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(54) **MULTIPURPOSE MICROSTRIP ANTENNA FOR USE ON MISSILE**

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Related U.S. Application Data

(63) Continuation-in-part of application No. 10/107,343, filed on Mar. 28, 2002, now Pat. No. 6,549,168, which is a continuation-in-part of application No. 10/039,939, filed on Oct. 19, 2001, now Pat. No. 6,466,172.

(51) **Int. Cl.**[7] **H01Q 1/36**

(52) **U.S. Cl.** .... **343/705**; 343/700 MS; 343/846

(58) **Field of Search** .... 343/700 MS, 705, 343/725, 853, 846, 829, 815

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,466,172 B1 * 10/2002 Ryken et al. .... 343/700 MS
6,549,168 B1 * 4/2003 Ryken et al. .... 343/700 MS

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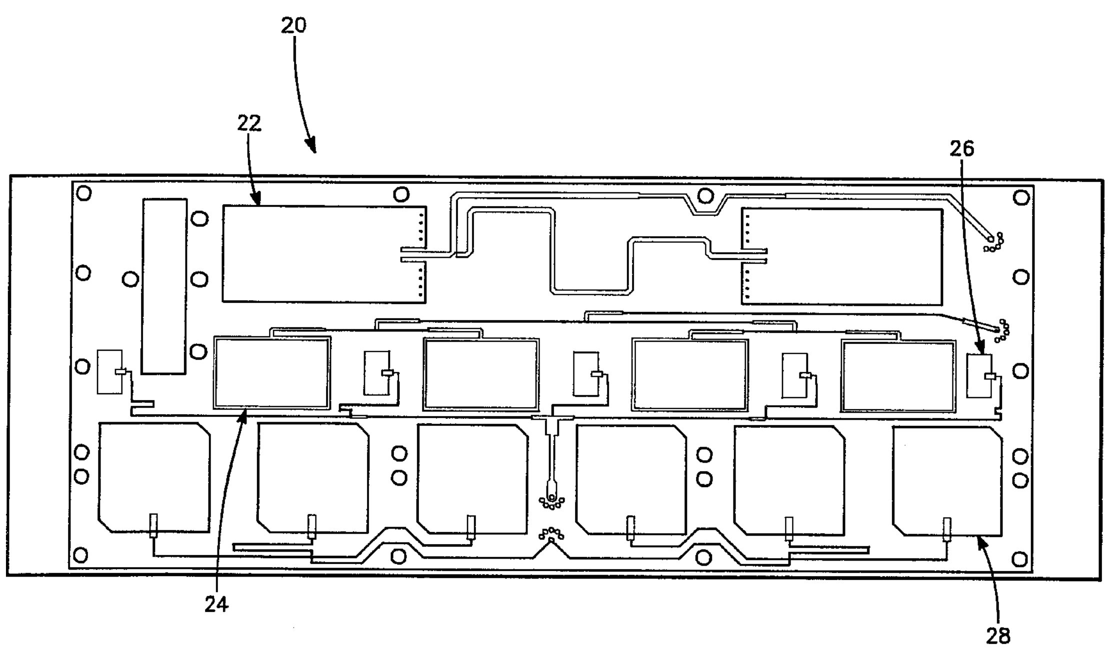
(57) **ABSTRACT**

A microstrip antenna system having a GPS antenna for receiving GPS data, a telemetry antenna for transmitting telemetry data, a Flight Termination System antenna which receives an RF signal having a set of decoder tones and a beacon tracking antenna for providing an RF signal to allow tracking of the device utilizing the microstrip antenna system. The microstrip antenna system is designed for use on a missile.

