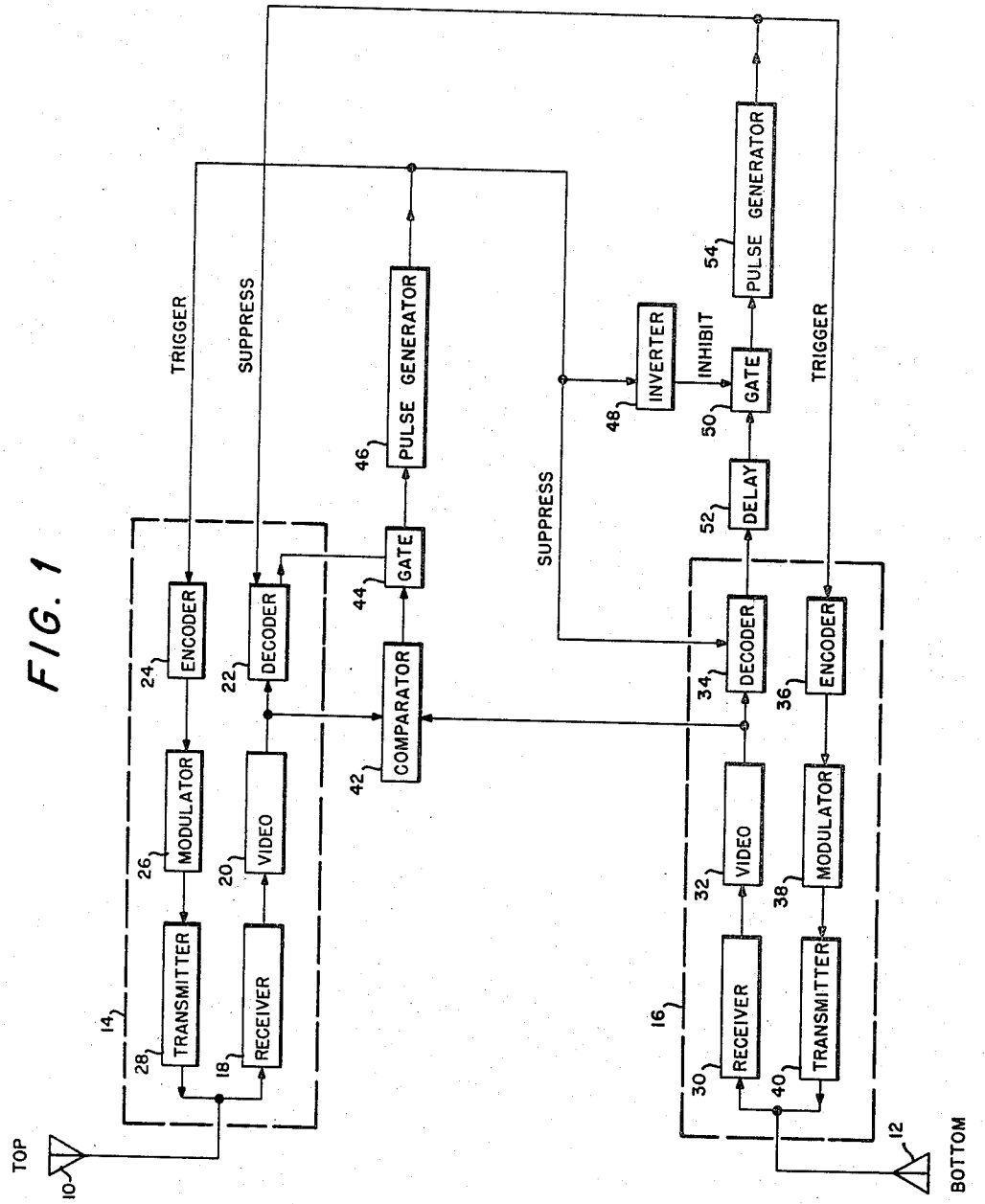
March 26, 1968 G. E. HART ET AL 3,375,516

