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Holmes et al.

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[54] ACTIVE PASSIVE FUZING SYSTEM

[75] Inventors: **Daniel D. Holmes; Albert Weiss,** both of Riverside, Calif.

[73] Assignee: **The United States of America as represented by the Secretary of the Navy,** Washington, D.C.

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[52] **U.S. Cl.** ..... **102/70.2 P;** 343/7 PF

[51] **Int. Cl.**[2] **F42C 13/04**

[58] **Field of Search** ..... 102/50, 70.2; 343/5 MD, 343/7

[56] **References Cited**

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Primary Examiner—Harvey E. Behrend
Assistant Examiner—C. T. Jordan
Attorney, Agent, or Firm—Richard S. Sciascia; Joseph M. St. Amand; T. M. Phillips

EXEMPLARY CLAIM

1. An active passive fuzing system for use in a guided missile comprising:

a. means for transmitting radio frequency energy,

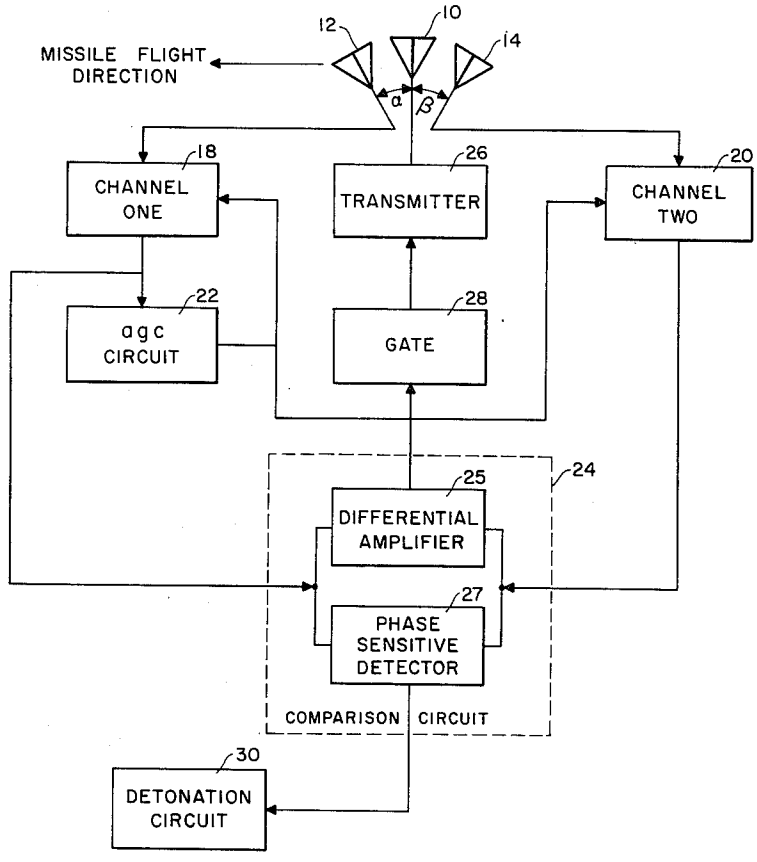
b. first receiving circuit means including a receiving antenna that is oriented to receive signals in the direction of missile flight and second receiving circuit means including a receiving antenna oriented to receive signals in the direction opposite to the direction of missile flight for receiving and detecting said transmitted energy reflected from a target to be detected,

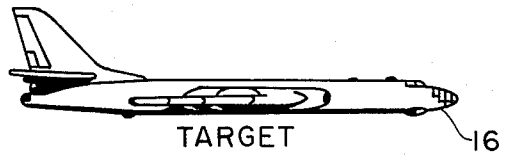
c. comparison circuit means coupled to said first and second receiving means for comparing the magnitudes and phase of the received reflected signals and producing a detonating signal when like signals are received in each of said first and second receiving means, and

