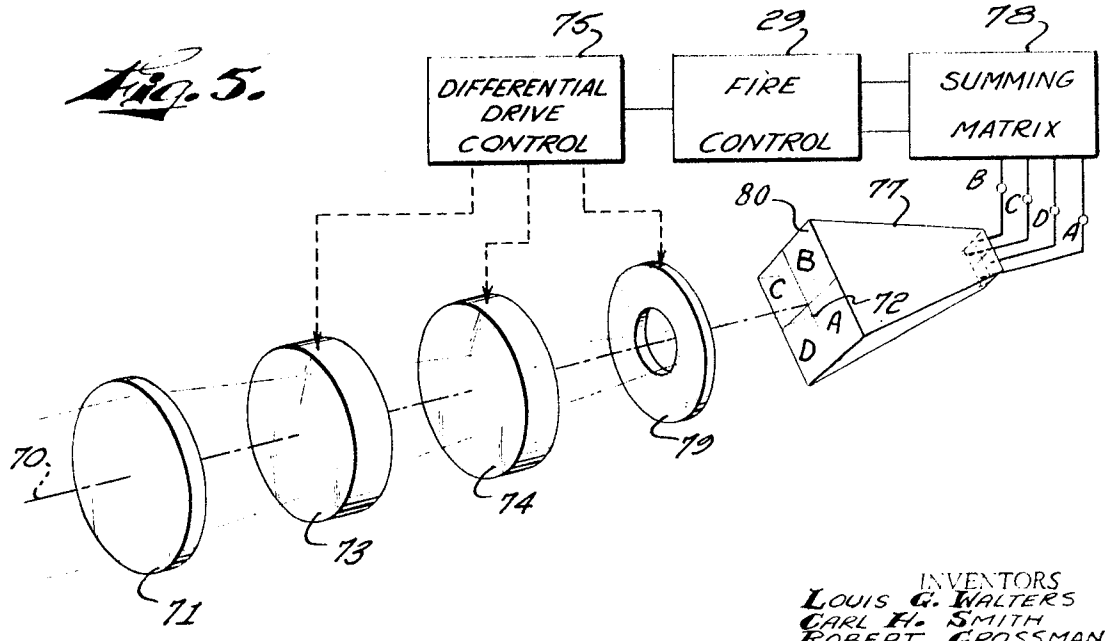


Fig. 5.



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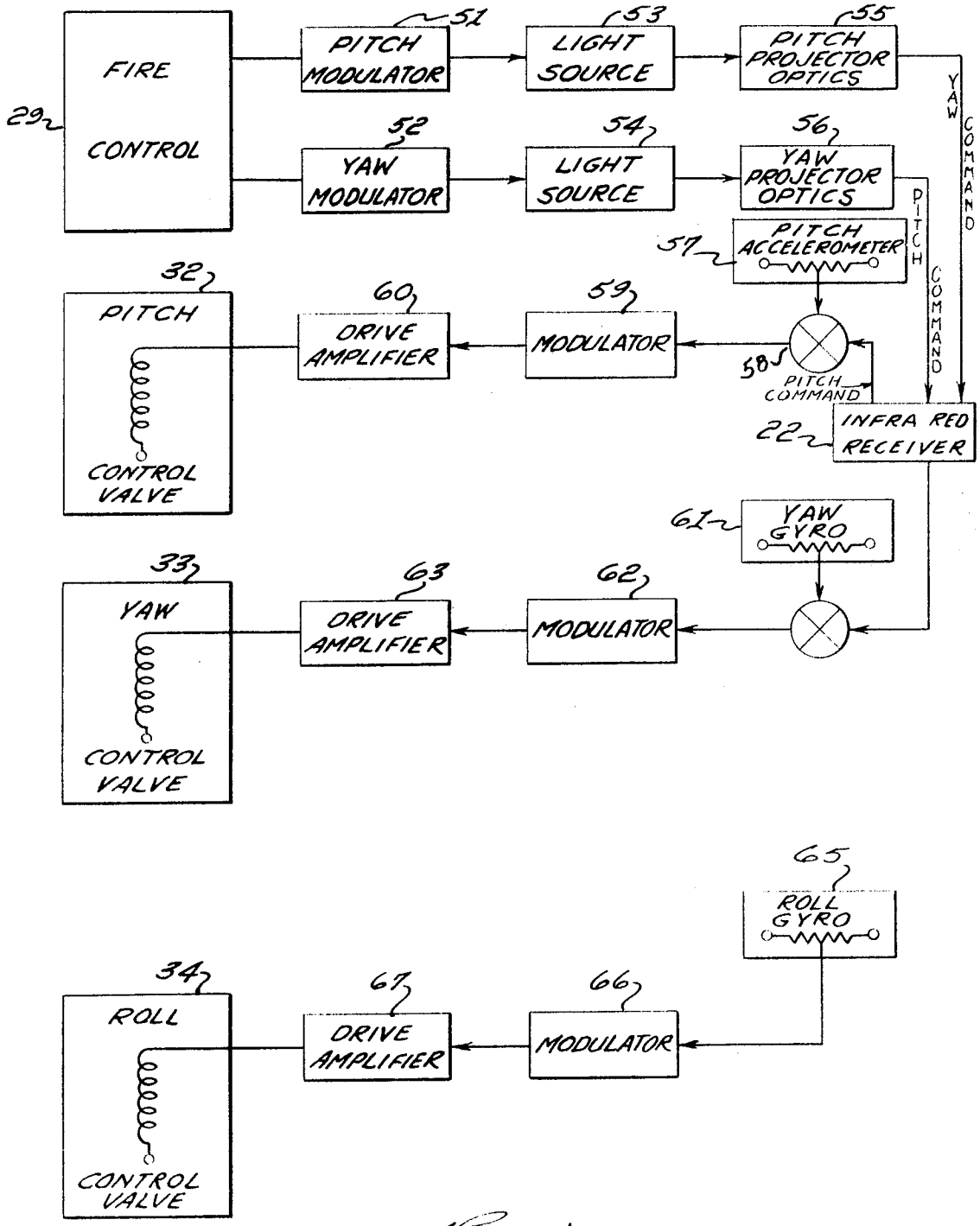