DUAL ANTENNA SYSTEM FOR TRANSPONDER BEACON DEVICES

Filed May 26, 1967 6 Sheets-Sheet 1

FIG. 1



INVENTORS

GERALD E. HART

CHARLES E. QUIGLEY

BY James B Murray

Robert Isacco

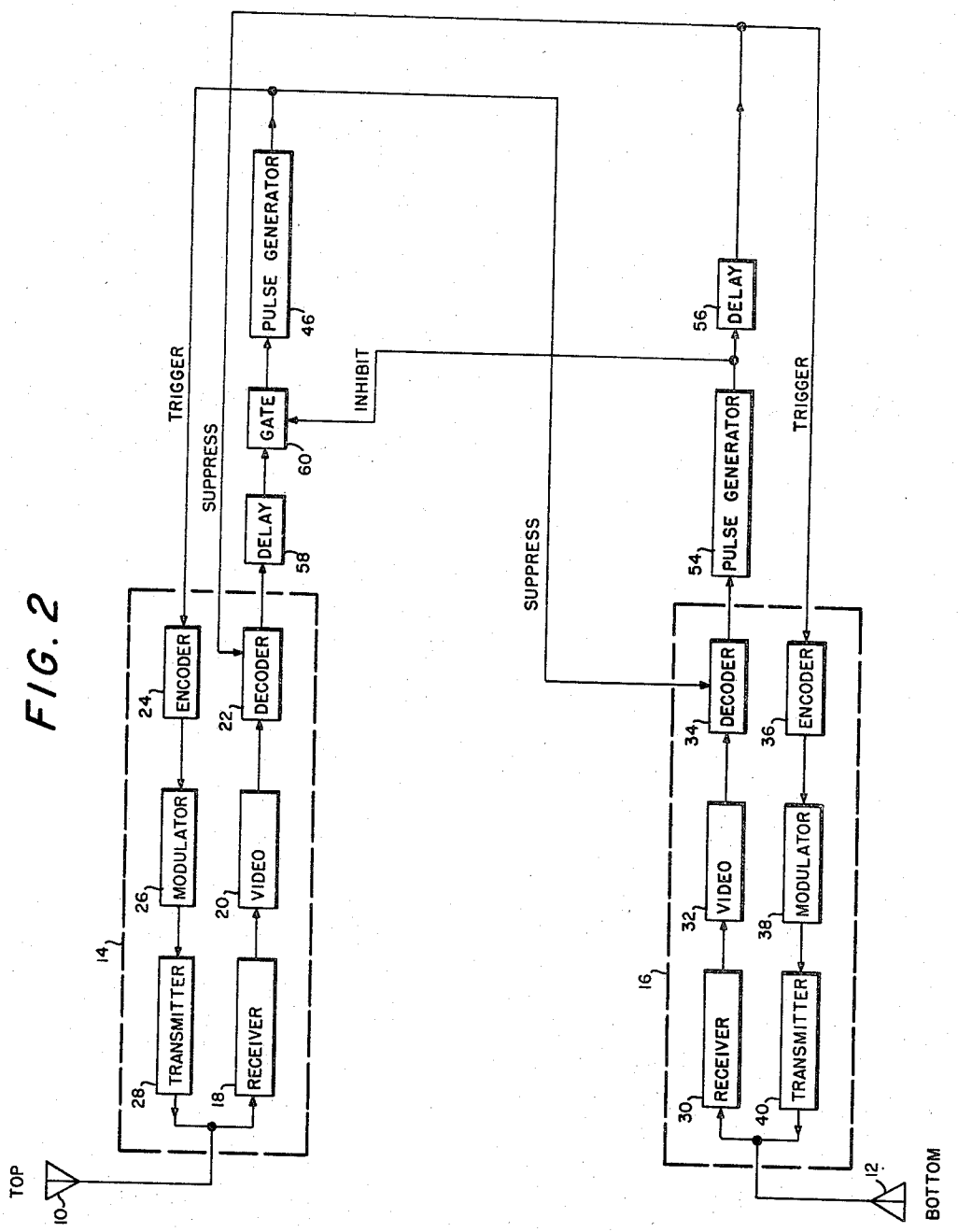
ATTORNEYS

March 26, 1968 G. E. HART ET AL 3,375,516

DUAL ANTENNA SYSTEM FOR TRANSPONDER BEACON DEVICES

Filed May 26, 1967 6 Sheets-Sheet 2

FIG. 2



INVENTORS
GERALD E. HART
CHARLES E. QUIGLEY
BY James B. Murray
Rescianese ATTORNEYS