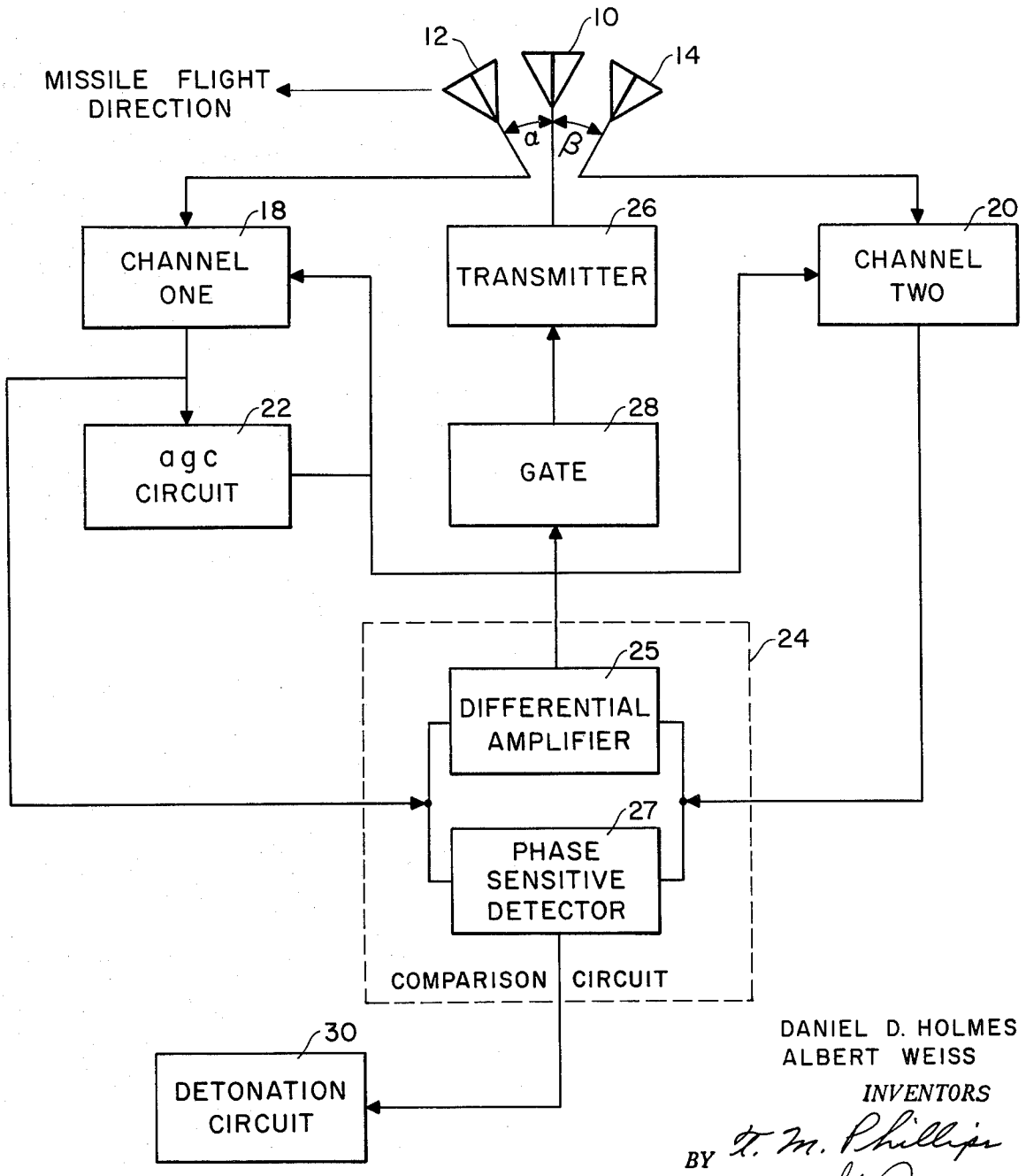
d. gate circuit means coupled to said comparison circuit means and being responsive to an output signal thereof to turn off said transmitting means when a countermeasures signal overrides the reflected signals from the target and turning said transmitting means on when said countermeasures signal ceases.

4 Claims, 1 Drawing Figure









DANIEL D. HOLMES
ALBERT WEISS
INVENTORS
BY T. M. Phillips
J. M. St. Amand
ATTORNEYS

ACTIVE PASSIVE FUZING SYSTEM

The invention herein described may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

The present invention relates to an active passive fuzing system and more particularly to an active passive fuzing system which minimizes the probability of premature fuze detonation or deactivation (dudding) due to undesired signals such as enemy countermeasures or other external interfering signals.

The present invention provides a simple effective system which utilizes a single transmitting antenna and two receiving antennas oriented at angles α and β respectively, as referred to the transmitting antenna. Angles α and β are chosen so as to provide a coincidental coverage of the smallest target at a distance not exceeding the lethal effectiveness of the missile warhead.