Fig. 4.

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MISSILE COMMAND SYSTEM

This is a continuation of copending application Ser. No. 371,715 filed June 1, 1964, now abandoned.

This invention relates to command control systems for controlling missiles and more particularly to a system for guiding a missile from a vehicle gun barrel to a ground target.

In weapons systems for guiding a missile launched from a vehicle toward a target it is common practice to employ an optical sight mounted in the launching vehicle which the gunner uses to establish a line of sight between the vehicle and the target. In order to guide the missile from the vehicle to the target, means must be provided to track the course of the missile and indicate any deviation between the course of the missile and the line of sight to the target.

In one guidance system heretofore proposed, a missile is provided with a suitable light source, such as a flare, which is continuously tracked by a device on the vehicle responsive to light from the flare to produce error signals indicative of the direction of deviation of the missile, from the line of sight. While such a system may be operable in airborne or spaceborne guidance systems where little interference from the atmosphere is present, such systems may be inoperable on the ground since the short ranged involved, atmospheric shimmer, and other disturbances at a target on the ground having comparatively short range introduces errors in the guidance and control system which make the prior systems wholly inoperable. For example, atmospheric shimmer and other disturbances near the ground prevent any substantial degree of reliability or accuracy in control. Accordingly, it is an object of this invention to provide a command control system for reliably guiding a missile over comparatively short ranges at ground altitudes.

The system of this invention utilizes infrared signals for continuously tracking and controlling a missile. The system is simple, reliable, and accurate and is able to operate within severe environmental conditions.

Therefore another object of this invention is to provide a system for guiding a missile at ground levels, utilizing infrared signals.

Another object is to provide a missile control system utilizing infrared tracker and command links.

A further object is to utilize infrared tracker and command links which provide continuous communication between the missile and the vehicle.

Other objects of invention will become apparent from the following description read in conjunction with the accompanying drawings, in which:

FIG. 1 is a diagrammatic view of one embodiment of the invention illustrating the flight of a missile from a vehicle gun barrel to a ground target.

FIG. 2 is a block diagram illustrating a principal aspect of a system according to a second embodiment of the invention.

FIG. 3 is a block diagram illustrating the optical link from the missile to its control system according to said second embodiment.

FIG. 4 is a block diagram illustrating the infrared command link from the control system at the missile launching site to the missile, as well as control elements within the missile responsive to commands received via that link.

FIG. 5 is a schematic diagram of the infrared tracker of FIG. 2.

FIG. 1 contains a diagrammatic view of the line of travel of a missile **14** between the gun barrel **17** and a target (represented by a tank) **13**. In the control vehicle a gunner (not shown) visually sights the target **13** and continuously maintains a line of sight **11** to the target through an optical sight **12**. Launch control means in the vehicle (not shown) are manually controlled by the gunner to launch missile **14**. Initially, the missile **14** is launched on a path which is approximately aligned with line of sight **11** since launch barrel **17** is coupled to sight **12**. As soon as missile **14** leaves gun barrel **17**, an infrared tracker **25** receives modulated infrared light from an infrared transmitter (not shown) in missile **14** and continuously indicates the deviation of the position of the missile from the axis of the tracker, which, due to the coupling between tracker **25** and sight **12**, is approximately aligned with line of sight **11**. The missile **14** is continuously controlled by an infrared command means (not shown) in the control vehicle in response to a signal indicative of the missile's deviation supplied by tracker **25**. Command signals are sent to missile **14** to maintain it on line of sight **11** until target **13** is reached.