March 26, 1968 G. E. HART ET AL 3,375,516

DUAL ANTENNA SYSTEM FOR TRANSPONDER BEACON DEVICES

Filed May 26, 1967 6 Sheets-Sheet 3

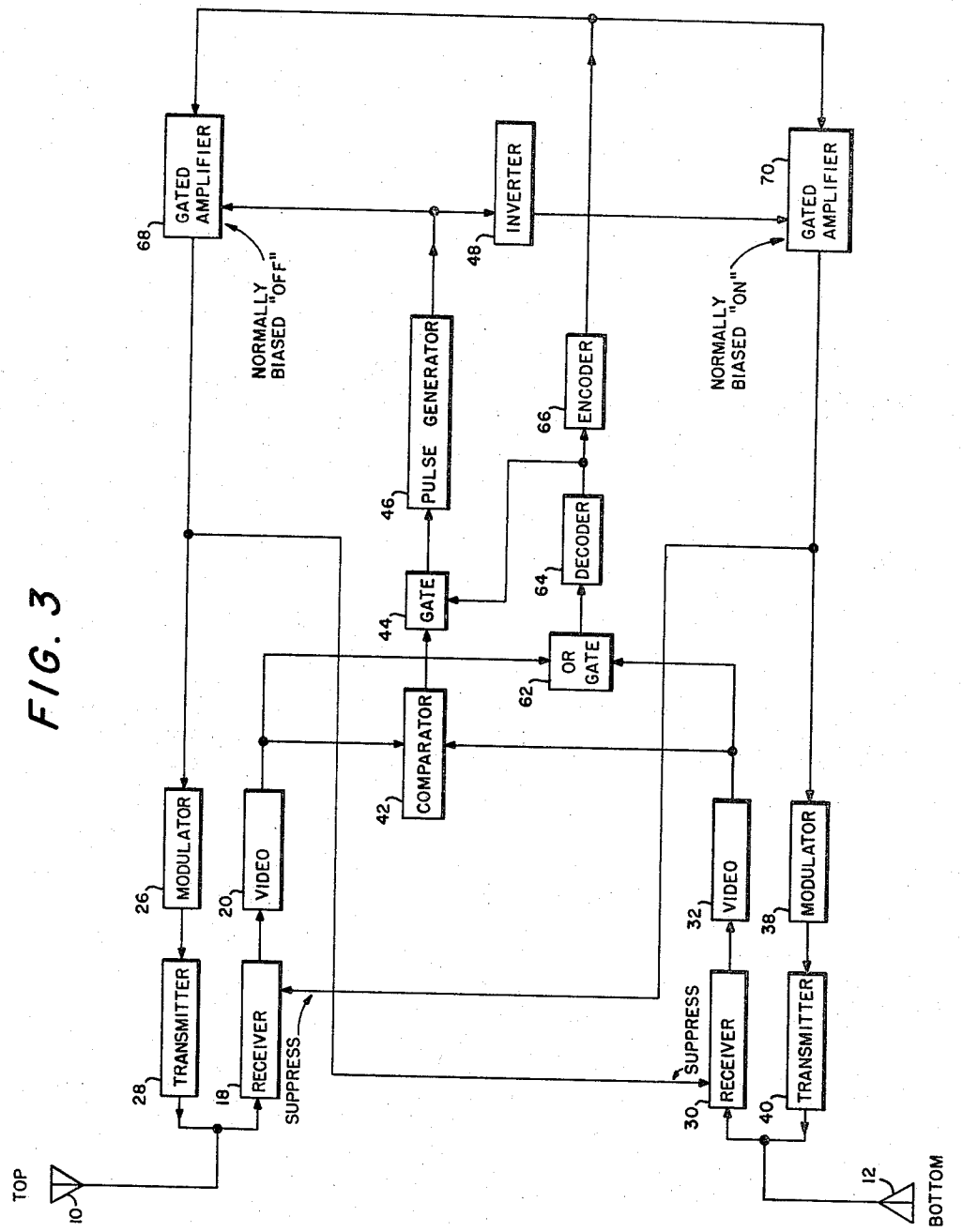


FIG. 3

INVENTORS

GERALD E. HART

CHARLES E. QUIGLEY

BY James B. Murray

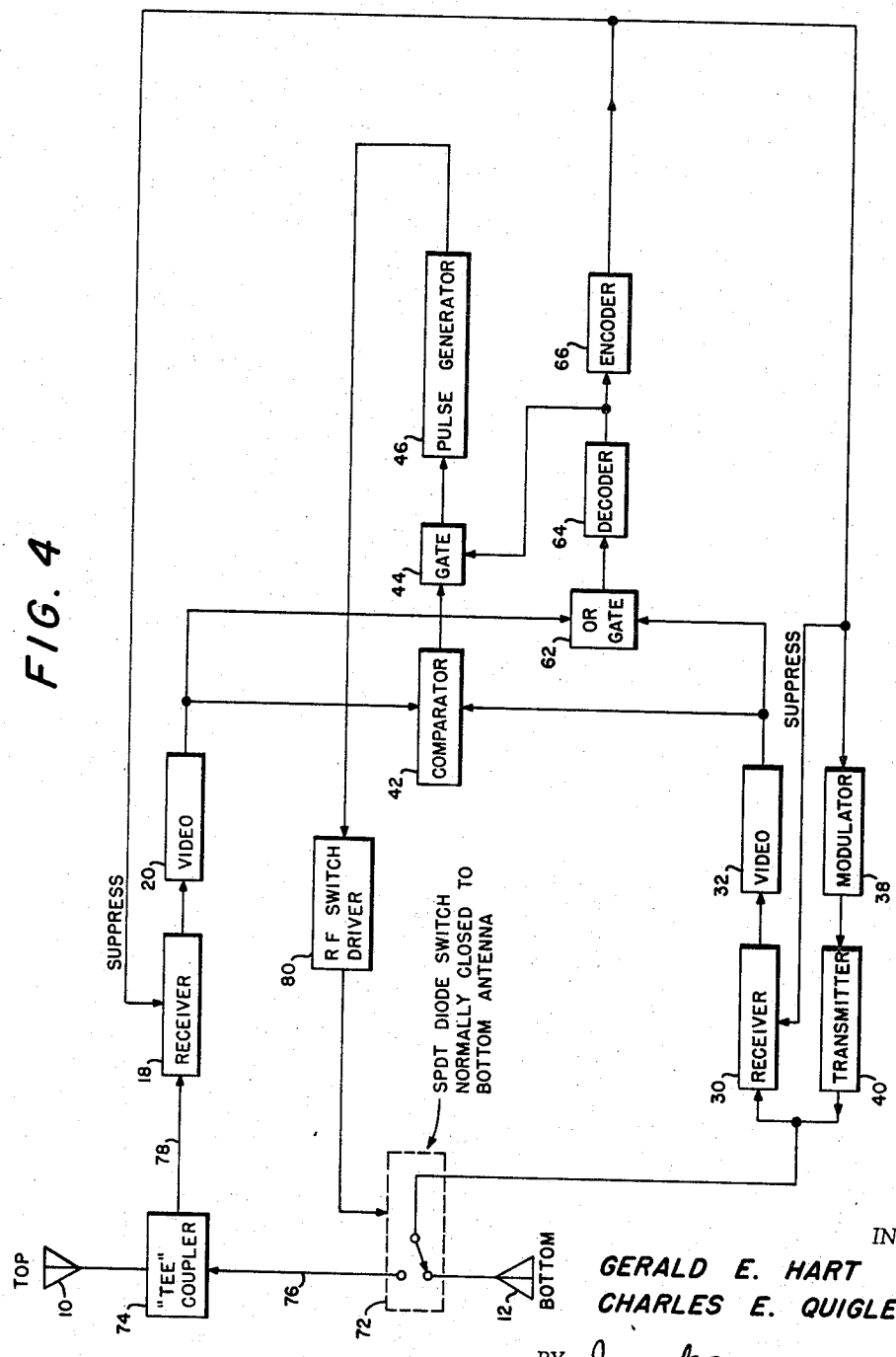
Robert Isaacs ATTORNEYS

March 26, 1968 G. E. HART ET AL 3,375,516

DUAL ANTENNA SYSTEM FOR TRANSPONDER BEACON DEVICES

Filed May 26, 1967 6 Sheets-Sheet 4

FIG. 4



INVENTORS

GERALD E. HART

CHARLES E. QUIGLEY

BY James B Murray

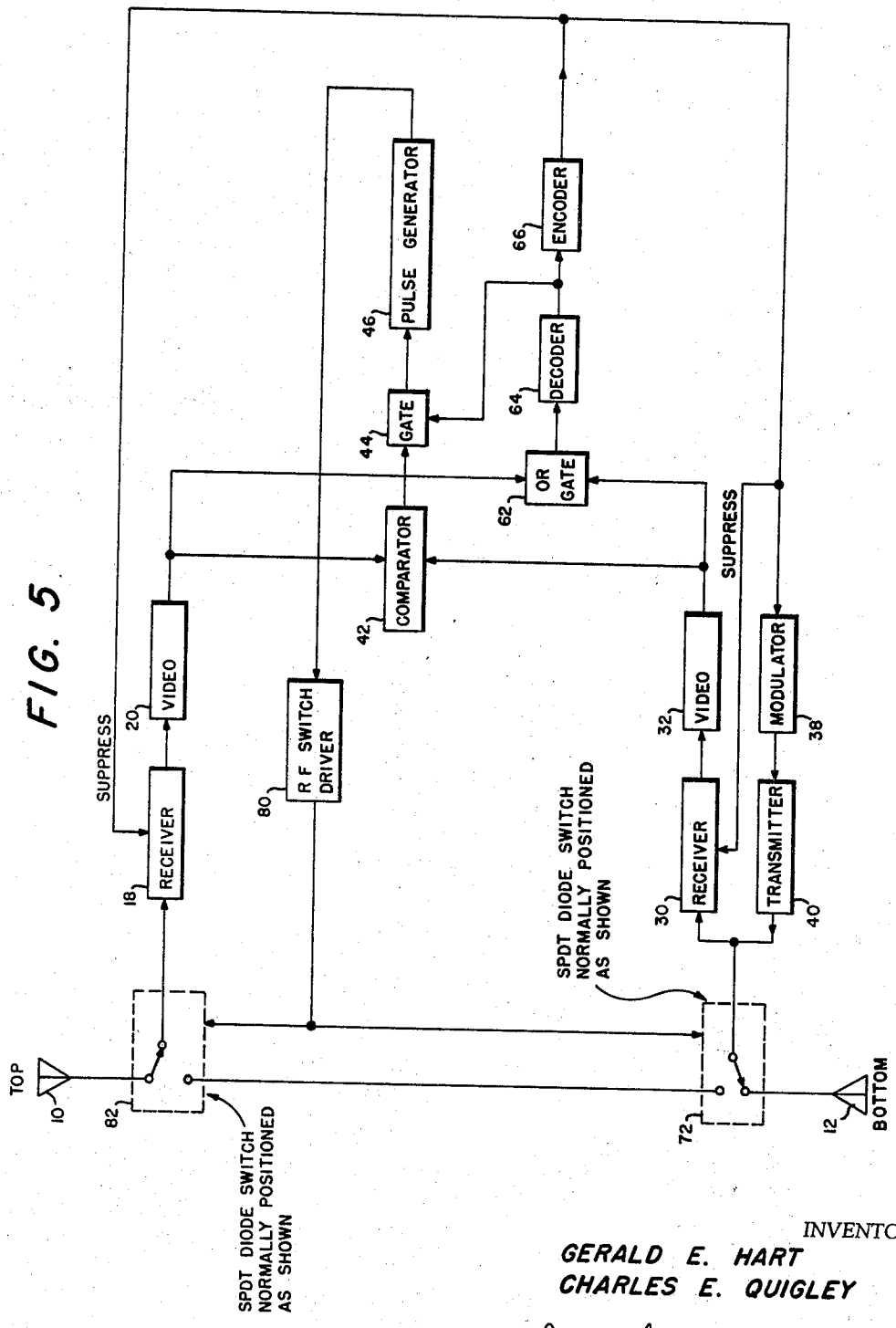
Rothwell, Figg & Ernst ATTORNEYS

March 26, 1968 G. E. HART ET AL 3,375,516

DUAL ANTENNA SYSTEM FOR TRANSPONDER BEACON DEVICES

Filed May 26, 1967 6 Sheets-Sheet 5

FIG. 5



INVENTORS

GERALD E. HART

CHARLES E. QUIGLEY

BY James B. Murray

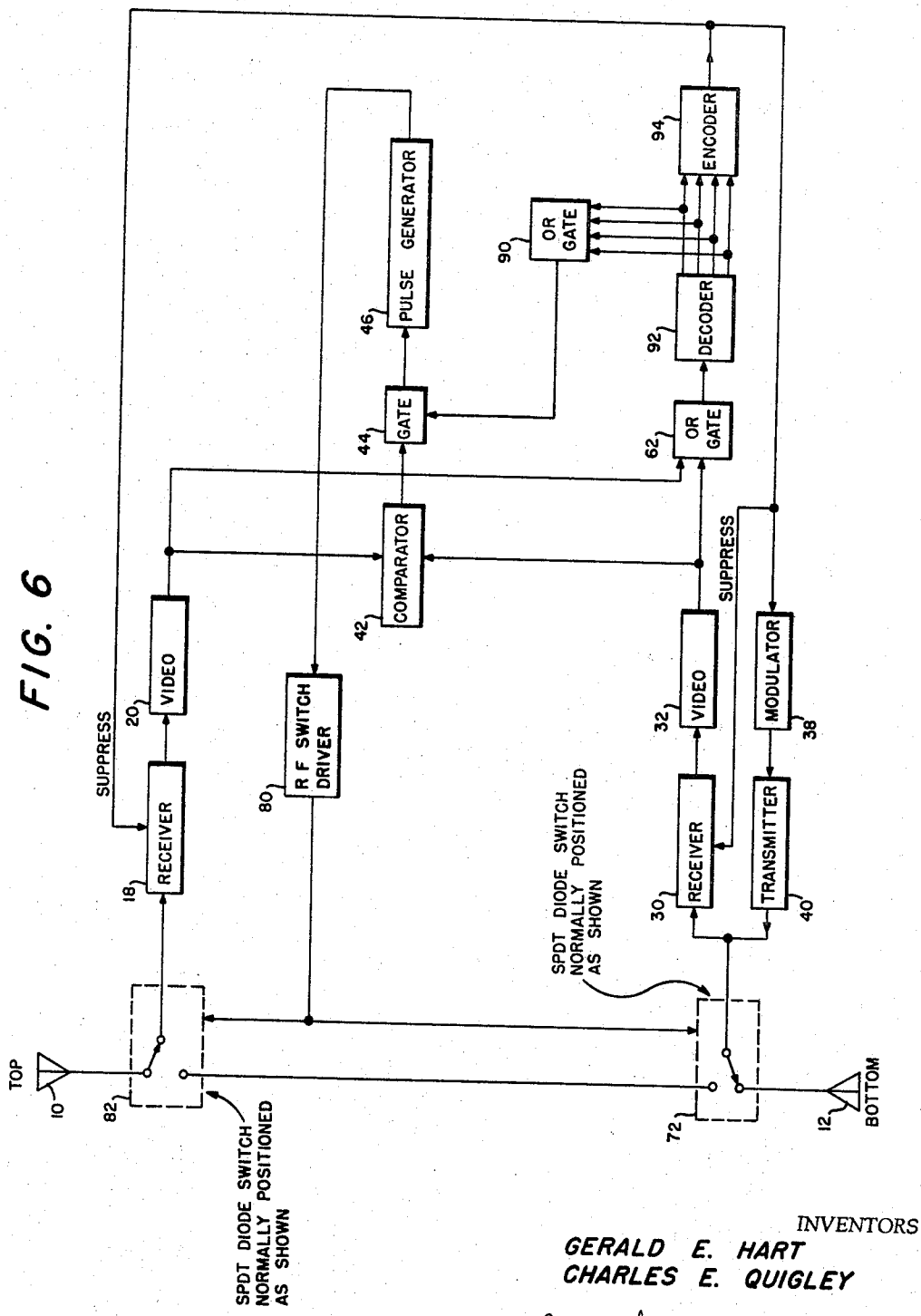
Addicasa & ATTORNEYS

March 26, 1968 G. E. HART ET AL 3,375,516

DUAL ANTENNA SYSTEM FOR TRANSPONDER BEACON DEVICES

Filed May 26, 1967 6 Sheets-Sheet 6

FIG. 6



INVENTORS
GERALD E. HART
CHARLES E. QUIGLEY

BY James B Murray
Robert Scarcella
ATTORNEYS

United States Patent Office 3,375,516
Patented Mar. 26, 1968

3,375,516

DUAL ANTENNA SYSTEM FOR TRANSPONDER BEACON DEVICES

Gerald E. Hart, Washington, D.C., and Charles E. Quigley, Chevy Chase, Md., assignors to the United States of America as represented by the Secretary of the Navy

Filed May 26, 1967, Ser. No. 643,023
10 Claims. (Cl. 343—6.8)

ABSTRACT OF THE DISCLOSURE

Transponder system having dual antennas. Different switching arrangements whereby transponder response is through antenna selected on basis of intercepted signal strength.

The invention described herein 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.

BACKGROUND OF THE INVENTION

Field of the invention

Transponder systems are widely used in civil and military air traffic control systems to determine the identity and/or altitude of aircraft and in military IFF (Identification Friend or Foe) systems to establish the military identity of airplanes. In these systems an interrogation station, which may either be located on the ground or on another airplane, transmits a coded interrogation signal, often by radar. Transponders, which are carried on the airplanes interrogated, are triggered by the coded interrogation signal to produce and transmit a response (or reply) signal which is also coded and which, when received by the interrogation station, furnishes the desired information to the operator of the interrogation station. The contemplated environment of this invention is in the responding portions of transponders systems which are carried on airplanes.