Accordingly, an object of the present invention is to provide a fuzing system which is simple to construct but effective in the environment of undesired signals such as enemy countermeasures or other external interfering signals.

Other objects and many of the attendant advantages of this invention will become readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein there is shown in a single FIGURE a preferred embodiment of the invention.

Referring now to the drawing there is shown a radio frequency energy transmitting antenna **10** and two receiving antennas **12** and **14** for transmitting energy in the direction of target **16** and for receiving reflected energy therefrom. Antenna **12** is positioned to "look ahead" at an angle α in the direction of flight and "sees" target **16** first and antenna **14** is positioned to "look" in the opposite direction at an angle β, as referred to antenna **10.** There is a receiving channel associated with each of the receiving antennas; antenna **12** is coupled to channel one, designated by numeral **18,** and antenna **14** is coupled to channel two, designated by the numeral **20.** The output from channel one, **18,** feeds an automatic gain control circuit, **22,** and a comparision circuit, **24.** Channel two, **20,** also feeds into comparison circuit, **24.** The output of automatic gain control circuit **22** is connected to channels **18** and **20** to control their gain. Transmitting antenna **10** is coupled to a transmitter **26** which is controlled by gating circuit **28.** Channels **18** and **20** may be of any of the well known receiving and detecting channels of radar system restricted to the frequency of transmitter **26.** Transmitter **26** may be of any of the standard radar transmitters available on the market. Comparison circuit **24** comprises a differential amplifier **25** which compares the negative amplitudes of the signals from channels one and two.

The output of the amplifier is a function of the disimilarity of the signals in channels one and two. Regardless of amplitude, signals which are similar in amplitude and phase give essentially no output. In the event of a countermeasure signal being received by either channel, the output is essentially proportional to the received signal. At a predetermined level the output from the differential amplifier **25** will activate the gate **28** turning off the transmitter. This places the system in the passive state. The differential amplifier is standard circuitry of the type described on page 10 and FIG. 10 of the text "Functional Circuits and Oscillators" by Herbert J. Reich. The gate **28** is standard circuitry as described in pages 47 to 58 of the same text.

The output of the phase sensitive detector **27** is a function of the relative amplitude and phase of the signals in channels one and two. When the signal in channel one reaches a predetermined level and its phase is consistent with the signal in channel two, the detector **27** will produce an output proportional to the signal in channel two. When the amplitudes rise to the predetermined level and the phase approaches identity, the output rises and actuates the detonation circuit **30.** The phase sensitive detector **27** is standard circuitry as described on page 141, FIGS. 8–18 of the text "Principles of Electronic Instruments" by Gordon R. Partridge. There would be a d.c. bias on the diodes to set the predetermined signal level for triggering the detonation circuit **30.** The detonation circuit **30** can be any desired circuit as is used in current fuze design.

In operation, a radio wave is transmitted via antenna **10** by transmitter **26.** As the missile (not shown) on which the fuzing system is mounted intercepts target **16,** the transmitted energy is reflected into the receiving antennas **12** and **14.** The relative magnitudes and phase are functions of the angles α and β and the position of target **16** with respect to antennas **10, 12** and **14.** The absolute magnitude is dependent upon missile-target distance, target size, target structure, etc.. The phase is a function of the respective path lengths from antenna **10** to target **16** and back to antennas **12** and **14.** The reflected radiation as received by antennas **12** and **14** is detected and amplified by channels **18** and **20** respectively. The output of channel **18** feeds automatic gain control circuit **22** and comparison circuit **24.** The output of control circuit **22** controls the amplification of channels **18** and **20,** by negative feedback which is a function of the signal level in antenna **12.** The operation of control circuit **18** is such that it operates to reduce the gain of both channels proportionately to an increase in the signal level at antenna **10** above the normal target signal, should there be a lack of corresponding signal at antenna **12** to indicate the proximity of an actual target. The presence of an actual target will cause the outputs of channels **18** and **20** to reach a predetermined similarity in amplitudes and/or similarity or dissimilarity in phase. Comparison circuit **24** will produce an output signal to actuate detonation circuit **30** at the optimum point for the missile warhead.

In the event of countermeasures action from target **16** originating at a point in space other than the optimum detonation point, the outputs of channels **18** and **20** would produce greatly dissimilar amplitudes at comparison circuit **24.** The duration of this dissimilarity at amplitudes above the detectability threshold will be long compared to the normal fuzing signal because of transmitter **26** power and the orientation and characteristics of antennas **10, 12** and **14,** i.e., if the countermeasures signal originates from a point in space external to the coincidental coverage of antennas **12** and **14.** When the amplitude of the countermeasures signal reaches a predetermined value in channel **18,** gate **28** is actuated, turning off transmitter **26.** As the system approaches the transmitted countermeasures signal, the signals received by antennas **12** and **14** are compared by comparison circuit **24.** When the signals are

similar in amplitude and reach the required similarity and/or dissimilarity in phase, circuit **24** produces an output signal to initiate detonation circuit **30** in the same manner as described above. Automatic gain control circuit **22** also serves to prevent saturation of either channel, with a resulting premature firing of the system. Should the countermeasures signal be turned off before target intercept, gate **28** will turn transmitter **26** on and the system reverts to active operation as described above. In either active or passive operation, the system functions to initiate detonation circuit **30** only when the radiation received by antennas **12** and **14** are similar in amplitude and/or phase. This similarity occurs only in a narrow region between the antennas. Thus, the burst position of the system is defined and can be controlled by the beam width of the antennas and the angular displacement of the antennas. In the event countermeasures signals are present, the system becomes passive and functions at the normal burst position, on the radiation from the countermeasures source.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. An active passive fuzing system for use in a guided missile comprising:

a. means for transmitting radio frequency energy,

b. first receiving circuit means including a receiving antenna that is oriented to receive signals in the direction of missile flight and second receiving circuit means including a receiving antenna oriented to receive signals in the direction opposite to the direction of missile flight for receiving and detecting said transmitted energy reflected from a target to be detected,

c. comparison circuit means coupled to said first and second receiving means for comparing the magnitudes and phase of the received reflected signals and producing a detonating signal when like signals are received in each of said first and second receiving means, and

d. gate circuit means coupled to said comparison circuit means and being responsive to an output signal thereof to turn off said transmitting means when a countermeasures signal overrides the reflected signals from the target and turning said transmitting means on when said countermeasures signal ceases.

2. An active passive fuzing system for use in a guided missile comprising:

a. means for transmitting radio frequency energy,

b. first receiving circuit means including a receiving antenna that is oriented to receive signals in the direction of missile flight and second receiving circuit means including a receiving antenna oriented to receive signals in the direction opposite to the direction of missile flight for receiving and detecting said transmitted energy reflected from a target to be detected,

c. comparison circuit means coupled to said first and second receiving means for comparing the magnitudes and phase of the received signals and producing a detonating signal when like signals are received in each of said first and second receiving means,

d. automatic gain control circuit means having an input coupled to the output of the first receiving circuit means and having a first output coupled as an input to said first receiving circuit means and a second output coupled as an input to the second receiving circuit means for reducing the gains of both receiving circuits proportionately to an increase in the level of the received signals, and

e. gate circuit means coupled to said comparison circuit means and being responsive to an output signal thereof to turn off said transmitting means when a countermeasure signal overrides the reflected signal from the target and for turning said transmitting on when said countermeasures signal ceases.

3. An active passive fuzing system for use in a guided missile comprising:

a. means for transmitting radio frequency energy,

b. first receiving circuit means including a receiving antenna that is oriented to receive signals in the direction of missile flight and second receiving circuit means including a receiving antenna oriented to receive signals in the direction opposite to the direction of missile flight for receiving and detecting said transmitted energy reflected from a target to be detected,

c. comparison circuit means coupled to said first and second receiving means for comparing the magnitude and phase of the received reflected signals and producing a detonating signal when like signals are received in each of said first and second receiving means, and

d. means coupled to said comparison circuit means and to said transmitting means for turning off said transmitting means when signals of dissimilar predetermined amplitudes persist for a predetermined time.

4. An active passive fuzing system for use in a guided missile comprising:

a. means for transmitting radio frequency energy,

b. first receiving circuit means including a receiving antenna that is oriented to receive signals in the direction of missile flight and second receiving circuit means including a receiving antenna oriented to receive signals in the direction opposite to the direction of missile flight for receiving and detecting said transmitted energy reflected from a target to be detected,

c. comparison circuit means coupled to said first and second receiving means for comparing the magnitude and phase of the received reflected signals and producing a detonating signal when like signals are received in each of said first and second receiving means, and

d. means coupled to said comparison circuit means and to said transmitting means for turning off said transmitting means in the presence of countermeasures signals.

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