FIG. 2 is a block diagram of a preferred embodiment of the invention. In FIG. 2 missile **14** is controlled from vehicle **21** by a pair of infrared links, one between an infrared receiver **22** in missile **14** and an infrared transmitter **23** in vehicle **21** and the other between an infrared transmitter **24** in the missile **14** and a single optical control **31** in vehicle **21**, which receives both IR tracking and visual line of sight information. Initially, a gunner **26** sights the target **13** via a gun sight **12** and an optical control **31**. The gunner **26** then fires the missile by activating fire control **29** which in turn activates a launch control **28** which ignites rocket motor in missile **14** causing missile **14** to launch from the barrel **27** of FIG. **1**.

After the missile leaves barrel **17**, infrared transmitter **24** in the missile **14** continuously provides a modulated infrared signal which is received by tracker **25** in the vehicle via optical control **31**. Infrared tracker **25** presents output signals to fire control **29** which continuously indicates the deviation of missile **14** from the line of sight to the target maintained by gunner **26**. Fire control **29**, which is responsive to output signals dependent upon the line of sight of gunner **26** and signals from infrared tracker **25** presents a signal to the transmitter **23** which provides an infrared command signal to receiver **22** in missile **14** for maintaining missile **14** on the prescribed line of sight.

Missile **14** includes a flight control **35** which is responsive to the output of receiver **22** for controlling pitch, yaw, and roll fuel control valves **322, 33**, and **34**.

FIG. 3 is a schematic diagram of optical control **31** of FIG. **2**. Optical control **31** includes a window assembly **43** which receives ordinary light reflected from target **13** and infrared signals generated by transmitter **24** of missile **14**. The optical line of sight runs from target **13** through window **43** to a diagonal reflector **42** and then through an objective **41** to a beam splitting pentagonal and roof prism assembly **47**. Assembly **47** includes a surface **46** which reflects the visible light to a second surface **48** which in turn reflects the light through an objective **42** of gun sight telescope **12** to the gunner's eye **53**. Infrared signals from transmitter **24** also are transmitted through window assembly **43** to reflector **42** and through objective **41** to roof prism **47**. Reflecting surface **46** is an infrared transmitting dichroic surface which passes the infrared energy to a surface **45** of prism **47** wherefrom it is reflected to tracker **25**. Thus, both image of target **13** and infrared signals from transmitter **24** are coupled through a common optical control **31**. This insures that the line of sight **11** always will be precisely aligned with the tracking axis of tracker **25**.

FIG. 4 is a block diagram, of the infrared system which transmits command signals from vehicle **21** to missile **14**. In FIG. 4 fire control **29** provides coded electrical pitch and yaw command signals to a pitch modulator **51** and a yaw modulator **52**. The command signals are converted into infrared command signals by modulators **51** and **52** and light sources **53** and **54**. Sources **53** and **54** may be arc lamps whose current sources are modulated by modulators **51** and **52**. Pitch projection optics **55** collimate the pitch command infrared signals into a very narrow beam which is sent to infrared receiver **22** in missile **14**. Yaw projection optics **56** likewise directs the yaw command infrared signals to the infrared receiver **22**.

The infrared receiver **22** in missile **14** receives the modulated infrared command signals from the projection optics **55** and **56** and develops a pitch command signal which is combined with a signal from a pitch accelerometer **57** in an adder **58** to provide a control signal to a modulator **59**. A drive am-

plifier 60 responds to the signal from the modulator 59 to operate pitch control valve 32 in missile 14. Similarly, receiver 22 develops a yaw command signal which is combined with a signal from a yaw gyro 61 to provide a control signal to a modulator 62 which drives an amplifier 63. The output of the amplifier 63 operates yaw control valve 33 of the missile 14. A roll control valve 34 is controlled by a roll gyro 65 via a modulator 66 and an amplifier 67.

FIG. 5 illustrates the infrared tracker 25 of FIGS. 2 and 3. Tracker 25 determines the deviation of the missile from the line of sight axis 70. Axis 70 is aligned optically with line of sight 11 of FIGS. 1 and 3. The incoming signal from a modulated source (not shown) forming part of the infrared transmitter 24 within the missile is focused by an aperture lens 71 which forms a target image at a point 72 on a photosensitive surface 80 of a detector 77. The image point 72 is nutated in a circular pattern normal to axis 70 by means of a pair of optical wedges 73 and 74 which are rotated by a differential drive control 75 which in turn is controlled by a fire control 29. The image point 72 is nutated in a symmetrical circular pattern about the junction of surfaces A, B, C, and D of detector 77 when the missile is on the line of sight axis. The field of view is regulated by a field stop 79, which may be an ordinary camera iris, and which is controlled by the differential drive control 75 in accordance with programmed signals from the fire control 29.