20 Claims, 4 Drawing Sheets



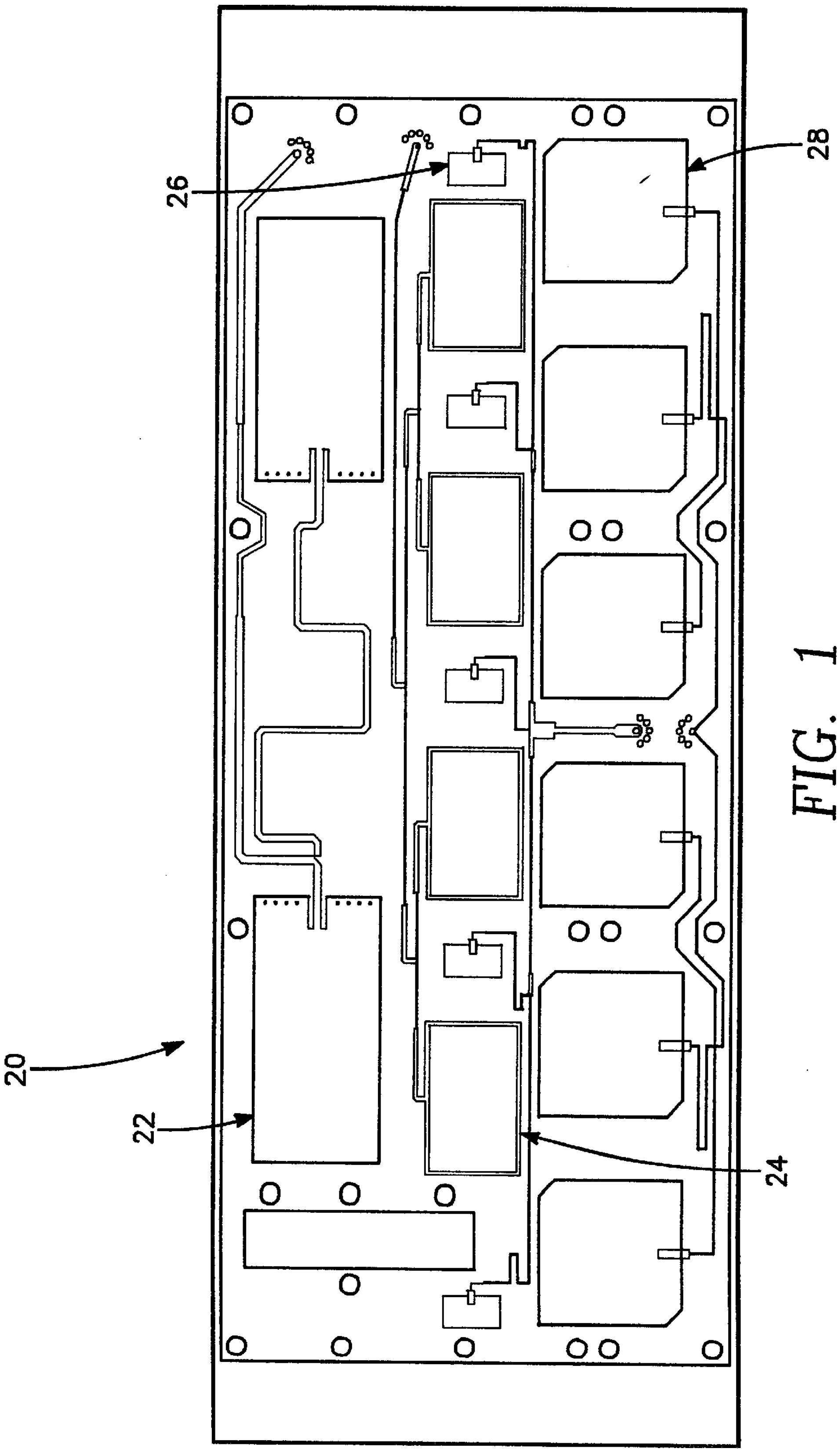


FIG. 1

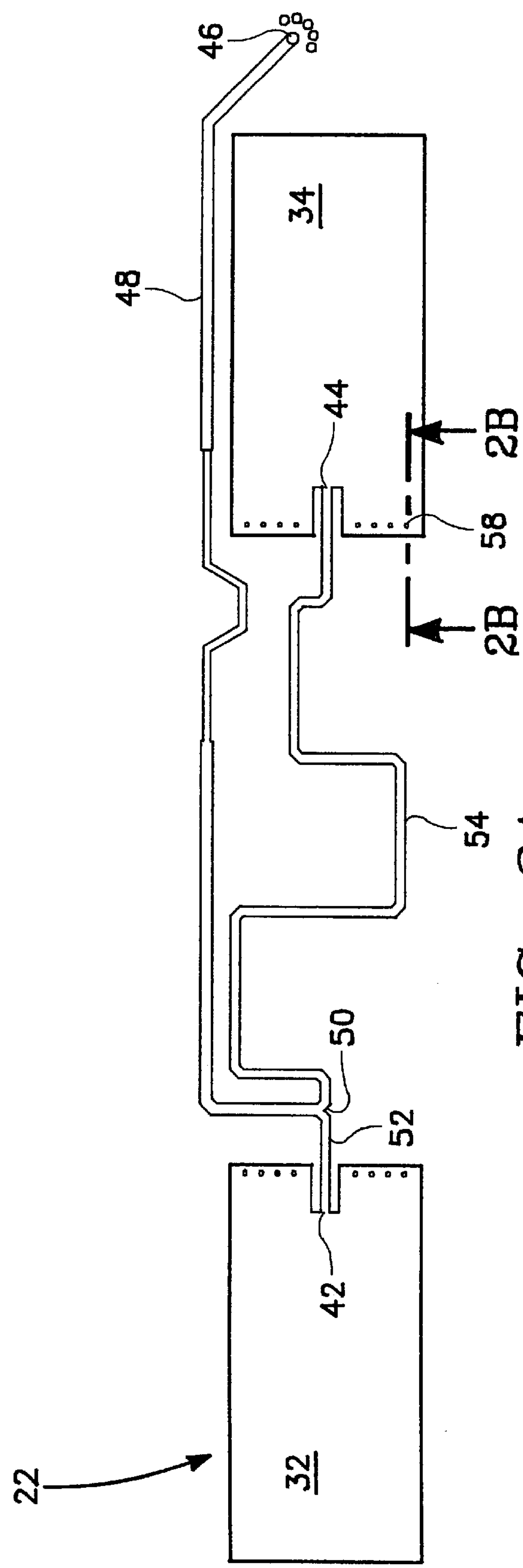


FIG. 2A

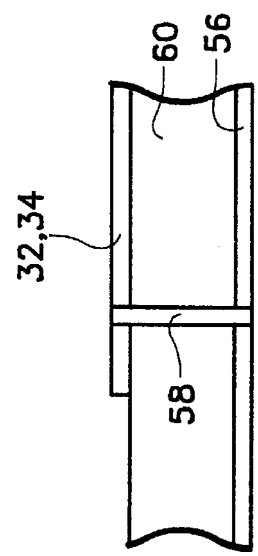


FIG. 2B

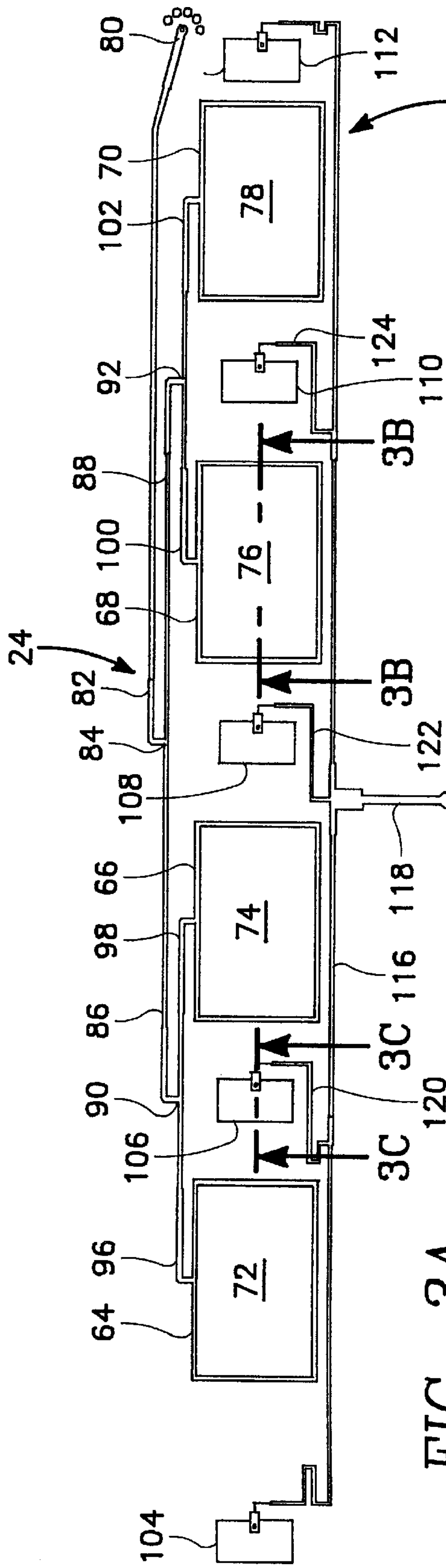


FIG. 3A

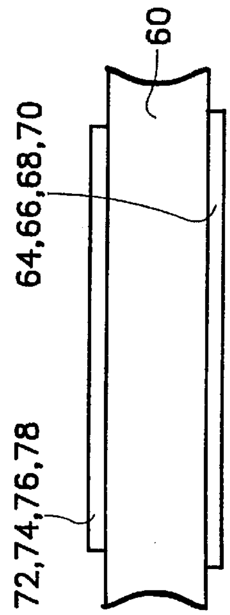


FIG. 3B

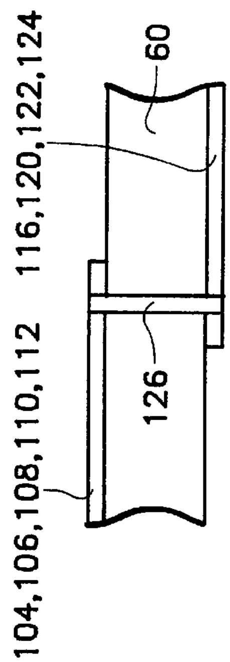


FIG. 3C

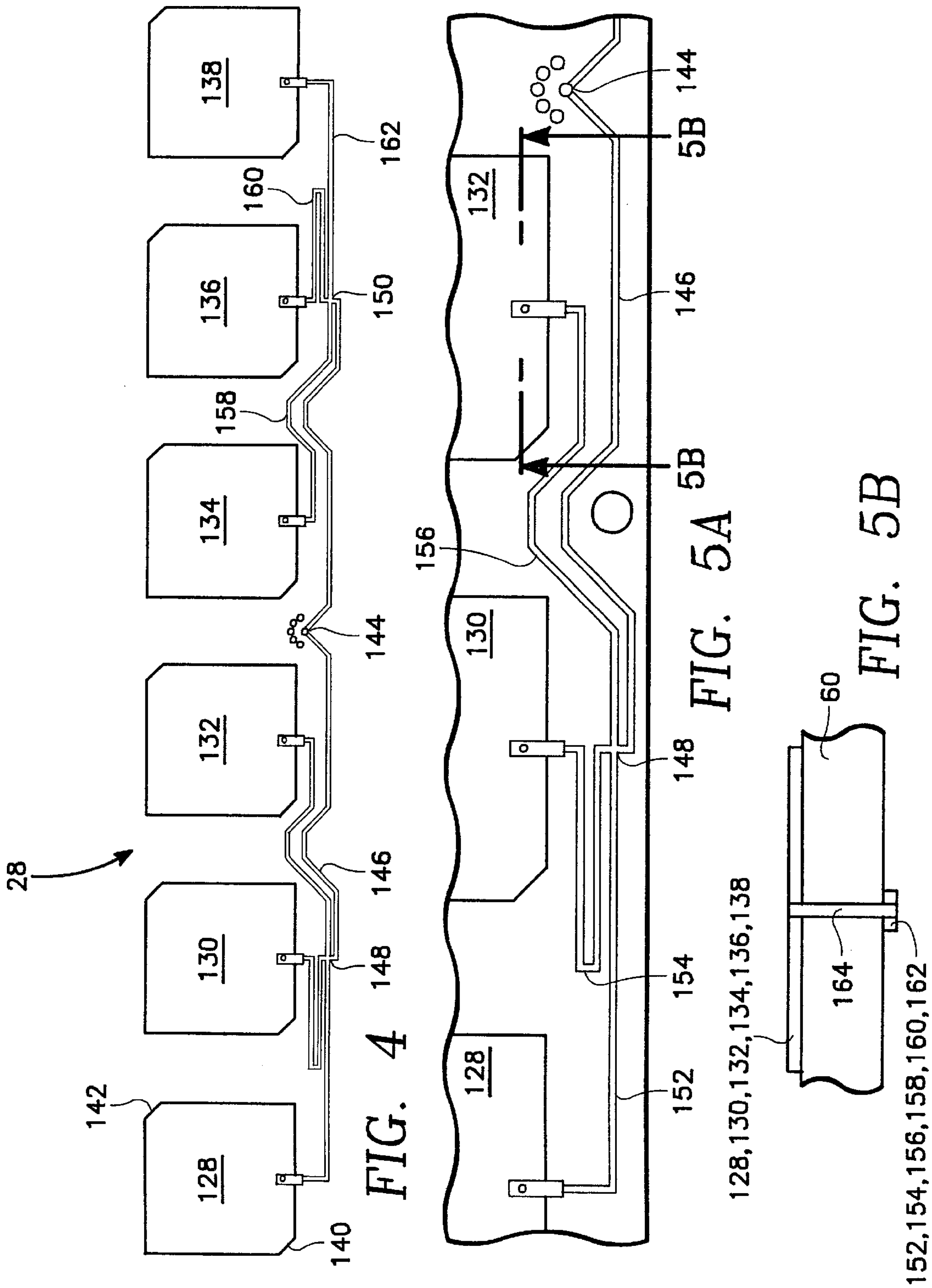


FIG. 4

FIG. 5A

FIG. 5B

MULTIPURPOSE MICROSTRIP ANTENNA FOR USE ON MISSILE

This application is a continuation-in-part of U.S. patent application Ser. No. 10/107,343, filed Mar. 28, 2002 now U.S. Pat. No. 6,549,168, which is a continuation-in-part of U.S. patent application, Ser. No. 10/039,939, filed Oct. 19, 2001 now U.S. Pat No. 6,466,172.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to an antenna for use on a missile or the like. More specifically, the present invention relates to a microstrip antenna, designed for use with missiles, which includes a GPS antenna for receiving GPS data, an FTS (Flight Termination System) antenna, a telemetry antenna for transmitting telemetry data, a beacon tracking antenna.

2. Description of the Prior Art

In the past military aircraft and weapons systems such as airplanes, target drones, pods and missiles have included flight termination and beacon tracking antenna to monitor performance during test flights. For example, a missile under test will always have an antenna which is generally surface mounted to transmit telemetry data to a ground station. The ground station then performs an analysis of the telemetry data from the missile to determine its performance during flight while tracking a target.

U.S. Pat. No. 4,356,492 is an example of a prior art microstrip antenna which is adapted for use on a missile as a wrap around band to a missile body without interfering with the aerodynamic design of the missile. U.S. Pat. No. 4,356,492 teaches a plurality of separate radiating elements which operate at widely separated frequencies from a single common input point. The common input point is fed at all the desired frequencies from a single transmission feed line.

With the emerging use of the Global Positioning System (GPS) for tracking purposes, there is a need to include GPS within the instrumentation package for a missile and target drone to accurately measure flight performance. GPS data is extremely accurate and thus allows for a thorough analysis of the missile's performance as well as the target drone's performance in flight while the missile tracks the target drone on a course to intercept the target drone.

The use of satellite provided GPS data to monitor the position of a missile and a drone target in flight will require that an antenna for receiving the GPS data be included in the instrumentation package. The receiving antenna should preferably be mounted on the same dielectric substrate as the transmitting antenna so that the antenna assembly can be applied readily as a wrap around band to the missile body without interfering with the aerodynamic design of the missile. Similarly, the antenna assembly which would include a GPS data receiving antenna and telemetry data transmitting antenna configured as a wrap around band to the projectile's body without interfering with the aerodynamic design of the projectile.

There is also a need for a flight termination system antenna to be included in the missile antenna package in the event that a failure occurs during a missile test flight. A monitoring station can initiate a flight termination action which destroys the missile.

Further, there is a need for a beacon tracking antenna to be included in the missile antenna package which allows a monitoring station to track the flight path of the missile during a test flight.

SUMMARY OF THE INVENTION

The present invention overcomes some of the disadvantages of the past including those mentioned above in that it comprises a relatively simple in design yet highly effective and efficient microstrip antenna assembly which can receive satellite provided GPS position and also transmit telemetry data. The microstrip antenna of the present invention also includes a flight termination system (FTS) antenna and a beacon tracking antenna.

The microstrip antenna comprising the present invention is configured to wrap around the projectile's body without interfering with the aerodynamic design of the projectile.

The antenna assembly of the present invention includes a telemetry antenna mounted on a dielectric substrate. The telemetry antenna transmits telemetry data to ground station or other receiving station. There is a GPS antenna mounted on the dielectric substrate which is physically separated from the telemetry antenna on the dielectric substrate. The GPS antenna is adapted to receive satellite provided GPS position data.

An FTS (Flight Termination System) antenna is also mounted on the dielectric substrate and is physically separated from the GPS and telemetry antennas. The FTS antenna receives a set of decoder tones from an external source and supplies the tones to a flight termination system on board the missile which processes the tones and detonates destruct charges on board the missile destroying the missile. Further, the multipurpose microstrip antenna has a beacon tracking antenna mounted on the dielectric substrate which transmits RF signals allowing a radar at a remote location to track the missile during its flight.

The antenna assembly is a wrap around antenna assembly which fits on the outer surface of a missile, target drone or any other small diameter projectile.

The feed structure for the GPS antenna is mounted on the bottom side of the dielectric substrate and a first plurality of plated through connecting pins electrically connect the antenna receiving elements of the GPS antenna, which are mounted the top side of the dielectric substrate, to the feed structure for the GPS antenna. Similarly, the feed structure for the FTS antenna is mounted on the bottom side of the dielectric substrate and second plurality of plated through connecting pins electrically connect the antenna transmitting elements of the FTS antenna, which are mounted the top side of the dielectric substrate, to the feed structure for the FTS antenna.

The Telemetry antenna includes a plurality of parasitic elements mounted on the top side of the dielectric substrate and a plurality of driven antenna elements and their associated feed structure mounted on the bottom side of the dielectric substrate.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a plan view of a preferred embodiment of the multipurpose microstrip antenna comprising the present invention which includes a GPS, an FTS (Flight Termination System), a beacon tracking and a telemetry microstrip antenna mounted on a dielectric substrate;

FIGS. **2**A and **2**B depict, in detail, the FTS antenna for microstrip antenna of FIG. **1**;

FIGS. **3**A, **3**B and **3**C depict, in detail, the telemetry and the beacon tracking antennas for the microstrip antenna of FIG. **1**; and

FIGS. **4**, **5**A and **5**B depict, in detail, the GPS antenna for the microstrip antenna of FIG. **1**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring first to FIG. **1**, there is shown a microstrip antenna assembly **20** comprising a flight termination system (FTS) antenna **22**, a telemetry antenna **24**, a beacon tracking antenna **26** and a GPS (Global Positioning System) antenna **28**, for use on small diameter projectiles such as missiles. The antenna **20** has an overall length of 21.475 inches and is designed for a missile having a diameter of the projectile for which antenna assembly **20** is designed is approximately 6.84 inches.

Referring to FIGS. **1**, **2**A and **2**B, there is shown the flight termination system antenna **22** for the microstrip antenna **20** of the present invention. The flight termination system antenna **22** has two separate antenna receiving elements **32** and **34** and operates at a center frequency of 425 megahertz. Each of the receiving elements **32** and **34** are quarter-wave length microstrip antenna elements. The radiating elements **32** and **34** each have a shape which is rectangular and are notch fed respectively via element feed points **42** and **44**. The flight termination system antenna **22** includes a single FTS (Flight Termination System) feed point **46**, a main microstrip feed line **48** which connects feed point **46** to an electrical junction **50**. Extending from junction **50** are branch microstrip feed lines **52** and **54** with branch feed line **52** connecting junction **50** to element feed point **42** and branch feed line **54** connecting junction **50** to element feed point **44**.

There is a 180 degree phase shift of the feed line from feed point **46** to receiving element **32** relative to the feed line from feed point **46** to receiving element **34**. This insures that the electric field generated by the RF (radio frequency) signal received by elements **32** and **34** of FTS antenna **22** is continuous around the circumference of the missile. The feed point **46** is a 50 ohm impedance and the transmission lines to elements **32** and **34** are sized to match the 50 ohm impedance. The receiving elements **32** and **34** and feed lines **48**, **52** and **54** are fabricated from etched copper.

The flight termination antenna **22** receives an RF signal having a set of decoder tones from an external source and supplies the tones to a flight termination system on board the missile which processes the tones and detonates destruct charges on board the missile destroying the missile.

As is best shown in FIG. **2**B, one side of each receiving element **32** is electrically connected to the antenna's ground plane **56** by a plurality of copper vias or plated through connecting pins **58**. This connection is required because the elements **32** and **34** are quarter-wave length microstrip antenna elements. There is also shown in FIG. **2**B a dielectric substrate **60** which has receiving elements **32** and **34** mounted on its upper surface or top side. Dielectric surface is its lower surface or bottom side mounted on ground plane **56**.

Referring to FIGS. **1**, **3**A, **3**B and **3**C, there is shown a detailed electrical schematic of the telemetry antenna **24** and beacon tracking antenna **26**.

Telemetry antenna **26** has an array of four driven elements **64**, **66**, **68** and **70** and an array of four parasitic elements **72**, **74**, **76** and **78**. The array of four parasitic elements **72**, **74**, **76** and **78** are mounted on the top side of dielectric substrate **60**, while the array of four driven elements **64**, **66**, **68** and **70** are mounted on the bottom side of dielectric substrate **60** as is best illustrated in FIG. **3**B. Each parasitic element **72**, **74**, **76** and **78** and each driven element **64**, **66**, **68** and **70** are rectangular in shape with the parasitic elements being slightly smaller than the driven elements of telemetry antenna **24**. The combination of the driven elements **64**, **66**, **68** and **70** and the parasitic elements **72**, **74**, **76** and **78** of telemetry antenna **24** provides for a broaden bandwidth for telemetry antenna **24** allowing telemetry antenna **24** to operate in the S-Band Frequency range of 2.2–2.3 GHz.

Telemetry antenna **24** also includes a microstrip transmission line structure or feed structure. The feed structure for antenna **24** has a 50 ohm feed point **80**. A main feed line **82** electrically connects feed point **80** to an electrical junction **84**. Extending from junction **84** is a first pair of branch microstrip feed lines **86** and **88** with branch feed line **52** connecting junction **84** to an electrical junction **90** and branch feed line **88** connecting junction **84** to an electrical junction **92**.

Extending from junction **90** is a second pair of branch microstrip feed lines **96** and **98** with branch feed line **96** connecting junction **90** to driven element **64** and branch feed line **98** connecting junction **90** to driven element **66**. Extending from junction **92** is a third pair of branch microstrip feed lines **100** and **102** with branch feed line **100** connecting junction **92** to driven element **68** and branch feed line **102** connecting junction **92** to driven element **70**. Each of the feed lines **82**, **86**, **88**, **96**, **98**, **100** and **102** as well as the parasitic elements **72**, **74**, **76** and **78** and the driven elements **64**, **66**, **68** and **70** are fabricated from etched copper.

It should be understood that the drawings are only a representation of the invention and that it is critical that each of the feed lines from the driven elements **64**, **66**, **68** and **70** to the feed point **80** be of exactly the same length to insure an omnidirectional radiation pattern is provided by antenna **24**. It should also be noted that the feed structure for telemetry antenna **24** is located on the bottom side of the dielectric substrate on the same plane as the driven elements **64**, **66**, **68** and **70**.

The beacon tracking antenna **26** includes an array of antenna transmitting elements **104**, **106**, **108**, **108** and **112** which operate within the C-band frequency range of 5.4–5.9 GHz. The array of antenna transmitting elements **104**, **106**, **108**, **108** and **112** is mounted on the top side of dielectric substrate **60** (FIG. **3**C), while the feed structure for beacon tracking antenna **26** is mounted on the on the bottom side of dielectric substrate **60**. The beacon tracking antenna **26** which provides RF signals of equal magnitude and phase allows a radar at a remote site to track the missile's flight path.

The feed structure for antenna **26** includes a 50 ohm feed point **114**, a main microstrip feed line **116** and a branch microstrip feed line **118** which electrically connects feed point **114** to feed line **116**. One end of feed line **116** connects to antenna element **104**, while the other end of feed line **116** connects to antenna element **112**. Extending from main feed line **118** is a branch feed line **120** which connects feed line **116** to antenna element **106**, a branch feed line **122** which connects feed line **116** to antenna element **108** and a branch feed line **124** which connects feed line **116** to antenna element **110**. As is best illustrated in FIG. **3**C, each of the antenna transmitting elements **104**, **106**, **108**, **110** and **112** is electrically connected to its associated feed line **116**, **120**, **122** or **124** by a copper via **126**.

The feed structure for beacon tracking antenna **26** is configured as a three way power divider with two units of power being supplied to antenna elements **104** and **106**, one unit of power being supplied to antenna element **108** and two units of power being supplied to antenna.

It should be noted that the feed structure for antenna **26** is mounted on the bottom side of the dielectric substrate to allow for substantially narrower feed lines than would be obtainable with a feed structure positioned on the same plane as the antenna elements **104**, **106**, **108**, **110** and **112** of antenna **26**. Close proximity of the feed structure of antenna **26** to the ground plane for microstrip antenna assembly **20** allows for the narrow feed lines **116**, **120**, **122** and **124**. The narrow feed lines for the feed structure of antenna are required to provide adequate space to mount the antenna elements of antennas **22**, **24**, **26** and **28** on the dielectric substrate **60** of microstrip antenna assembly **20**.

Referring to FIGS. **1**, **4**, **5**A and **5**B, there is shown detailed electrical schematics for the GPS antenna **28** of microstrip antenna assembly **20**. The GPS antenna **28**, which operates at a frequency of approximately 1575 MHz, includes an array of antenna receiving elements **128**, **130**, **132**, **134**, **136** and **138** which are adapted to receive GPS data from a remote source such as a satellite. Since antenna receiving elements **128**, **130**, **132**, **134**, **136** and **138** are required to be circularly polarized, opposed corners **140** and **142** of each element **128**, **130**, **132**, **134**, **136** and **138** are angled at approximately forty-five degrees. This results in truncated corner patches which allow for excitation of the elements **128**, **130**, **132**, **134**, **136** and **138** along their orthogonal axis.

The feed structure for GPS antenna **28** includes a 50 ohm feed point **144** and a main microstrip feed line **146** which connects feed point **144** to a pair of electrical junctions **148** and **150**. Extending from electrical junction **148** is a branch feed line **152** which connects feed line **146** to antenna element **128**, a branch feed line **154** which connects feed line **146** to antenna element **130** and a branch feed line **156** which connects feed line **146** to antenna element **132**. Extending from electrical junction **150** is a branch feed line **158** which connects feed line **146** to antenna element **134**, a branch feed line **160** which connects feed line **146** to antenna element **136** and a branch feed line **162** which connects feed line **146** to antenna element **138**.

As is best illustrated in FIG. **5**B, each of the antenna receiving elements **128**, **130**, **132**, **134**, **136** and **138** is electrically connected to its associated feed line **152**, **154**, **156**, **158**, **160** or **162** by a copper via or plated through connecting pins **164**.

It should be noted that the feed structure for antenna **28** is mounted on the bottom side of the dielectric substrate to allow for substantially narrower feed lines than would be obtainable with a feed structure positioned on the same plane as the antenna elements **128**, **130**, **132**, **134**, **136** and **138** of antenna **28**. Close proximity of the feed structure of antenna **28** to the ground plane for microstrip antenna assembly **20** allows for the narrow feed lines **146**, **152**, **154**, **156**, **158**, **160** and **162**. The narrow feed lines for the feed structure of antenna are required to provide adequate space to mount the antenna elements of antennas **128**, **130**, **132**, **134**, **136** and **138** on the dielectric substrate **60** of microstrip antenna assembly **20**.

It should be understood that the drawings are only a representation of the invention and that it is critical that each of the feed lines from the antenna elements **128**, **130**, **132**, **134**, **136** and **138** to the feed point **144** be of exactly the same length to insure an omnidirectional radiation pattern is provided by antenna **20**.

At this time it should be noted that a flight termination system (FTS) antenna **22**, a telemetry antenna **24**, a beacon tracking antenna **26** and a GPS (Global Positioning System) antenna **28** are separated physically from one another. Dielectric substrate **60** may be fabricated from a laminate material RT/Duroid 6002 commercially available from Rogers Corporation of Rogers Conn. This material allows sufficient strength and physical and electrical stability to satisfy environmental requirements and is also easily mounted on the surface of a missile or a target drone. The dielectric substrate **60** may be fabricated from two layers of 0.031 inch thick material, and a 0.010 inch thick antenna protective cover board. The use of the multi-layer fabrication to fabricate the substrate is to prevent wrinkling and cracking of the substrate when the dielectric **60** is mounted on the surface of a missile.

From the foregoing, it is readily apparent that the present invention comprises a new, unique, and exceedingly microstrip antenna for use on a missile, which constitutes a considerable improvement over the known prior art. Many modifications and variations of the present invention are possible in light of the above teachings. It is 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. A microstrip antenna system for use on a missile comprising:

a ground plane mounted on and wrapped around an outer circumference of said missile;

a dielectric substrate mounted on said ground plane;

a microstrip flight termination system antenna mounted on said dielectric substrate, said microstrip flight termination system antenna being electrically connected to said ground plane, said microstrip flight termination antenna receiving a first RF (radio frequency) signal;

a microstrip telemetry antenna spaced apart from and electrically separated from said ground plane by said dielectric substrate, said microstrip telemetry antenna being mounted on said dielectric plane, said microstrip telemetry antenna transmitting a second RF signal;

a microstrip GPS (Global Positioning System) antenna spaced apart from and electrically separated from said ground plane by said dielectric substrate, said microstrip telemetry antenna being mounted on said dielectric substrate, said microstrip antenna receiving a third RF signal; and

a beacon tracking antenna spaced apart from and electrically separated from said ground plane by said dielectric substrate, said beacon tracking antenna being mounted on said dielectric substrate, said beacon tracking antenna transmitting a fourth RF signal;

said microstrip flight termination system antenna, said microstrip telemetry antenna, said microstrip GPS antenna and said beacon tracking antenna being electrically separated from one another on said dielectric substrate.

2. The microstrip antenna system of claim **1** wherein said first RF signal has a center frequency of about 425 MHz, said first RF signal including a set of decoder tones.

3. The microstrip antenna system of claim **1** wherein said second RF signal is an S-Band radio frequency signal having a frequency range of 2.2 to 2.3 GHz.

4. The microstrip antenna system of claim **1** wherein said third RF signal has a frequency of about 1575 MHz.

5. The microstrip antenna system of claim **1** wherein said fourth RF signal is a C-band radio frequency signal having a frequency range of 5.4 to 5.9 GHz.

6. The microstrip antenna system of claim **1** wherein said microstrip flight termination system antenna comprises:

a single feed input point;

a first antenna receiving element positioned on one side of said missile, said first antenna receiving element having a rectangular shape and a notch feed point, said first antenna receiving element being mounted on said dielectric substrate;

a second antenna receiving element positioned on an opposite side of said missile, said second antenna receiving element having a rectangular shape and a notch feed point, said second antenna receiving element being mounted on said dielectric substrate;

a main feed line having one end connected to said single feed input point;

a first branch feed line having one end connected to the notch feed point of said first antenna receiving element and an opposite end connected to the opposite end of said main feed line;

a second branch feed line having one end connected to the notch feed point of said second antenna receiving element and an opposite end connected to the opposite end of said main feed line; and

said second feed line including a plurality of right angle bends which lengthen said second feed line allowing said second feed line to provide for a 180 degree phase shift of said first RF signal when received by said second antenna receiving element, the 180 degree phase shift of said first RF signal insuring that an electric field for said first RF signal is continuous around the outer circumference of said missile.

7. The microstrip antenna system of claim **6** further comprising a plurality of plated through connecting pins which pass through said dielectric substrate to electrically connect said first antenna receiving element and said second antenna receiving element to said ground plane, each of said plated through connecting pins having one end connected to said ground plane and the opposite end connected to said first antenna receiving element or said second antenna receiving element.

8. The microstrip antenna system of claim **1** wherein said microstrip telemetry antenna comprises:

an S-band feed point;

a first antenna array having a plurality of driven antenna elements mounted on a bottom surface of said dielectric substrate around the outer circumference of said missile, said driven antenna elements being electrically separated from said ground plane;

a second antenna array having a plurality of parasitic elements mounted on an upper surface of said dielectric substrate around the outer circumference of said missile, said plurality of parasitic elements being electrically separated from said ground plane, said first antenna array being spaced apart from said second antenna array by said dielectric substrate; and

a feed structure connecting each of said plurality of driven antenna elements to said S-band feed point.

9. The microstrip antenna system of claim **8** wherein the combination of said plurality of driven antenna elements and said plurality of parasitic elements allow said telemetry antenna to operate over an S-Band Frequency range of 2.2 to 2.3 GHz.

10. The microstrip antenna structure of claim **1** wherein said beacon tracking antenna comprises:

a C-band feed point;

an antenna array having a plurality of antenna transmitting elements, said antenna transmitting elements being mounted on an upper surface of said dielectric substrate around the outer circumference of said missile, said antenna transmitting elements being electrically separated from said ground plane;

a feed structure mounted on a bottom surface of said dielectric substrate, said feed structure being connected to said C-band feed point; and

a plurality of plated through connecting pins which pass through said dielectric substrate to electrically connect each of said plurality of antenna transmitting elements to said feed structure, each of said plated through connecting pins having one end connected to said feed structure and the opposite end connected to one of said plurality of antenna transmitting elements.

11. The microstrip antenna structure of claim **1** wherein said microstrip GPS antenna comprises:

a 50 ohm feed point;

a GPS antenna array having a plurality of antenna receiving elements, said antenna receiving elements being mounted on an upper surface of said dielectric substrate around the outer circumference of said missile, said antenna receiving antenna elements being electrically separated from said ground plane;

a feed structure mounted on a bottom surface of said dielectric substrate, said feed structure being connected to said 50 ohm feed point; and

a plurality of plated through connecting pins which pass through said dielectric substrate to electrically connect each of said plurality of antenna receiving elements to said feed structure, each of said plated through connecting pins having one end connected to said feed structure and the opposite end connected to one of said plurality of antenna receiving elements.

12. The microstrip antenna system of claim **1** wherein said microstrip flight termination system antenna, said microstrip telemetry antenna, said microstrip GPS antenna and said beacon tracking antenna are each fabricated from etched copper.

13. A microstrip antenna system for use on a missile comprising:

a ground plane mounted on and wrapped around an outer circumference of said missile;

a dielectric substrate mounted on said ground plane;

a microstrip flight termination system antenna mounted on said dielectric substrate, said microstrip flight termination system antenna being electrically connected to said ground plane, said microstrip flight termination antenna receiving a first RF (radio frequency) signal, said first RF signal having a center frequency of about 425 MHz;

a microstrip telemetry antenna spaced apart from and electrically separated from said ground plane by said dielectric substrate, said microstrip telemetry antenna being mounted on said dielectric substrate, said microstrip telemetry antenna transmitting a second RF signal, said second RF signal being an S-Band radio frequency signal having a frequency range of 2.2 to 2.3 GHz;

a microstrip GPS (Global Positioning System) antenna spaced apart from and electrically separated from said ground plane by said dielectric substrate, said microstrip telemetry antenna being mounted on said dielectric substrate, said microstrip antenna receiving a third RF signal, said third RF signal having a frequency of about 1575 MHz; and

a beacon tracking antenna spaced apart from and electrically separated from said ground plane by said dielectric substrate, said beacon tracking antenna being mounted on said ground plane, said beacon tracking antenna transmitting a fourth RF signal being an

S-band radio frequency signal having a frequency range of 5.4 to 5.9 GHz;

said microstrip flight termination system antenna, said microstrip telemetry antenna, said microstrip GPS antenna and said beacon tracking antenna being electrically separated from one another on said dielectric substrate.

14. The microstrip antenna system of claim **13** wherein said microstrip flight termination system antenna comprises:

a single feed input point;

a first antenna receiving element positioned on one side of said missile, said first antenna receiving element having a rectangular shape and a notch feed point;

a second antenna receiving element positioned on an opposite side of said missile, said second antenna receiving element having a rectangular shape and a notch feed point;

a main feed line having one end connected to said single feed input point;

a first branch feed line having one end connected to the notch feed point of said first antenna receiving element and an opposite end connected to the opposite end of said main feed line;

a second branch feed line having one end connected to the notch feed point of said second antenna receiving element and an opposite end connected to the opposite end of said main feed line; and

said second feed line including a plurality of right angle bends which lengthen said second feed line allowing said second feed line to provide for a 180 degree phase shift of said first RF signal when received by said second antenna receiving element, the 180 degree phase shift of said first RF signal insuring that an electric field for said first RF signal is continuous around the outer circumference of said missile.

15. The microstrip antenna system of claim **14** further comprising a plurality of plated through connecting pins which pass through said dielectric substrate to electrically connect said first antenna receiving element and said second antenna receiving element to said ground plane, each of said plated through connecting pins having one end connected to said ground plane and the opposite end connected to said first antenna receiving element or said second antenna receiving element.

16. The microstrip antenna system of claim **13** wherein said beacon tracking antenna comprises:

an S-band feed point;

a first antenna array having a plurality of driven antenna elements mounted on a bottom surface of said dielectric substrate around the outer circumference of said missile, said driven antenna elements being electrically separated from said ground plane;

a second antenna array having a plurality of parasitic elements mounted on an upper surface of said dielectric substrate around the outer circumference of said missile, said parasitic elements being electrically separated from said ground plane, said first antenna array being spaced apart from said second antenna array by said dielectric substrate; and

a feed structure connecting each of said plurality of driven antenna elements to said S-band feed point.

17. The microstrip antenna system of claim **13** wherein the combination of said plurality of driven antenna elements and said plurality of parasitic elements allow said telemetry antenna to operate over an S-Band Frequency range of 2.2 to 2.3 GHz.

18. The microstrip antenna structure of claim **13** wherein said microstrip GPS antenna comprises:

a C-band feed point;

an antenna array having a plurality of antenna transmitting elements, said antenna transmitting elements being mounted on an upper surface of said dielectric substrate around the outer circumference of said missile, said antenna transmitting elements being electrically separated from said ground plane;

a feed structure mounted on a bottom surface of said dielectric substrate, said feed structure being connected to said C-band feed point; and

a plurality of plated through connecting pins which pass through said dielectric substrate to electrically connect each of said plurality of antenna transmitting elements to said feed structure, each of said plated through connecting pins having one end connected to said feed structure and the opposite end connected to one of said plurality of antenna transmitting elements.

19. The microstrip antenna structure of claim **13** wherein said microstrip GPS antenna comprises:

a 50 ohm feed point;

a GPS antenna array having a plurality of antenna receiving elements, said antenna receiving elements being mounted on an upper surface of said dielectric substrate around the outer circumference of said missile, said plurality of antenna receiving elements being electrically separated from said ground plane;

a feed structure mounted on a bottom surface of said dielectric substrate, said feed structure being connected to said 50 ohm feed point; and

a plurality of plated through connecting pins which pass through said dielectric substrate to electrically connect each of said plurality of antenna receiving elements to said feed structure, each of said plated through connecting pins having one end connected to said feed structure and the opposite end connected to one of plurality of antenna receiving elements.

20. A microstrip antenna system for use on a missile comprising:

(a) a ground plane mounted on and wrapped around an outer circumference of said missile;

(b) a dielectric substrate mounted on said ground plane;

(c) a microstrip FTS (flight termination system) antenna mounted on said dielectric substrate, said microstrip flight termination system antenna being electrically connected to said ground plane, said microstrip flight termination antenna receiving a first RF (radio frequency) signal, said microstrip, said microstrip flight termination system antenna including:

(i) first and second FTS antenna receiving elements mounted on an upper surface of said dielectric substrate on opposite sides of said missile;

(ii) an FTS antenna feed structure mounted on the upper surface of said dielectric substrate, said FTS antenna feed structure being electrically connected to said first and second antenna receiving elements; and

(iii) a first plurality of plated through connecting pins which pass through said dielectric substrate to electrically connect said ground plane to said first and second FTS antenna receiving elements;

(d) a microstrip telemetry antenna spaced apart from and electrically separated from said ground plane by said dielectric substrate, said microstrip telemetry antenna being mounted on said dielectric substrate, said microstrip telemetry antenna transmitting a second RF signal, said microstrip telemetry antenna including:

(i) an S-band feed point;

(ii) a first antenna array having a plurality of driven antenna elements mounted on a bottom surface of said dielectric substrate around the outer circumference of said missile, said plurality of driven antenna elements being electrically separated from said ground plane;

(iii) a second antenna array having a plurality of parasitic elements mounted on an upper surface of said dielectric substrate around the outer circumference of said missile, said plurality of driven antenna elements being electrically separated from said ground plane, said first antenna array being spaced apart from said second antenna array by said dielectric substrate; and

(iv) a telemetry antenna feed structure connecting each of said plurality of driven antenna elements to said S-band feed point;

(e) a microstrip GPS (Global Positioning System) antenna spaced apart from and electrically separated from said ground plane by said dielectric substrate, said microstrip telemetry antenna being mounted on said dielectric substrate, said microstrip antenna receiving a third RF signal, said microstrip GPS antenna including:

(i) a GPS antenna feed point;

(ii) a GPS antenna array having a plurality of GPS antenna receiving elements, said GPS antenna receiving elements being mounted on an upper surface of said dielectric substrate around the outer circumference of said missile, said plurality of GPS antenna receiving antenna elements being electrically separated from said ground plane;

(iii) a GPS antenna feed structure mounted on a bottom surface of said dielectric substrate, said GPS antenna feed structure being connected to said GPS antenna feed point;

(iv) a second plurality of plated through connecting pins which pass through said dielectric substrate to electrically connect each of said plurality of GPS antenna receiving elements to said GPS antenna feed structure;

(f) a beacon tracking antenna spaced apart from and electrically separated from said ground plane by said dielectric substrate, said beacon tracking antenna being mounted on said dielectric substrate, said beacon tracking antenna transmitting a fourth RF signal, said beacon tracking antenna including:

(i) a C-band feed point;

(ii) a third antenna array having a plurality of beacon tracking antenna transmitting elements, said beacon tracking antenna transmitting elements being mounted on an upper surface of said dielectric substrate around the outer circumference of said missile, said beacon tracking antenna transmitting elements being electrically separated from said ground plane;

(iii) a beacon tracking antenna feed structure mounted on a bottom surface of said dielectric substrate, said feed structure being connected to said C-band feed point; and

(iv) a third plurality of plated through connecting pins which pass through said dielectric substrate to electrically connect each of said plurality of beacon tracking antenna transmitting elements to said beacon tracking antenna feed structure; and

(h) said microstrip flight termination system antenna, said microstrip telemetry antenna, said microstrip GPS antenna and said beacon tracking antenna being electrically separated from one another on said dielectric substrate.

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