Description of the prior art

Previous transponder systems which used a single transponder antenna were not completely satisfactory in that the single antenna did not provide adequate coverage. Although located on the bottom of the airplane, the single transponder antenna was frequently shadowed from the interrogation ground station during turns and banks and particularly when interrogation was from another airplane at a higher altitude.

To overcome the shadowing disadvantage of single transponder antenna systems, some prior transponder systems have also utilized dual antennas, i.e. an antenna on both the top and bottom of the responding airplane. If operated in parallel, that is with both antennas always connected to the transponder, the dual antenna systems are unsatisfactory in that the radiation pattern is not uniform because of cancellation nulls. Programmed switching, whereby the antennas are alternately and individually connected to the transponder, has also been used in prior art dual antenna systems, but is not entirely satisfactory because of the signal loss whenever an antenna which is shaded from the interrogation station is connected to the transponder.

Summary of the invention

The present invention avoids the shortcomings of prior transponder antenna systems by providing dual antennas which are individually and selectively connected to the transponder transmitter, the connection being selected primarily on the basis of which antenna most strongly receives the interrogation signal. To accomplish the selective connection, the invention includes a plurality of different signal comparing and switching arrangements, each of which may be most preferable in certain circumstances.

It is, therefore, an object of the invention to provide an improved transponder system.

Another object is to provide an improved transponder system which includes dual antennas.

Still another object is the provision of an improved transponder system which includes dual antennas that are individually and selectively connected to the transponder transmitter in a manner related to the strength of the interrogation signal intecepted by each antenna.

A still further object is to provide an improved transponder system which includes dual antennas which are individually and selectively connected to the transponder transmitter, the connection being selected primarily on the basis of which antenna most strongly receives the interrogation signal.

Brief description of the drawings

These and other objects and features of the invention will become apparent to those skilled in the art as the disclosure is made in the following description of preferred embodiments of the invention which are illustrated in the accompanying drawings in which:

FIG. 1 illustrates a first embodiment of the invention;

FIG. 2 illustrates a second embodiment of the invention;

FIG. 3 shows a third embodiment of the invention;

FIG. 4 is a block diagram of a fourth embodiment of the invention;

FIG. 5 illustrates a fifth embodiment of the invention; and

FIG. 6 shows a sixth embodiment of the invention.

Description of the preferred embodiments

Referring now to the drawings, wherein like reference characters designate like or corresponding parts throughout the several views, there is shown in FIG. 1 (which illustrates a first preferred embodiment of the invention) a top antenna **10** and a bottom antenna **12** respectively connected to conventional transponders **14** and **16** which, per se, do not form part of the present invention and which are illustrated only to the extent necessary for describing the present invention. Transponder **14** includes a receiver **18**, video circuits **20** and decoder **22** connected in series for receiving an interrogation signal and an encoder **24**, modulator **26** and transmitter **28** connected in series for transmitting a reply signal. Transponder **16** similarly includes receiver **30**, video circuits **32**, decoder **34**, encoder **36**, modulator **38** and transmitter **40**.

Comparator **42** is connected to receive the video output signals from top transponder **14** and bottom transponder **16** and in turn produces a signal the polarity of which is indicative both of which of the video signals is the larger and of which of the antennas **10** or **12** more strongly intercept the interrogation signal. If the top antenna **10** intercepts the stronger interrogation signal, the polarity of the signal from comparator **42** is such that the gate **44** passes the signal from decoder **22** to trigger pulse generator **46** which in turn is connected to trigger encoder **24** to initiate a replay signal through modulator **26**, transmitter **28** and top antenna **10**. The signal from pulse generator **46** is also connected to suppress the bottom transponder decoder **34** and, through inverter **48**, to inhibit the gate **50**, thereby keeping the bottom transponder **16** from transmitting a replay signal through the antenna **12**.

If the bottom antenna intercepts the stronger interrogation signal, the comparator **42** will not be effective to open the gate **44**. Rather, the signal from decoder **34** will, after a slight delay in component **52**, pass through gate **50** and energize the pulse generator **54** which is in turn connected to trigger encoder **36** to initiate a reply signal through modulator **38**, transmitter **40** and bottom antenna **12**. The signal from pulse generator **54** is also connected to suppress decoder **22**, thereby keeping the top transponder **14** from transmitting a replay signal through the antenna **10**.

The operation of the embodiment of the invention illustrated in FIG. 1 is by now apparent. If, as is usual, the bottom antenna **12** intercepts the stronger interrogation signal, the comparator **42** does not participate and allows both the usual energization of encoder **36** (by decoder **34**, gate **50** and pulse generator **54**) to transmit a reply signal via bottom antenna **12** and the usual suppression of the top transponder **14** (by pulse generator **54**). In the unusual event when the top antenna **10** intercepts the stronger signal, the comparator **42** acts to open gate **44** to allow decoder **22** both to energize encoder **24** (by means of pulse generator **46**) to transmit a reply signal via top antenna **10** and to suppress the bottom transponder **16**.

The signal from bottom decoder **34** is connected through delay **52**, which typically can be of 0.5 microsecond, to ensure that inhibit action of pulse generator **46**, when the top antenna **10** intercepts the stronger signal, precedes the trigger from decoder **34** occurring at gate **50**. The width of the output pulse from pulse generator **46**, which typically can be 1.5 microsecond, is sufficient to inhibit the trigger from delay **52** at gate **50**. In this manner a reply signal is transmitted via only one antenna, whose selection is primarily on the basis of which antenna most strongly receives the interrogation signal.

It will be recognized that the embodiment of the invention illustrated in FIG. 1 is advantageous in that it utilizes conventional transponders which do not require modification. However, the use of two transponder units necessarily entails large space and weight requirements which may be a major disadvantage in certain installations. A further and not quite so obvious advantage implicit in the embodiment of FIG. 1 is that the circuits which are part of the present invention, in order not to interfere with normal operation of the transponder, must function rapidly in response to each individual interrogation signal.

The performance of the embodiment of FIG. 1 also may not be completely satisfactory due to possible limited dynamic range of receivers **18** and **30** and video circuits **20** and **32**, which may cause possible loss of close-in replies. Certain close-in maneuvers may result in the transponder reply being transmitted from a shadowed antenna. The shadowing may be sufficiently great, coupled with the gain time control of the interrogation station receiver (to avoid side lobe response problems), that the signal will be of too low strength to be detected by the receiver which is set at very low gain at short ranges. Further, and of even more serious consequence, the embodiment of FIG. 1 is not entirely satisfactory inasmuch as time jitter may occur during reply path transition, caused by additional time delay **52** in the bottom transponder trigger circuit, with the likelihood that a "defruiter" circuit in the interrogation station receiver will throw out the reply signal or that the automatic detection system will report two targets.

Although the embodiment of FIG. 1 is considered to be a substantial improvement over prior art transponder antenna systems, because of the above described limitations to the performance of the embodiment of FIG. 1, it is often desirable to use embodiments of the invention which are more sophisticated and which avoid the described shortcomings of the embodiment of FIG. 1.

Referring now to FIG. 2, there is shown a second embodiment of the invention wherein the reply signal is transmitted by the bottom antenna **12** unless the interrogation signal intercepted by antenna **12** is so weak as to fail to trigger the reply circuitry. The embodiment of FIG. 2 is similar to that of FIG. 1 in that complete and conventional transponders **14** and **16** are connected to top and bottom antennas **10** and **12**. As previously described the top transponder **14** includes receiver **18**, video circuits **20**, decoder **22**, encoder **24**, modulator **26** and transmitter **28** and the bottom transponder **16** includes receiver **30**, video circuits **32**, decoder **34**, encoder **36**, modulator **38** and transmitter **40**, all connected to operate as in the embodiment of FIG. 1.

The bottom decoder **34** is connected to pulse generator **54** which is in turn connected through delay **56** to both energize encoder **36** to initiate a reply signal through modulator **38**, transmitter **40** and bottom antenna **12** and to suppress decoder **22** of the top transponder **14**.

The decoder **22** of the top transponder **14** is connected through delay **58** to gate **60**. Gate **60** is connected to be inhibited by the signal from pulse generator **54** and in the absence of such a signal will pass the delayed signal from decoder **22** to pulse generator **46** which is in turn connected to both energize encoder **24** to initiate a reply signal through modulator **26**, transmitter **28** and top antenna **10** and to suppress decoder **34** of the bottom transponder **16**. The delay **56**, which typically is of 0.30 microsecond, is for the purpose of balancing the effect of delay **58** so as to reduce transponder jitter during periods when replies are shifting from the top transponder **14** to the bottom transponder **16** and vice versa.

The operation of the embodiment of FIG. 2 is such that the reply signal will be transmitted by bottom antenna **12** if that antenna intercepts the interrogation signal with sufficient strength to energize pulse generator **54** and without regard to the strength of the interrogation signal intercepted by top antenna **10**. The top transponder system is disabled, whenever the bottom system is operative, by the signal from pulse generator **54** to the gate **60**. In other respects the embodiment of FIG. 2 is similar to that of FIG. 1.

The embodiment of FIG. 2 is considered to be operationally superior to that of FIG. 1 with respect to jitter. However, as with FIG. 1, the embodiment of FIG. 2 has the weight and space disadvantages inherent in the use of the two complete transponder units **14** and **16**. Also, as with FIG. 1, the embodiment of FIG. 2 is still subject to possible loss of close-in replies, since transition to the bottom antenna **12** in this latter system does not depend on signal strength at the top antenna. Certain close-in maneuvers may result in the transponder reply being transmitted by the bottom antenna while it is shadowed, with consequent signal strength insufficient to be detected by the interrogation station receiver, which is set at very low gain at short ranges.

The embodiment of FIG. 3 overcomes (to some extent) the weight and space disadvantages of the previously described embodiments by using the same decoder and encoder units for both the top and bottom antenna systems together with a comparator controlled gating system which directs the reply signal to the antenna receiving the stronger interrogation signal.

Referring now to FIG. 3, the antennas **10** and **12**, the receivers **18** and **30**, the video circuits **20** and **32**, the transmitters **28** and **40** and the modulators **26** and **38**, as well as the comparator **42**, gate **44** and pulse generator **46** are connected and function similarly to the operation and cooperation of these components in the previously described embodiment illustrated in FIG. 1.

The output of video circuits **20** and **32**, in addition to being connected to comparator **42**, are also connected to an OR gate **62** which is in turn connected to decoder **64**. The decoder **64** is connected to both energize encoder **66** and to gate **44** which is enabled by the signal from

comparator **42** whenever the interrogation signal intercepted by top antenna **10** is stronger than the interrogation signal intercepted by the bottom antenna **12**. The signal from pulse generator **46** (which occurs only when the interrogation signal intercepted by the top antenna **10** is the stronger) is connected to both gated amplifier **68** and (through inverter **48**) to gated amplifier **70**. The gated amplifier **68** is normally biased "off," that is, not to pass a signal, and is turned "on," i.e., to pass the encoder signal to modulator **26**, by the signal from pulse generator **46**. The gated ampilfier **70** is normally biased "on," that is, to pass a signal from encoder **66** to modulator **28**, and is turned "off," i.e., to not pass a signal, by the inverted signal from pulse generator **46**.

It will be apparent that the operation of the embodiment of FIG. 3 is such that for the usual circumstance, that is, when the bottom antenna **12** intercepts the interrogation signal most strongly, the reply signal produced by encoder **66** will be passed through amplifier **70**, modulator **38** and transmitter **40** to be radiated by bottom antenna **12** and that the encoder signal will not reach the top modulator **26** because this signal will not be passed by the "off" biased amplifier **68**. In the event the top antenna **10** more strongly intercepts the interrogation signal, the comparator **42** will energize the pulse generator **46** to bias the amplifiers **68** and **70** so that the signal from the encoder **66** will not reach the bottom modulator **38** but will reach top modulator **26** and be transmitted by top antenna **10**.

It is, of course, fairly obvious that the embodiment of FIG. 3 possesses significant advantages in space and weight requirements (when compared to the embodiments of FIGS. 1 and 2) because the embodiment of FIG. 3 requires only one decoder and one encoder. A further and not quite so obvious advantage possessed by the embodiment of FIG. 3 is that the reply signal is less garbled by jitter than in the previously described embodiments which use both top and bottom decoders and encoders. To accomplish this, the same decoder and encoder function to produce the reply signal without regard to which antenna intercepts the stronger interrogation signal.

A further reduction in the required components is provided by the embodiment illustrated in FIG. 4 wherein single modulator and transmitter units (as well as decoder and encoder units) are used to selectively radiate signals from the top and bottom antennas. To accomplish this, the embodiment of FIG. 4 utilizes switching in the RF leads to the antennas rather than video switching as in the previously described embodiments.

Referring now to FIG. 4, the bottom antenna **12** is connected to receiver **30** and transmitter **40** through a switch **72**, preferably a SPDT diode type, that is normally closed to the bottom antenna. Top antenna **10** is also coupled to the normally open connection of switch **72** through "T" coupler **74** and tuned-line **76**. The other arm of coupler **74** is connected to receiver **18** by tuned-line **78**. The lines **76** and **78** are tuned, as is conventional practice, so that the one not in use during either transmission or reception will reflect an open circuit at the coupler **74**.

Receiver **18** is connected to comparator **42** and OR gate **62** through the video circuits **20**. Bottom receiver **30** is similarly connected through the video circuits **32**. As described previously in connection with the embodiment of FIG. 3, the OR gate **62**, decoder **64** and encoder **66** function to produce a reply signal without regard to which antenna intercepts the stronger interrogation signal whereas the comparator **42**, gate **44** (which is connected to the output of decoder **64**) and pulse generator **46** function to produce a signal only if the interrogation signal intercepted by top antenna **10** is stronger than the interrogation signal intercepted by bottom antenna **12**. The output of pulse generator **46** is connected to the driving circuitry **80** of switch **72** and functions to change the switch condition from the closed bottom antenna condition illustrated to the condition wherein the tuned line **76** is connected to the transmitter **40**. Transmitter **40** is in turn connected through modulator **38** to the output of encoder **66** which is also connected to the "Suppress" terminal of receiver **18** and to the "Suppress" terminal of receiver **30**.

The operation of the embodiment of the invention illustrated in FIG. 4 is by now apparent. If the bottom antenna **12** intercepts the stronger interrogation signal, the comparator **42** does not cause the pulse generator **46** to be triggered and the switch **72** remains in the normal (closed to bottom antenna) condition wherein the reply signal produced by encoder **66** is connected through modulator **38**, transmitter **40** and normally conditioned switch **72** to be radiated by bottom antenna **12**. When the top antenna **10** intercepts the stronger interrogation signal, the comparator **42** energizes the pulse generator **46** to produce a signal which causes the switch **72** to connect the top antenna **10** (through coupler **74**) to the transmitter **40**. When the switch **72** is so conditioned, the reply signal produced by encoder **66** is connected through modulator **38**, transmitter **40** and abnormally conditioned switch **72** to be radiated by top antenna **10**. A small but sufficient time delay exists in encoder **66** so that switch **72** connects the top antenna **10** to the transmitter **40** prior to commencement of the reply signal.

The embodiment of FIG. 4 is obviously advantageous compared to previously described embodiments of the invention in that only one transmitter unit and only one modulator unit is required. Further, this embodiment performs relatively well as to jitter and to loss of close-in replies. However, the tuned lines **76** and **78** can give rise to operational problems by becoming detuned in service. The embodiment of FIG. 5 overcomes this shortcoming by using two RF switches in order to eliminate the need for the tuned RF lines.

The embodiment illustrated in FIG. 5 is identical to that of FIG. 4 except that top antenna **10** is connected (in the normal condition) by switch **82** to receiver **18**. Switch **82** is similar to the previously described switch **72**, and like that switch is connected to be controlled by the driver **80**. The normally open terminals of switches **72** and **82** are connected together as shown.

In operation the embodiment of FIG. 5 is also similar to the embodiment of FIG. 4. When the bottom antenna **12** intercepts the stronger interrogation signal, the comparator **42** does not cause the pulse generator **46** to be triggered and the switches **72** and **82** remain in the conditions illustrated and the reply signal produced by encoder **66** is connected through modulator **38**, transmitter **40** and normally conditioned switch **72** to be radiated by bottom antenna **12**. When the top antenna **10** intercepts the stronger interrogation signal, the comparator **42** energizes the pulse generator **46** to produce a signal which causes the switches **72** and **82** to connect the top antenna **10** to the transmitter **40**. The reply signal produced by encoder **66** is connected through modulator **38**, transmitter **40**, abnormally conditioned switches **72** and **82** to be radiated by top antenna **10**. It will be recognized, of course, that a working design of the embodiment of FIG. 5 must include a provision, such as a short duration lock-in feature in the driver circuit **80**, whereby the switches, once thrown to their abnormal conditions, will remain in their abnormal conditions until the encoder reply signal has been transmitted. Without this feature, the disconnection of the top antenna from receiver **18** will cause the switches **72** and **82** to be returned to their normal conditions.

Whereas the embodiments of FIGS. 1, 2, 3, 4 and 5 deal with transponder system equipped only for operation on a single interrogation mode, the basic techniques described herein can obviously be employed with transponder systems equipped for reply in response to more than one interrogation mode.

The embodiment illustrated in FIG. 6 is identical with that of FIG. 5 except that OR gate **90** is employed to

accept triggers from any one of various output leads from decoder **92** corresponding to the interrogation mode being received at any moment. However, the embodiment of FIG. 6 is similar to that of FIG. 5 in that the combined outputs of decoder **92** appearing at the output of OR gate **90** are allowed to trigger pulse generator **46** through gate **44**, when properly energized by comparator **42**. Decoder **92**, of course, also energizes encoder **94**. In all other respects, the embodiment of FIG. 6 is similar to that of FIGURE 5.

Readers desiring a more comprehensive disclosure of certain aspects of the invention, such as details of circuitry, component values, tube identification, potential levels, etc. should consult NRL Report No. 6401 of the Naval Research Laboratory, Washington, D.C. dated Oct. 18, 1966 and titled "The Hartlobe Airborne Dual Antenna System for IFF."

It is by now apparent that there has been disclosed a plurality of embodiments of the invention which provides an improved transponder system that includes dual antennas that are individually and selectively connected to the transponder transmitter in a manner related to the strength of the interrogation signal intercepted by each antenna. 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 and desired to be secured by Letters Patent of the United States is:

1. A transponder system comprising:

dual antenna means including first and second antennas for intercepting coded interrogation signals;

transponder means connected to said dual antenna means for receiving said intercepted coded interrogation signals and for producing a coded reply signal and

switching means connected to said transponder means for causing said coded reply signal to be radiated from the one of said first and second antennas which is selected on the basis of the strengths of the coded interrogation signals intercepted by said first and second antennas.

2. A transponder system as set forth in claim **1** wherein said coded reply signal is normally radiated by said first antenna and said switching means includes comparator means for comparing the strengths of the coded interrogatory signals intercepted by said first and second antennas and causes said second antenna to radiate said coded reply signal only when said second antenna intercepts the coded interrogatory signal more strongly than said first antenna.

3. A transponder system as set forth in claim **2** wherein said first and second antennas are each connected to series circuits which each include a receiver, video circuits, a decoder, a gate, a pulse generator, an encoder, a modulator and a transmitter and said comparator means produces a signal which enables the gate in the series circuit connected to said second antenna and inhibits the gate in the series circuit connected to said first antenna, said signal being produced by said comparator means when said second antenna intercepts the coded interrogatory signal more strongly than said first antenna.

4. A transponder system as set forth in claim **2** wherein said transponder means includes a decoder and an encoder and said first antenna is connected to a series circuit which includes a first receiver, first video circuits, said decoder, said encoder, a first gated amplifier, a first modulator and a first transmitter and said second antenna is connected to a series circuit which includes a second receiver, second video circuits, said decoder, said encoder, a second gated amplifier, a second modulator and a second transmitter and said comparator means produces a signal which reverses the bias of said first and second gated amplifiers and thereby enables said second gated amplifier and inhibits said first gated amplifier, said signal being produced by said comparator means when said second antenna intercepts the coded interrogatory signal more strongly than said first antenna.

5. A transponder system as set forth in claim **2** wherein said transponder means are connected to said dual antenna means by a SPDT diode switch.

6. A transponder system as set forth in claim **5** wherein said transponder means includes a transmitter which is normally connected to said first antenna by said SPDT diode switch and said comparator means produces a signal which causes said SPDT diode switch to connect said transmitter to said second antenna, said signal being produced by said comparator means when said second antenna intercepts the coded interrogatory signal more strongly than said first antenna.

7. A transponder system as set forth in claim **2** wherein said transponder means are connected to said dual antenna means by first and second SPDT diode switches.

8. A transponder system as set forth in claim **7** wherein said transponder means includes a transmitter which is normally connected to said first antenna by said first SPDT diode switch and said comparator means produces a signal which causes said transmitter to be connected to said second antenna by a series connection including both said first and said second SPDT diode switches, said signal being produced by said comparator means when said second antenna intercepts the coded interrogatory signal more strongly than said first antenna.

9. A transponder system as set forth in claim **8** wherein said transponder means will selectively function in a plurality of modes according to the mode of said coded interrogatory signal.

10. A transponder system as set forth in claim **1** wherein said first antenna is connected to a series circuit which includes a first receiver, first video circuits, a first decoder, a first pulse generator, a first encoder, a first modulator and a first transmitter and said second antenna is connected to a series circuit which includes a second receiver, second video circuits, a second decoder, a gate, a second pulse generator, a second encoder, a second modulator and a second transmitter and said first oscillator output is connected to said gate whereby said gate is inhibited whenever said first oscillator produces an output signal.

References Cited

UNITED STATES PATENTS

3,035,169	5/1962	Griffith	325—304 X
3,095,538	6/1963	Silberstein.	

RODNEY D. BENNETT, *Primary Examiner.*

M. F. HUBLER, *Assistant Examiner.*