Radiant energy detector 77 may be in the form of a core, with the four detector surfaces A, B, C, and D preferably adjacent to each other to form a cross where their surfaces adjoin. A summing matrix 78, responsive to the output signals from the detector surfaces, provides signals indicative respectively of the vertical deviation of the target from the optical axis and the horizontal deviation from the optical axis.

The system illustrated in the present invention guides a missile from a vehicle gun barrel to a ground target by means of an infrared command link and an infrared tracker link which, being largely insensitive to atmospheric shimmer effects and the like provide a highly reliable and accurate missile control system. The system is particularly advantageous where used to guide a missile from a ground vehicle such as a tank gun to a target such as a tank along the ground.

The use of infrared command and tracker link signals having narrow directional beams allows the system to be highly resistant to enemy countermeasures.

We claim:

1. A command-type guided missile system comprising:

a control station for launching a missile and controlling its flight path,

said missile including means for emitting, during flight and rearwardly to said control station, a modulated infrared tracer signal,

said control station including

1. a gunsight which a gunner can adjust before and during missile flight to establish and maintain a line of sight on a target,

2. infrared tracker means, coupled to said gunsight, having a tracking axis and responsive to the modulated infrared light of said tracer signal, for providing error signals indicative of any deviation of a received image of said means for emitting from said tracking axis,

3. common optical means, coupled to said gunsight and said infrared tracker means, for (a) receiving visible light from said target and infrared light from said means for emitting through a common aperture and directing both types of light along a single axis so that said line of sight will be precisely aligned with said tracking axis, and (b) splitting said infrared and visible light so as to direct said infrared light to said infrared tracker means and said visible light to said gunsight, and

4. means responsive to said error signals for transmitting to said missile an infrared command signal having a narrow directional beam which is modulated with information related to the direction of deviation of said missile from said tracking axis and hence said line of sight,

said missile also including means responsive to said infrared command signal for changing the flight path of said missile in a direction opposite to its direction of deviation from said flight path, thereby to cause said flight path substantially to coincide with said line of sight.

2. The missile system of claim 1 wherein said infrared tracker means comprises (1) a detector having a photosensitive surface divided into plurality of sections, and (2) means for nutating said infrared beam over said sections such that said beam impinges on each of said sections an equal amount of time only when said image of said means for emitting is on said tracking axis.

3. In a command-type guided missile system of the type comprising:

a control station for launching a missile and transmitting command guidance signals to said missile when in flight in order to maintain the flight path of said missile substantially coincident with a line of sight to a target established by a gunner in said control station who trains a manually adjustable gunsight on said target,

said missile including a light source for providing a position indicating tracer,

said control station including (1) an optical sensor, having a tracking axis and coupled to said gunsight so that said tracking axis is approximately aligned with said line of sight, responsive to light from said light source for providing error signals indicative of the deviation of said missile from said line of sight, and (2) a transmitter responsive to said error signals for transmitting to said missile said command guidance signal,

the improvement wherein said light source of said missile emits modulated infrared light so that light from said source can be readily distinguished and separated from visible light from said target and other infrared light not so modulated, said optical sensor of said control station is responsive to said infrared light from said source, said control station includes common optical means, coupled optically to said optical sensor and said gunsight, for (a) receiving, through a common aperture thereof, infrared light from said source and visible light from said target, (b) directing both types of light along a single axis so that said tracking axis and said line of sight are precisely aligned, (c) splitting said two types of light and directing said infrared light to said optical sensor and said visible light to said gunsight, said transmitter being arranged to transmit to said missile a infrared command guidance signal having a narrow directional beam, whereby said signal will be difficult to detect or jam.

4. The missile system of claim 3 wherein said optical detector comprises (1) a photosensitive surface having a plurality of separate sections, and (2) means for nutating said infrared beam over said sections such that said beam impinges on each of said sections for an equal amount of time only when said image of said source is on said tracking axis.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,598,344 **Dated** August 10, 1971

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It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, fourth full paragraph, 9th line (line 25): "ranged" should be --ranges--.

Column 1, lines 26 to 30: the words from "at a target" to "near the ground" inclusive should be deleted.

Column 1, 3rd line from the bottom of column (line 71): after "path" --18-- should be inserted.

Column 2, line 21: before "rocket" --the--should be inserted.

Column 2, line 21: before "causing" a comma should be inserted.

Column 2, line 22: "27 should be changed to --17--.

Column 2, line 37: "322" should be changed to --32--.

Column 2, line 57: the comma should be deleted.

Column 3, line 38: a comma should be inserted after "like".

Signed and sealed this 6th day of June 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents