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Lee-Yow et al.

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(54) **COMPACT MULTI-FREQUENCY FEED WITH/WITHOUT TRACKING**

(75) Inventors: **Clency Lee-Yow**, Longmont, CO (US); **Jonathan Raymond Scupin**, Longmont, CO (US); **Philip Elwood Venezia**, Longmont, CO (US)

(73) Assignee: **Custom Microwave, Inc.**, Longmont, CO (US)

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(21) Appl. No.: **11/270,861**

(22) Filed: **Nov. 9, 2005**

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(51) **Int. Cl.**
H01P 5/12 (2006.01)

(52) **U.S. Cl.** .... **333/126**; 333/135; 333/137; 333/21 A; 333/21 R

(58) **Field of Classification Search** .... 333/126, 333/129, 134, 135, 137, 21 A, 21 R
See application file for complete search history.

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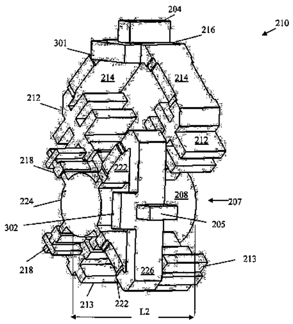
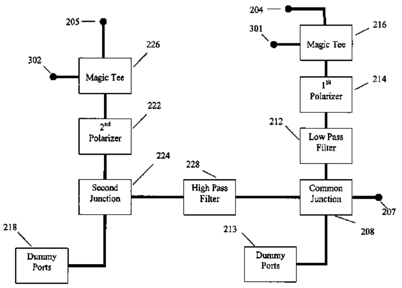
Primary Examiner—Robert J. Pascal
Assistant Examiner—Kimberly E Glenn
(74) *Attorney, Agent, or Firm*—Rick Martin; Patent Law Offices of Rick Martin, P.C.

(57) **ABSTRACT**

A method and apparatus forming an efficient and compact waveguide feed with all components for processing signals in multi-frequency band antenna feeds with single/dual linear/circular polarizations with/without tracking. The layout can be realized in a split block configuration using any number of fabrication methods, such as brazing, electroforming, and machining and is most effective when it is realized in a split-block construction, in which the waveguide components are formed in the recesses split about the zero current line. This layout results in a very compact feed, which has excellent electrical characteristics, is mechanically robust, eliminates flange connections between components, and is very cost effective.

20 Claims, 24 Drawing Sheets





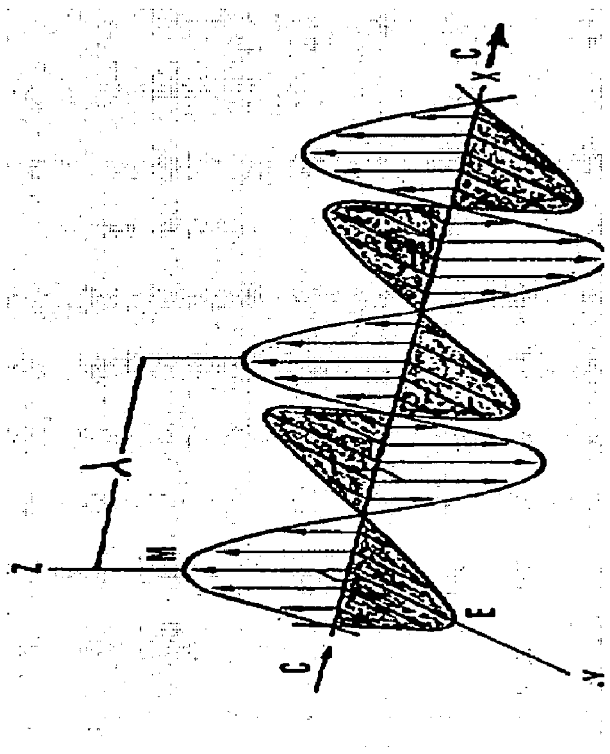


Figure 1A
(prior art)

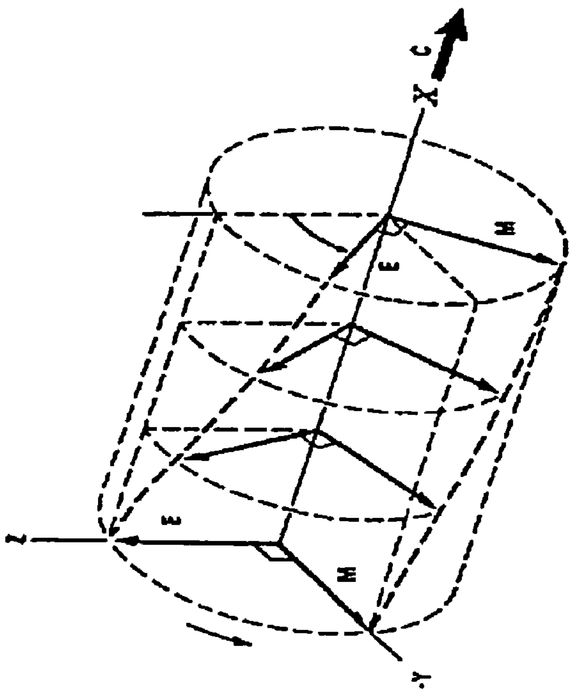


Figure 1B
(prior art)

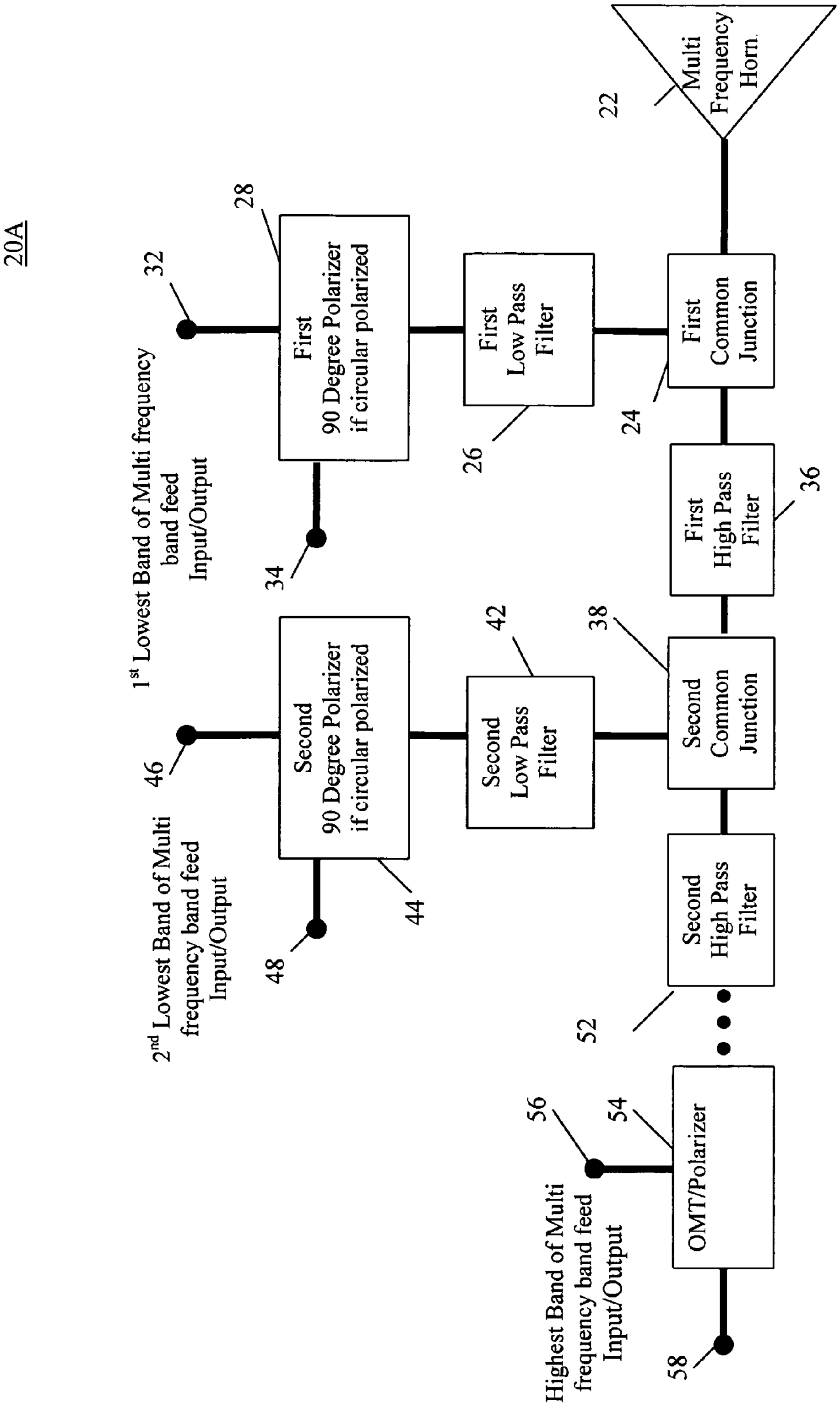


Figure 2A
(prior art)

20B

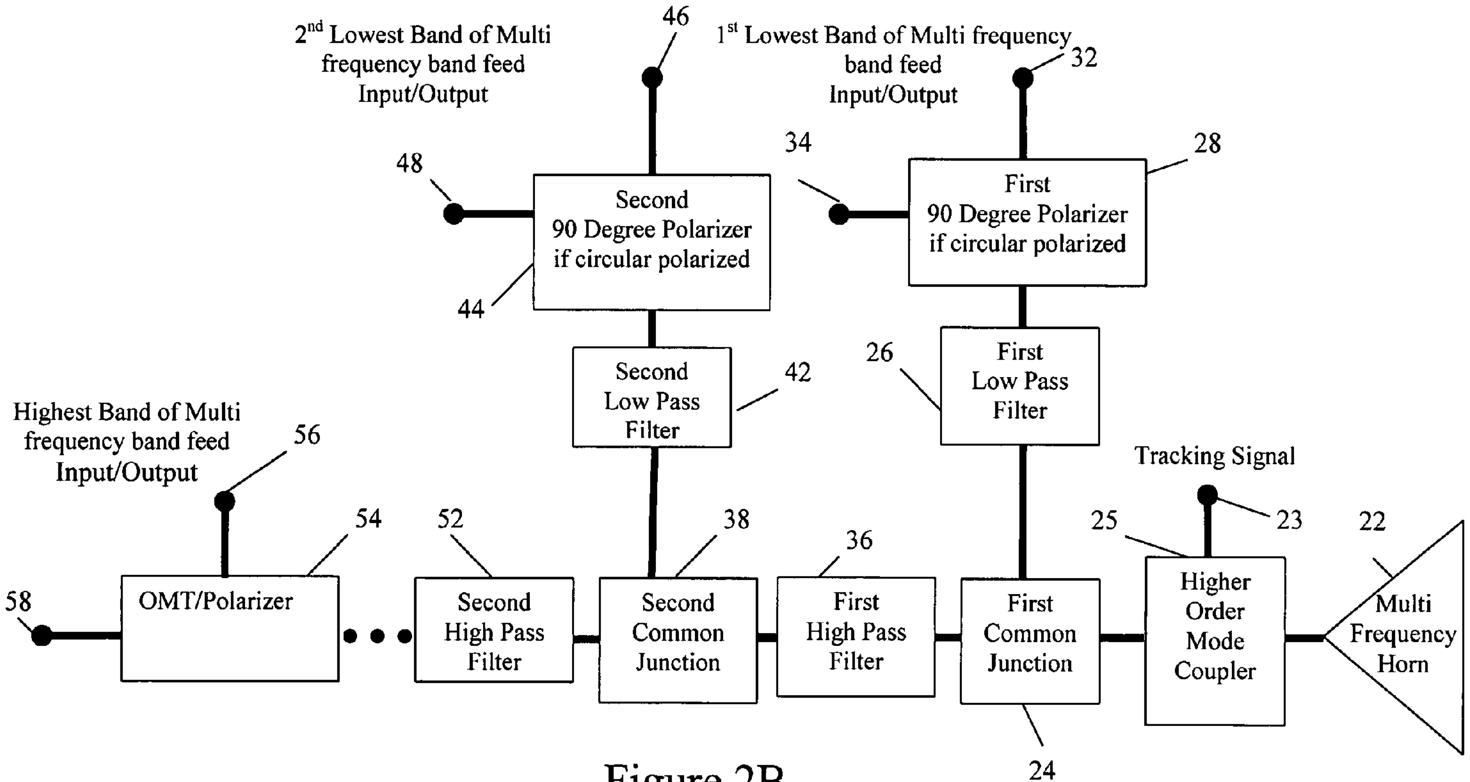


Figure 2B
(prior art)

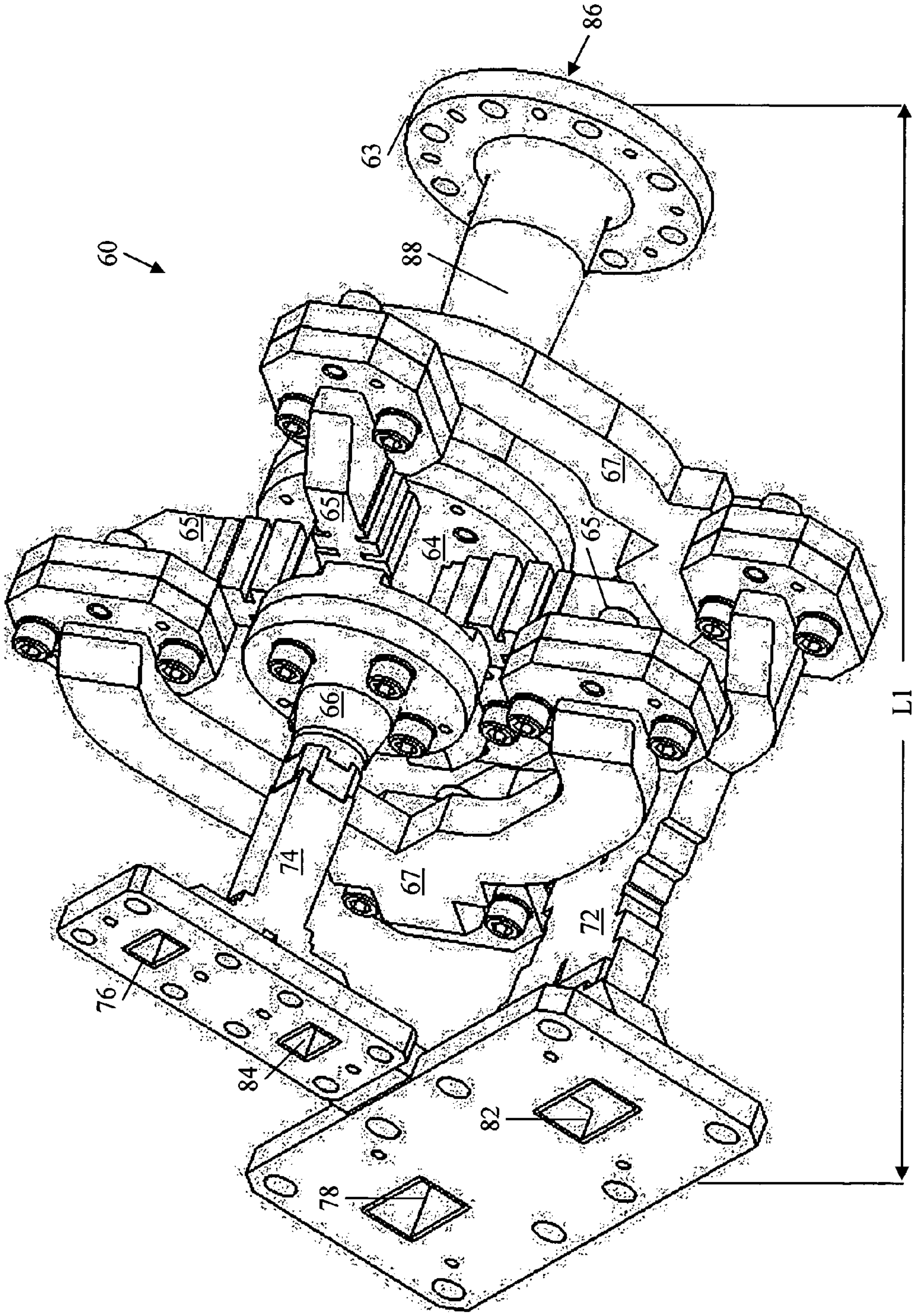
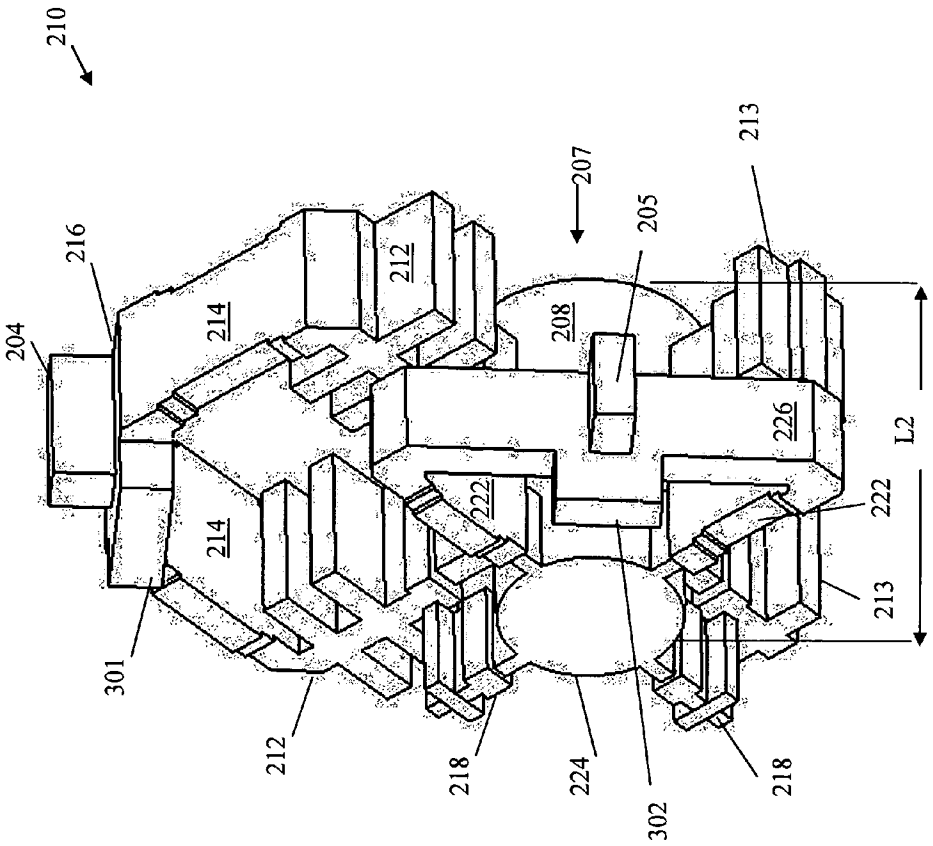


Figure 3
(prior art)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L2
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302
218

Figure 4A

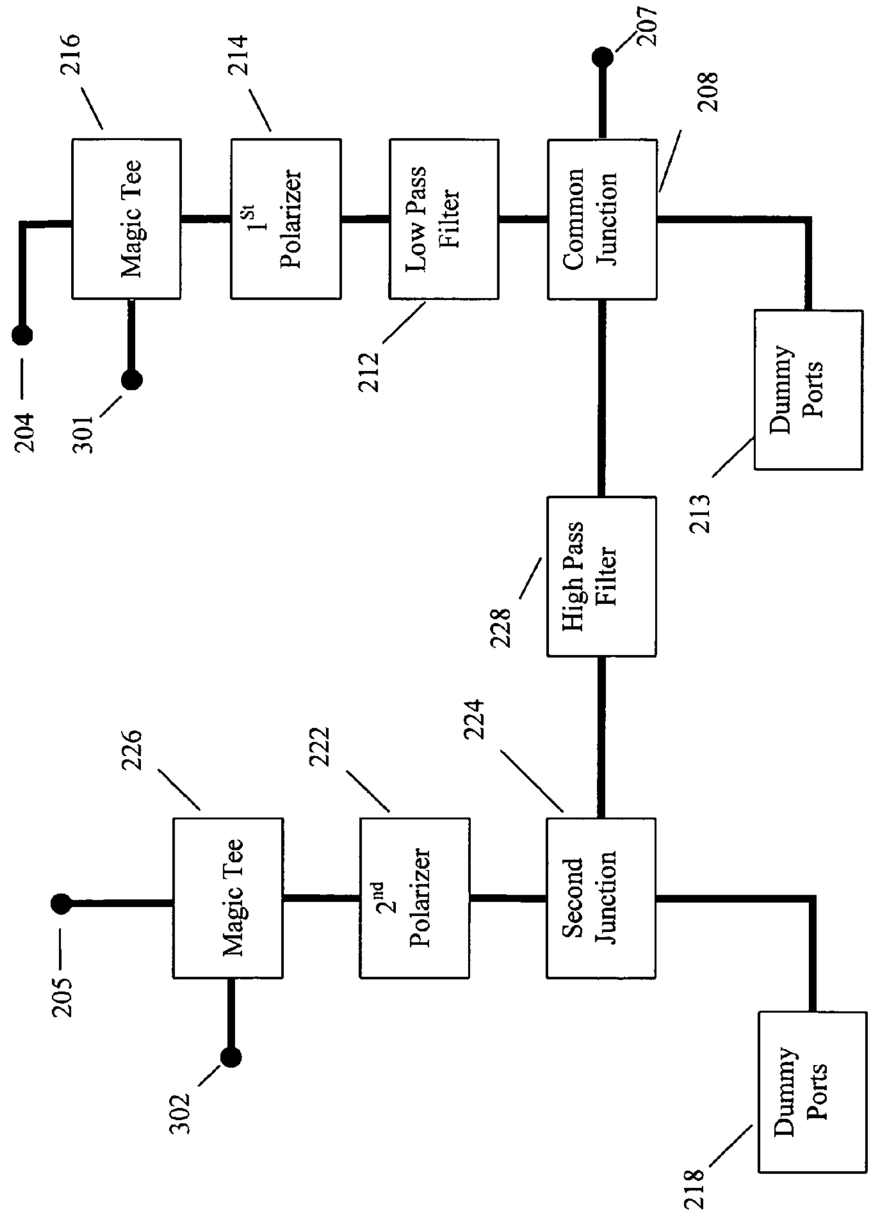
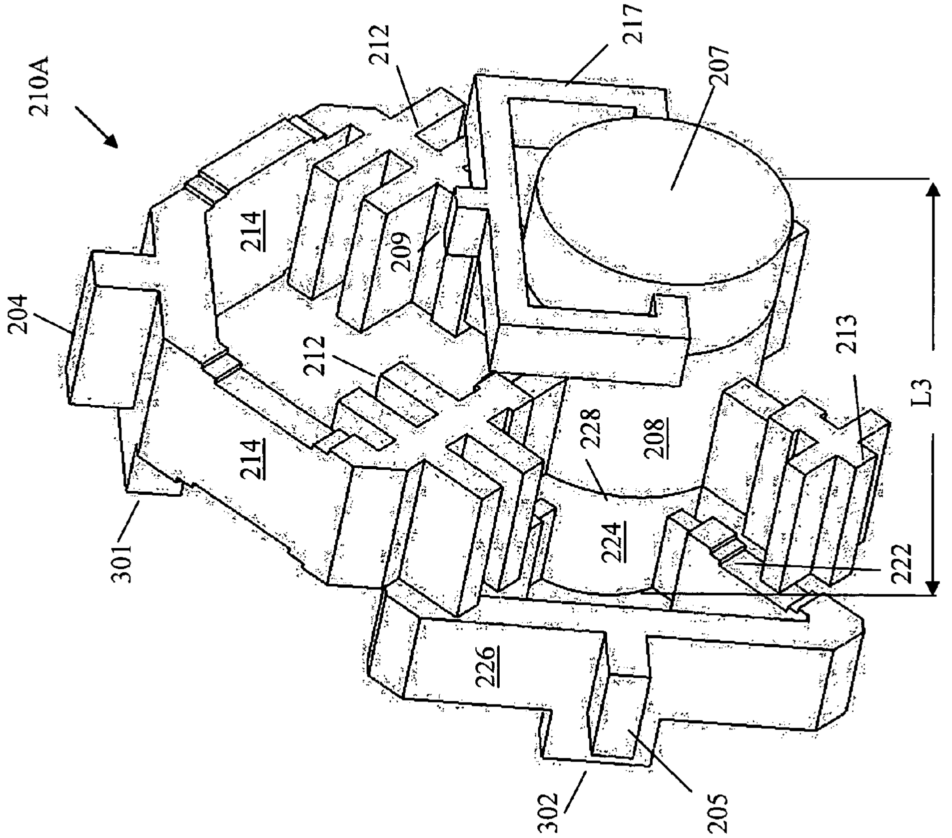

216
214
Magic Tee
1st Polarizer
Low Pass Filter
Common Junction
207
208
204
301
212
Dummy Ports
213
High Pass Filter
228
226
222
224
Magic Tee
2nd Polarizer
Second Junction
205
302
Dummy Ports
218

Figure 4B


210A
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213
L3
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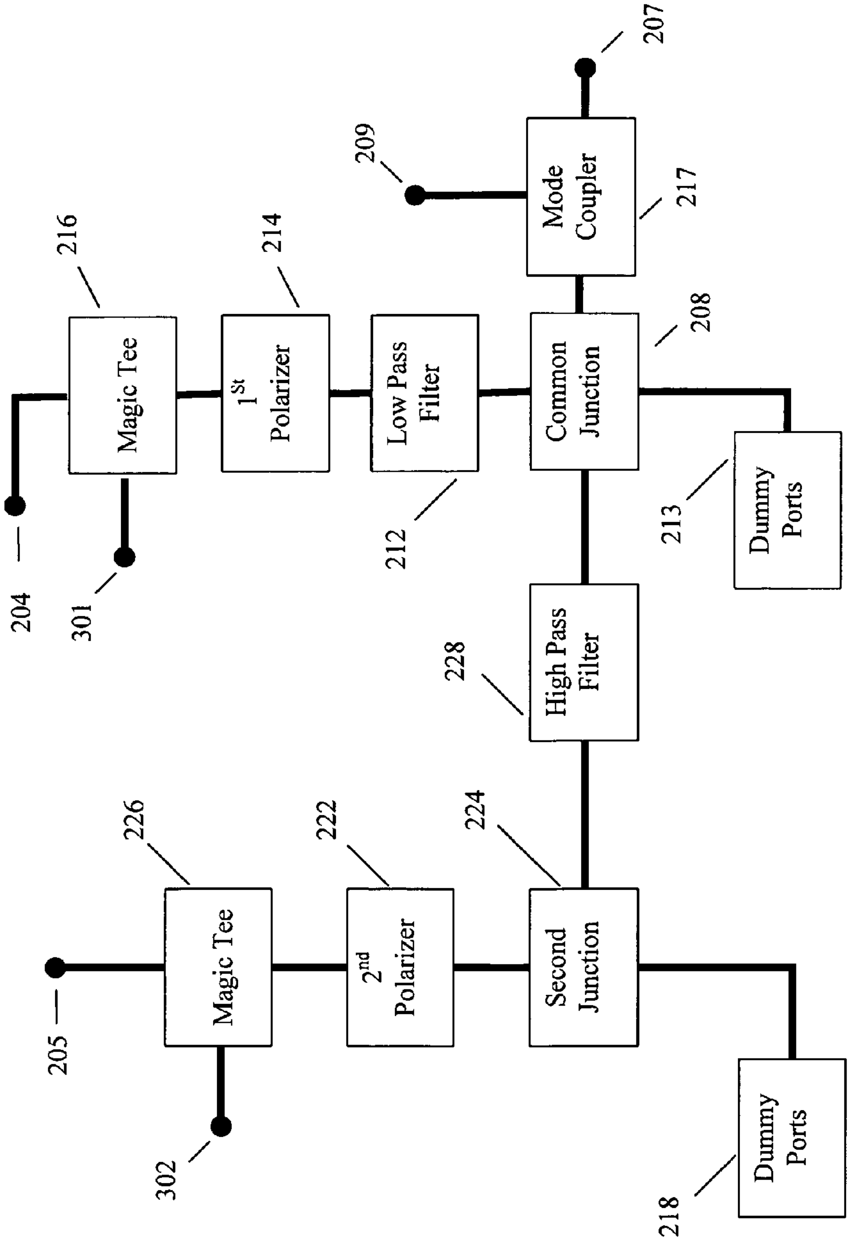
205

Figure 4C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Low Pass Filter
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Common Junction
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Mode Coupler
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209
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205
302
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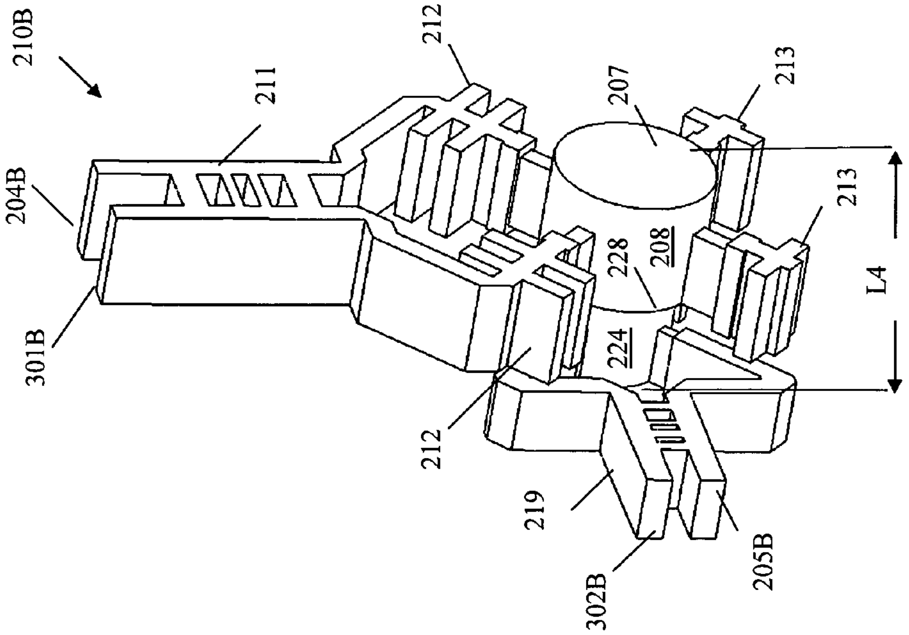
226
2nd Polarizer
222
Second Junction
224
Dummy Ports
218

Figure 4D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228
208
213
L4
224
212
219
302B
205B

Figure 4E

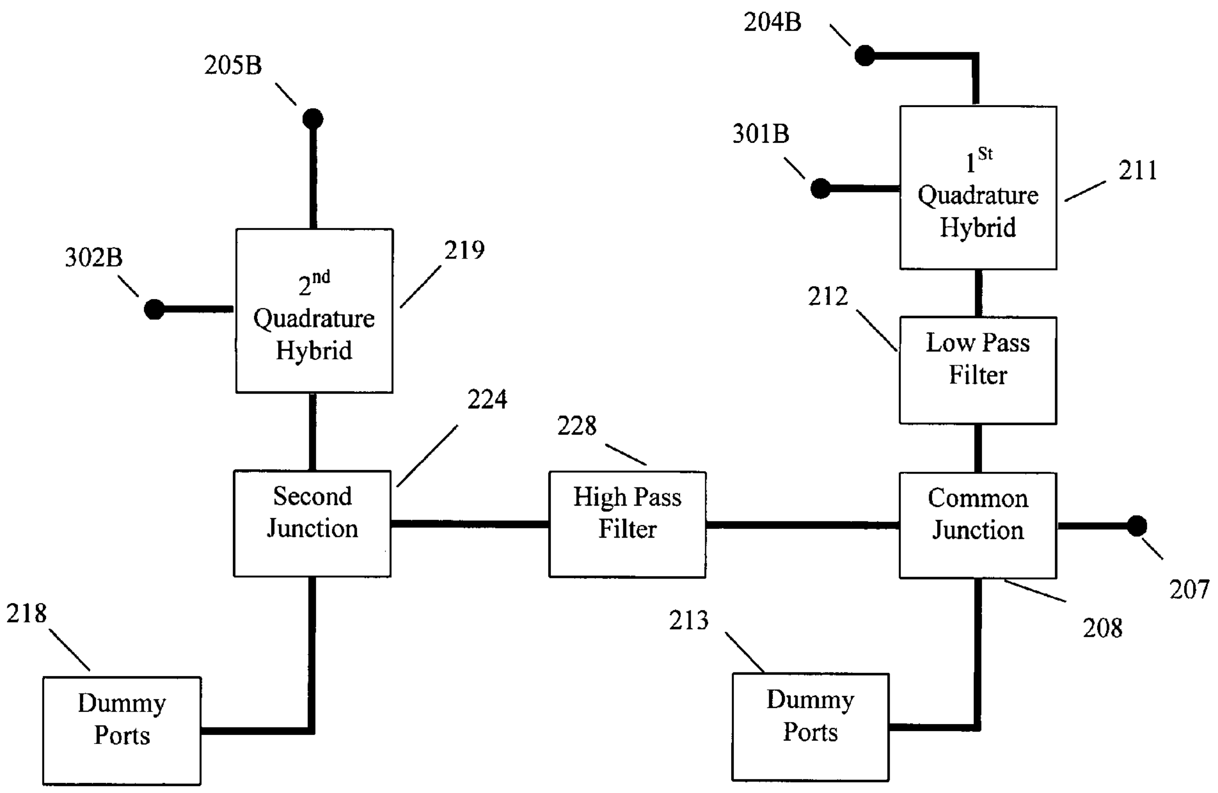
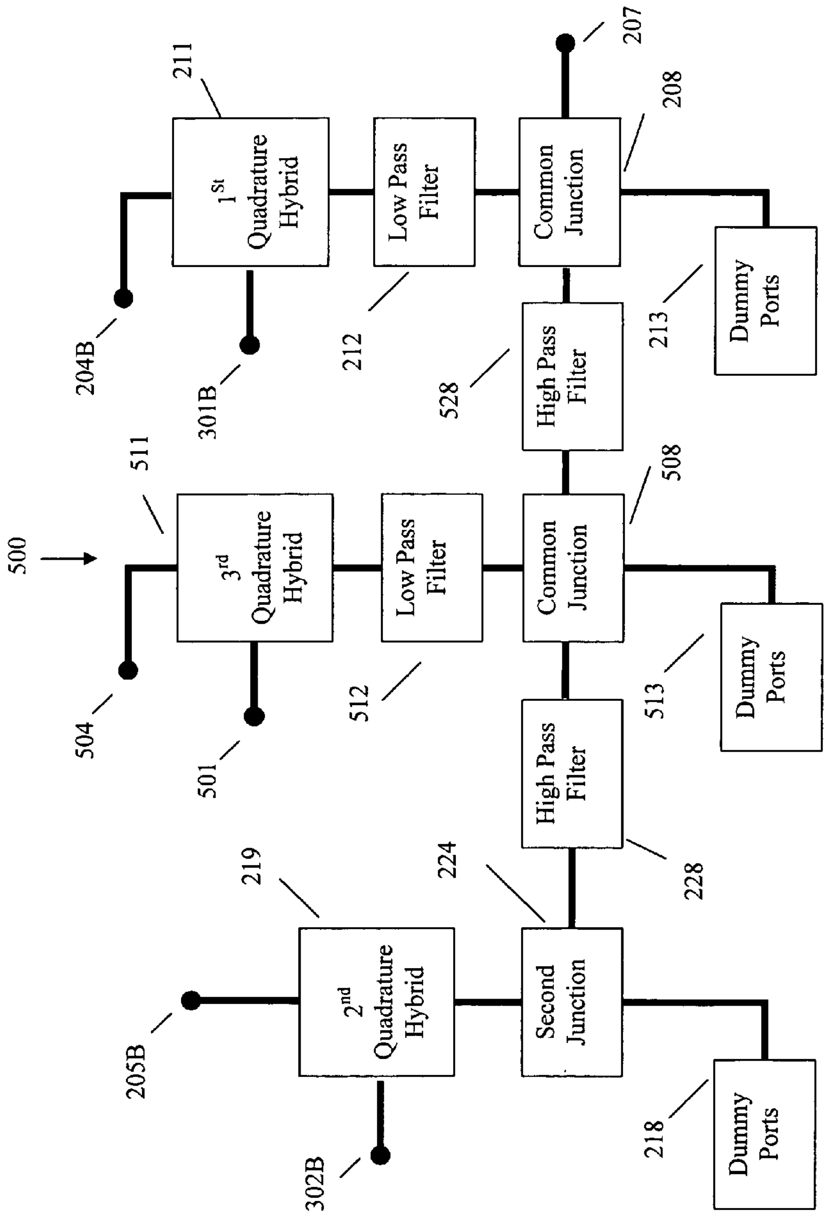

204B
205B
301B
1St Quadrature Hybrid
211
302B
2nd Quadrature Hybrid
219
212
Low Pass Filter
224
228
Second Junction
High Pass Filter
Common Junction
207
218
213
208
Dummy Ports
Dummy Ports

Figure 4F


1st Quadrature Hybrid
Low Pass Filter
Common Junction
Dummy Ports
High Pass Filter
3rd Quadrature Hybrid
Low Pass Filter
Common Junction
Dummy Ports
High Pass Filter
2nd Quadrature Hybrid
Second Junction
Dummy Ports
211
207
208
204B
301B
212
213
528
511
508
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504
501
512
513
219
224
228
205B
302B
218

Figure 4G

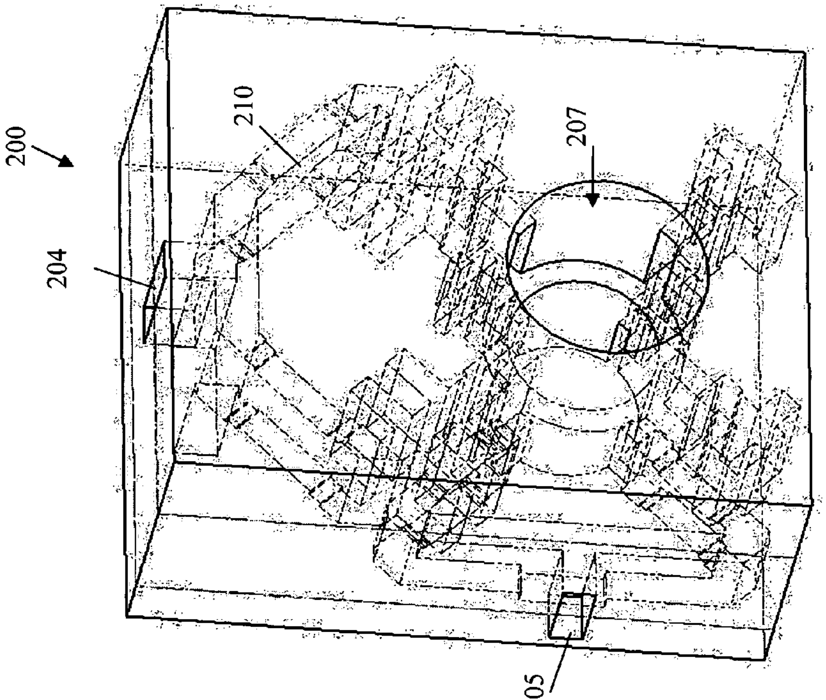


Figure 5B

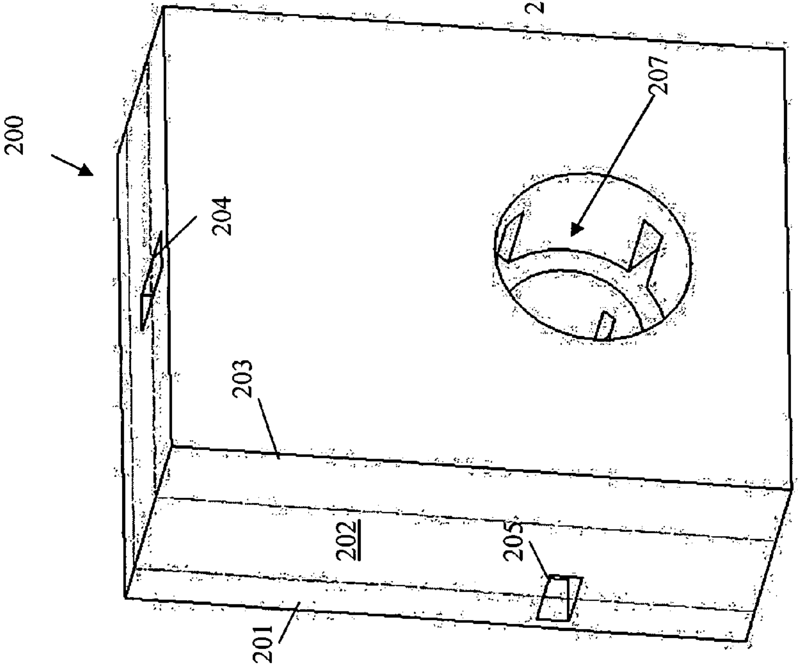
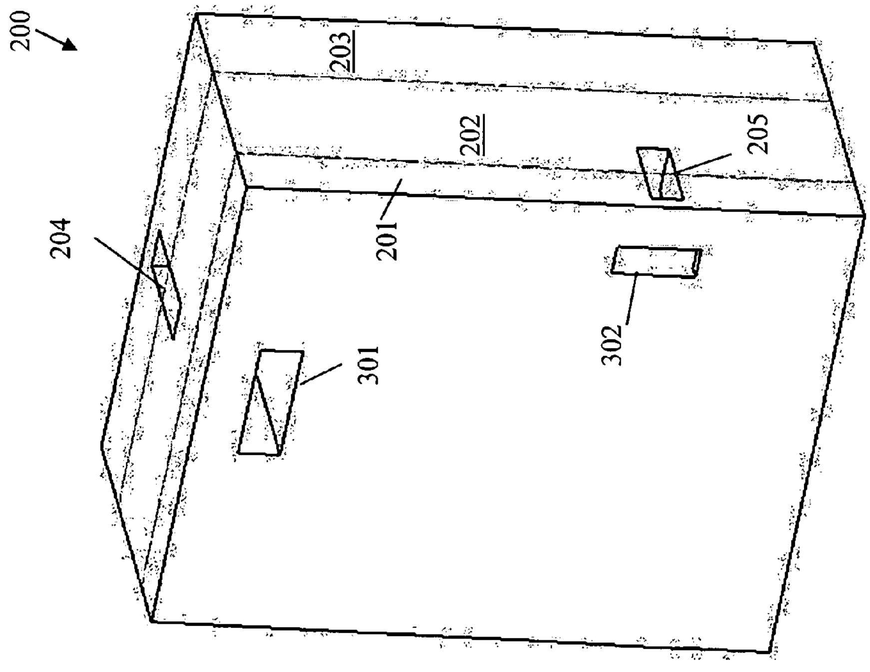


Figure 5A



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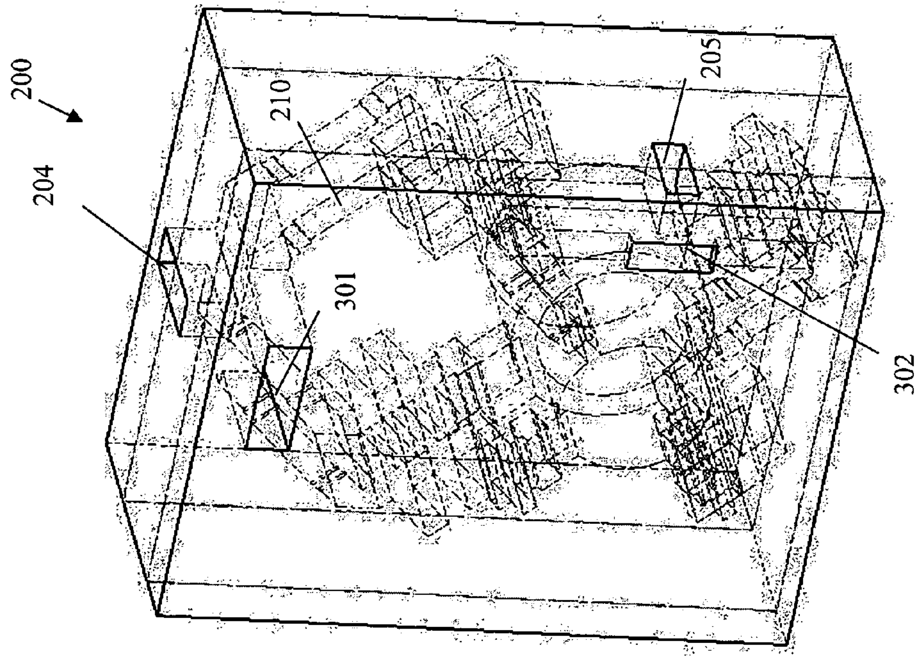

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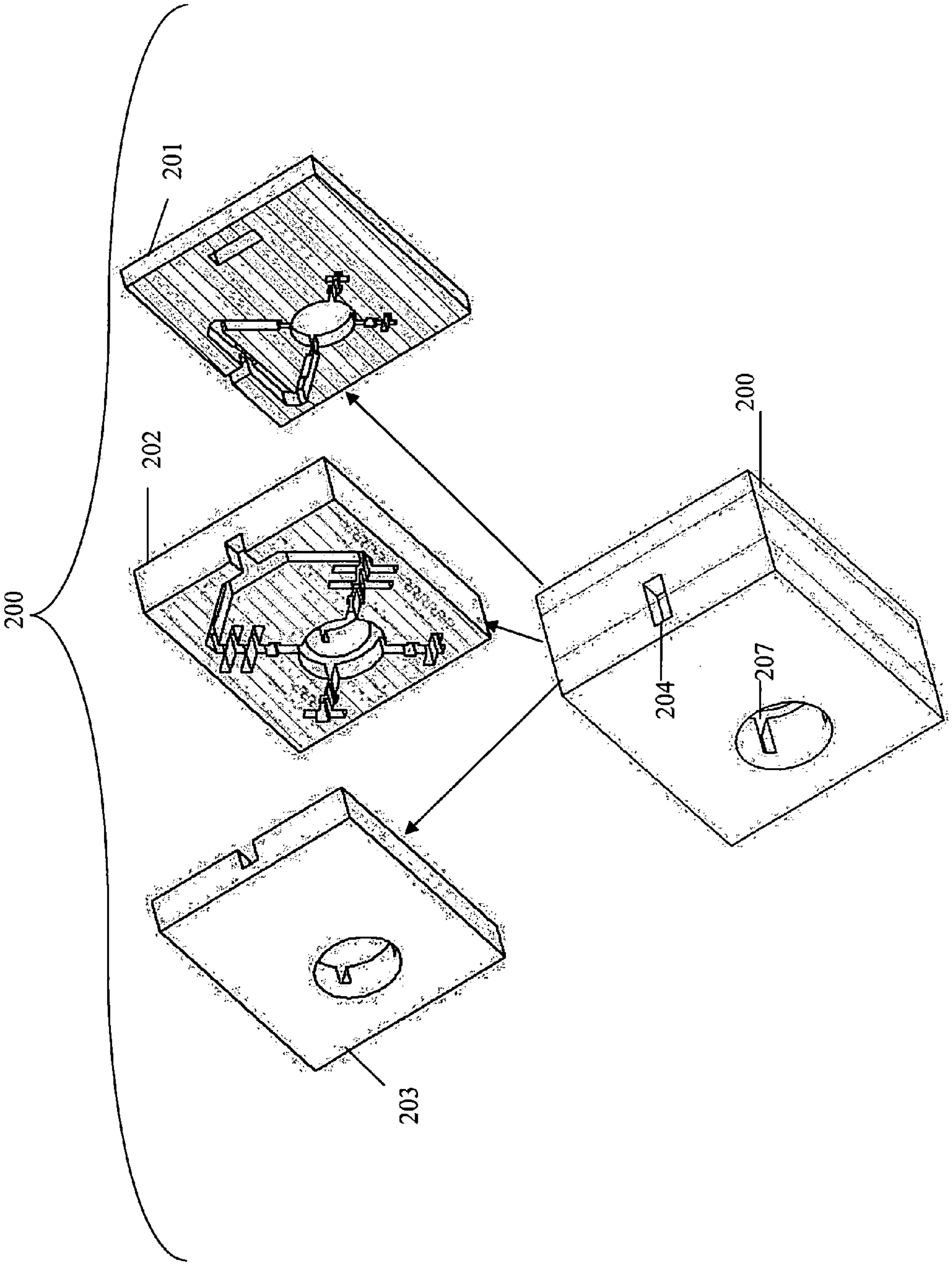


Figure 6A

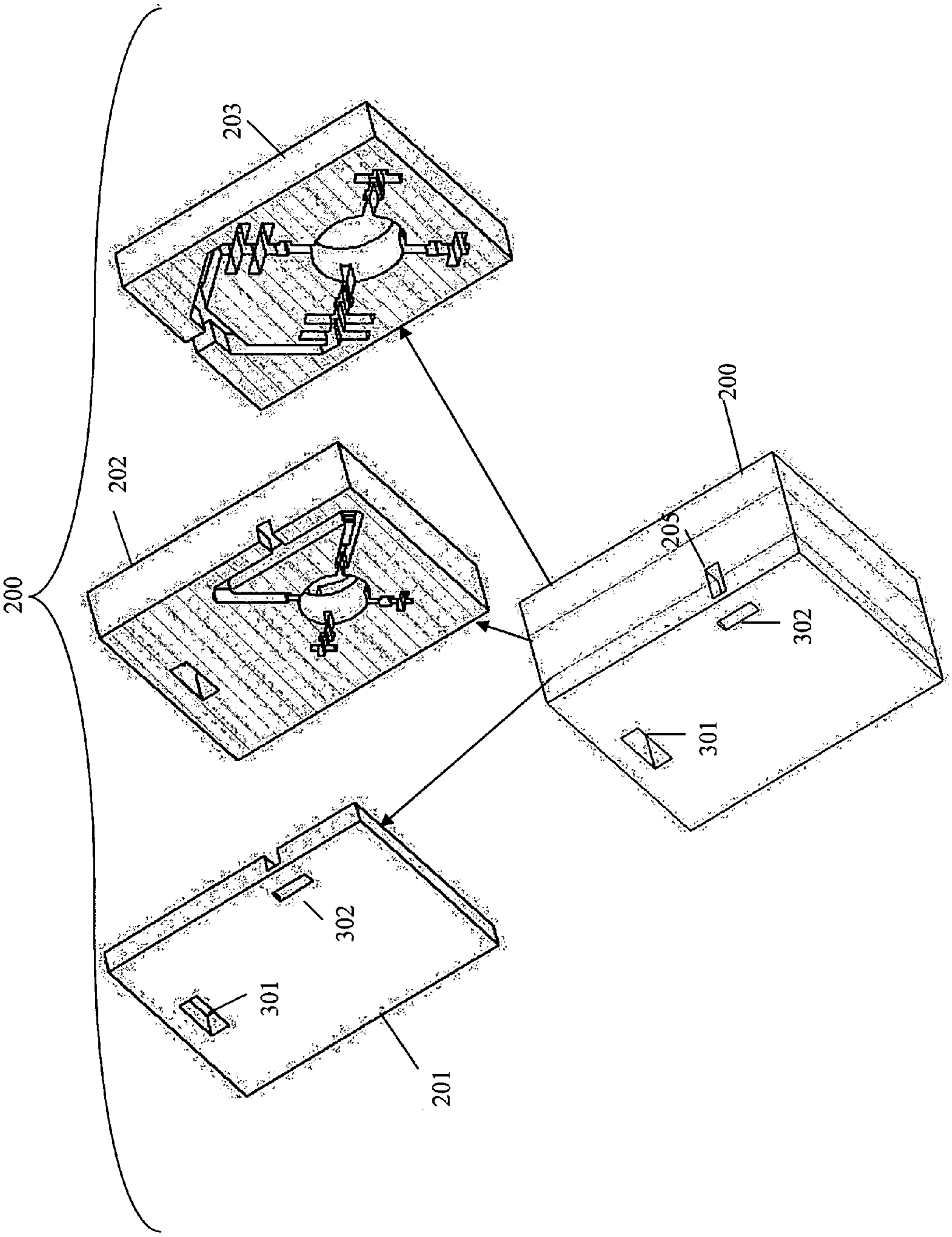


Figure 6B

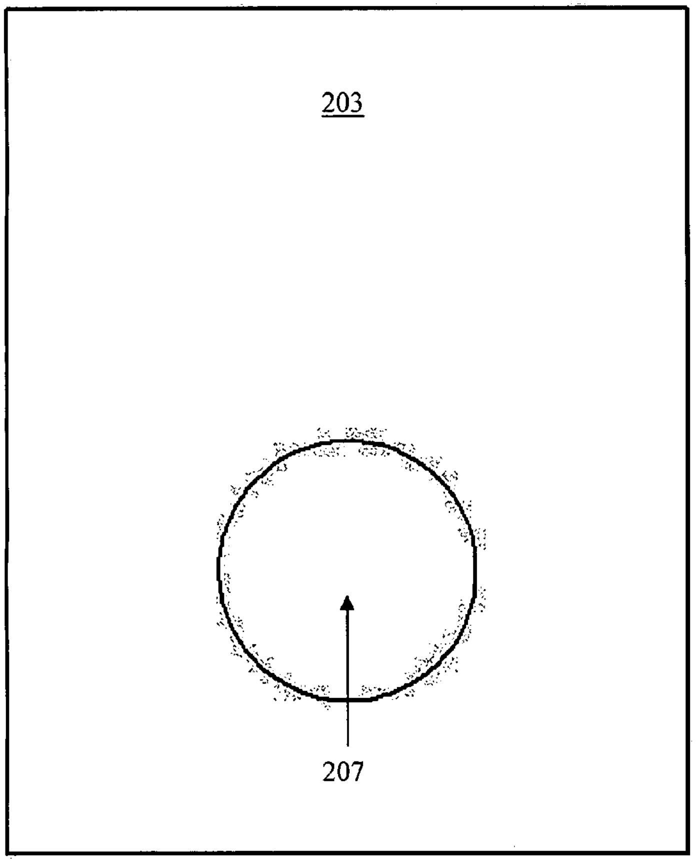


Figure 7A

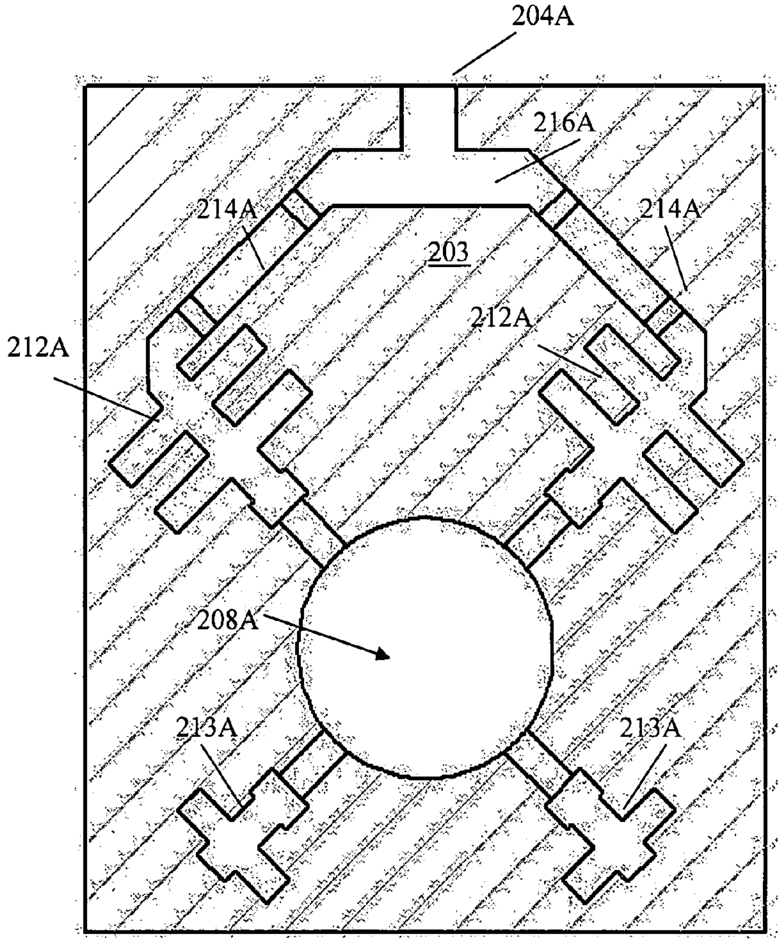


Figure 7B

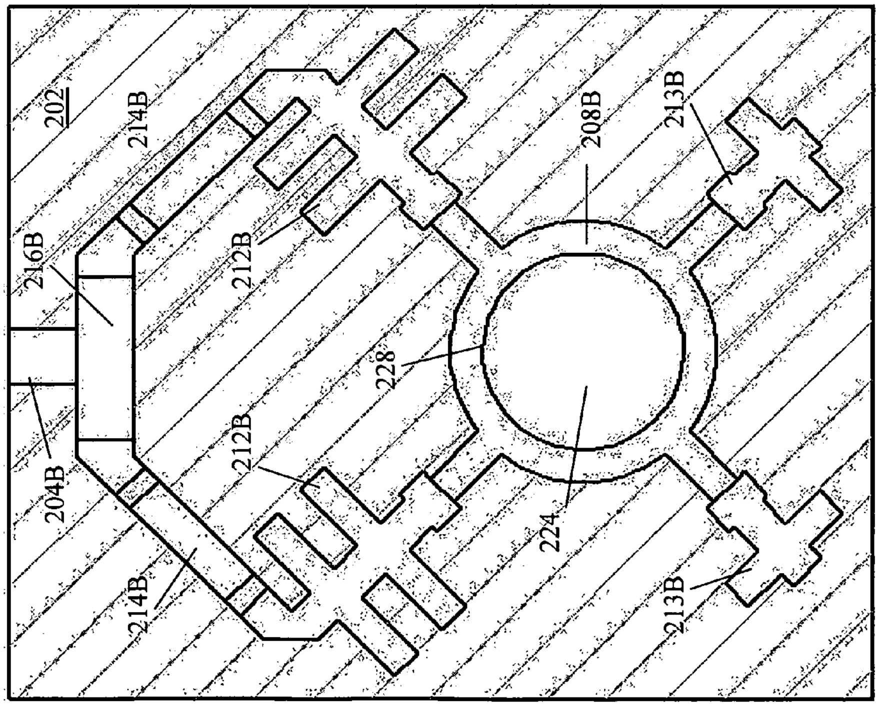


Figure 8A

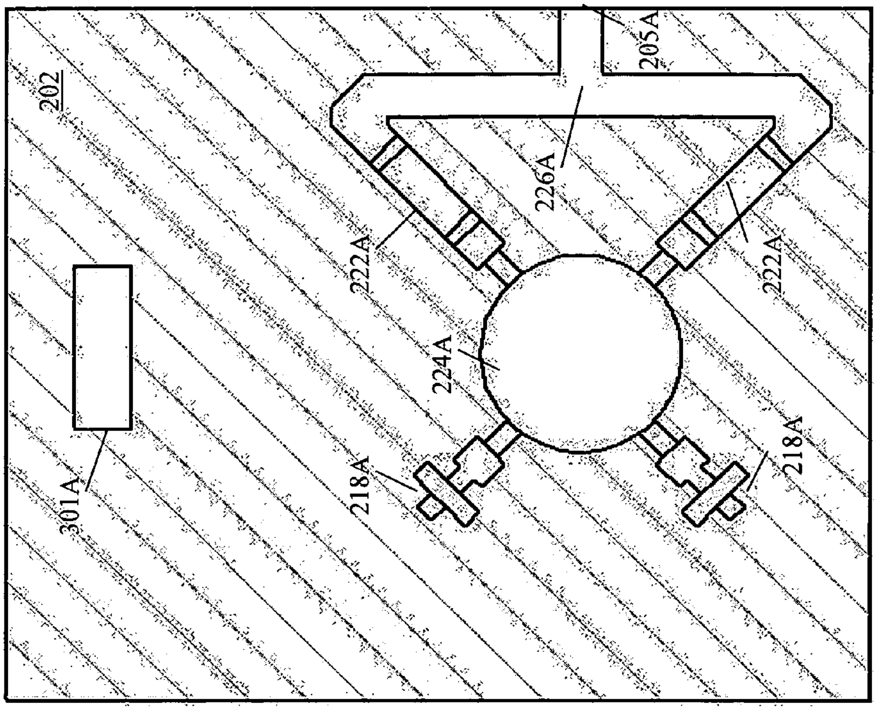


Figure 8B

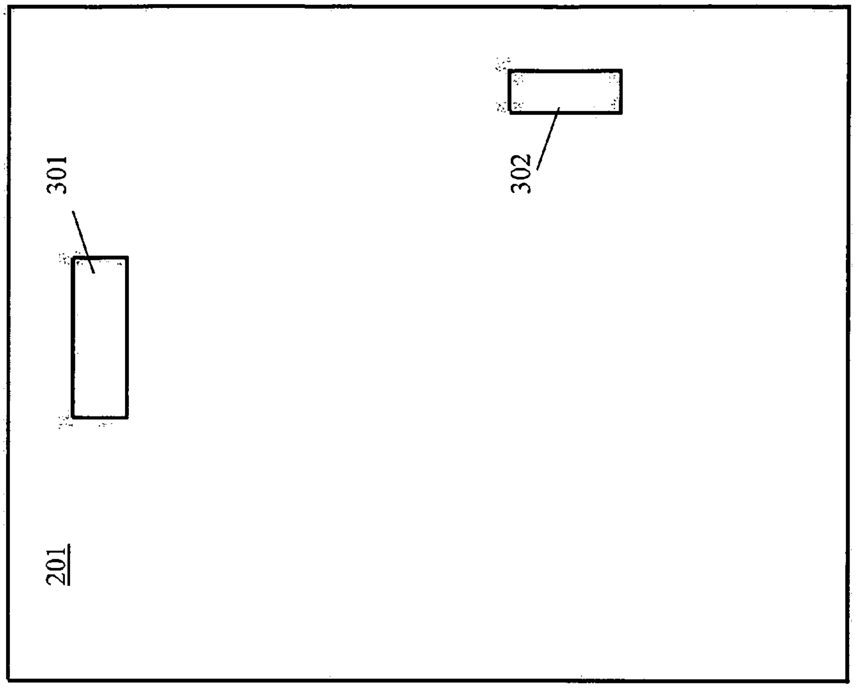


Figure 9B

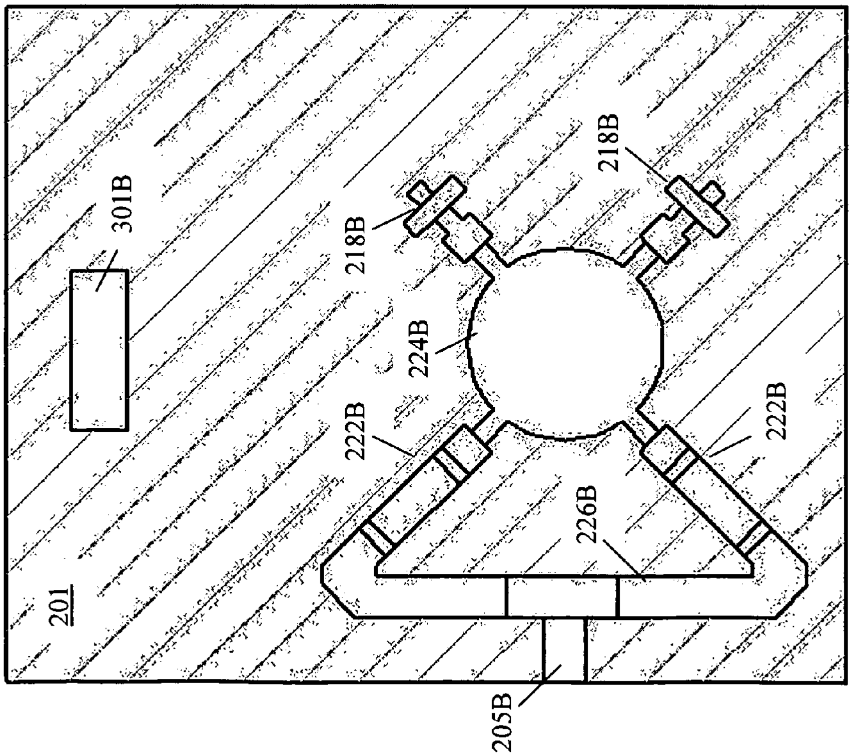


Figure 9A

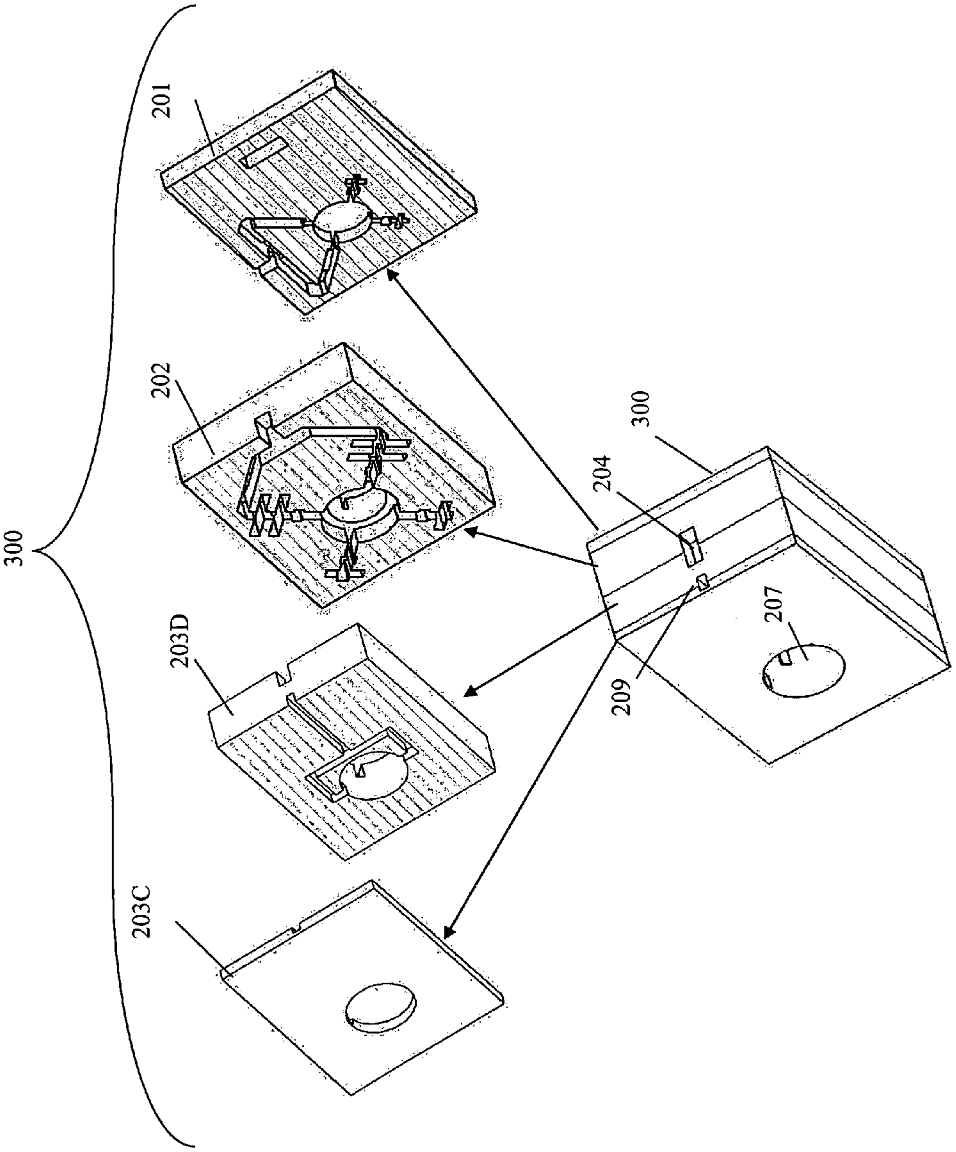


Figure 10A

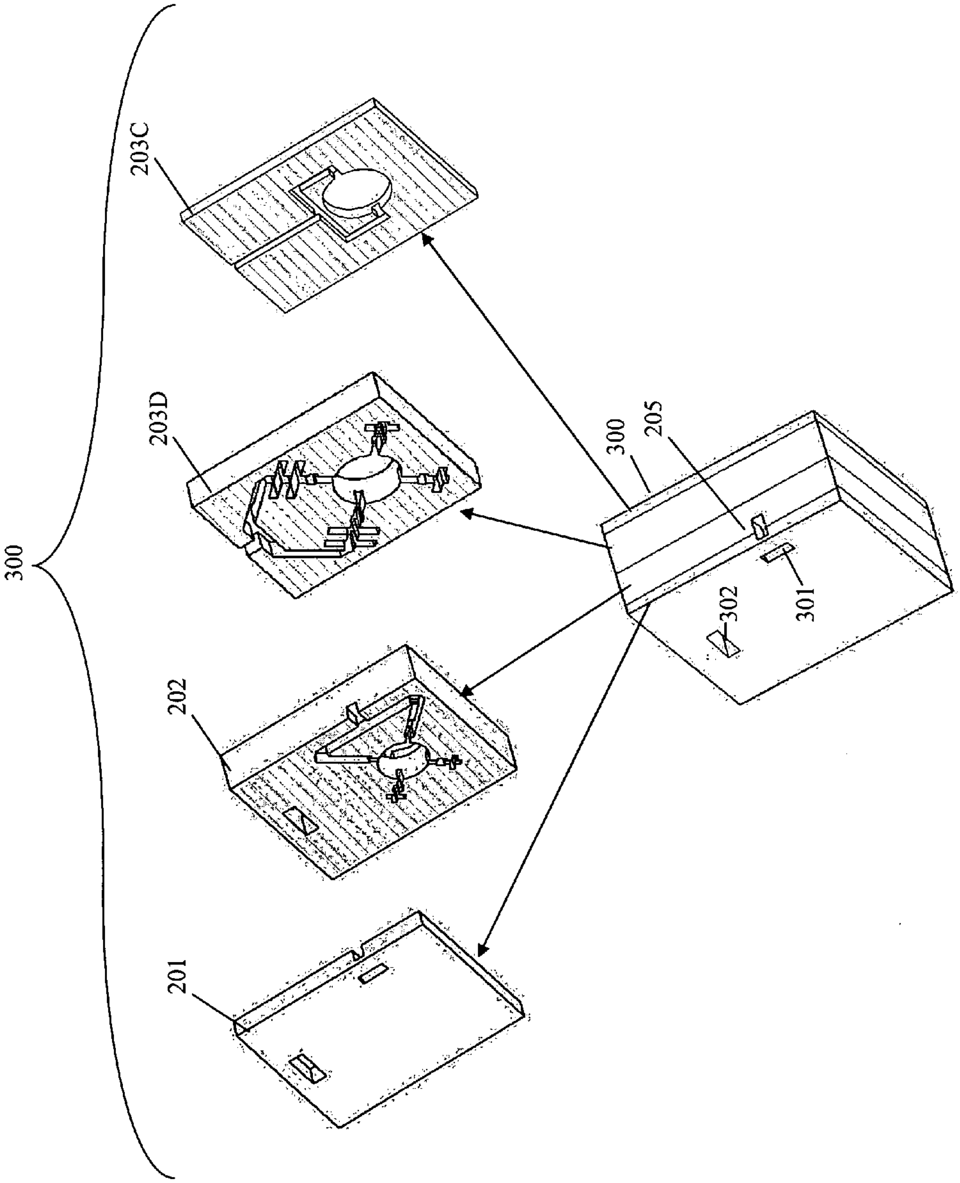


Figure 10B

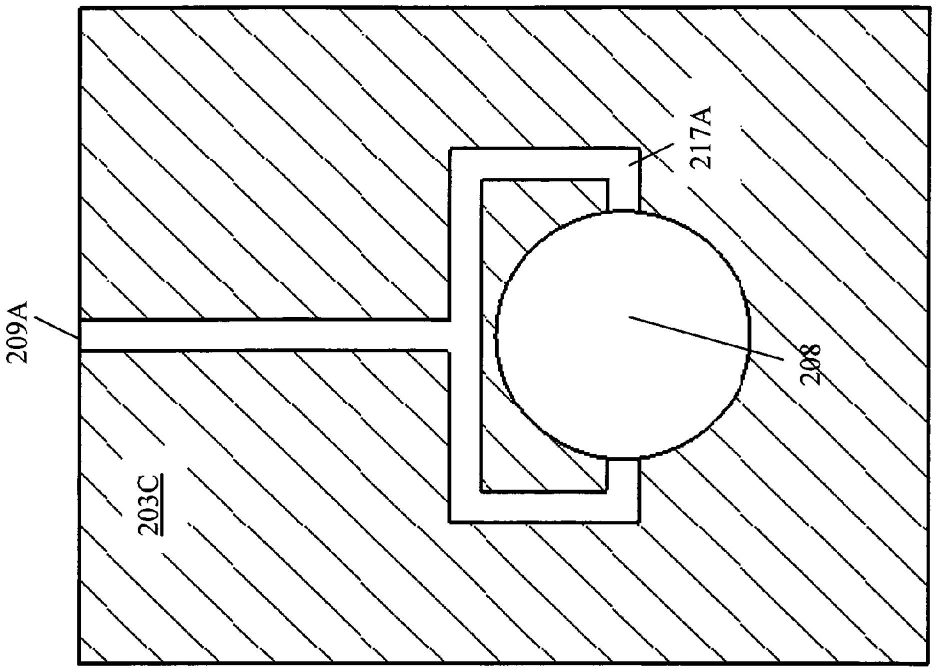


Figure 11B

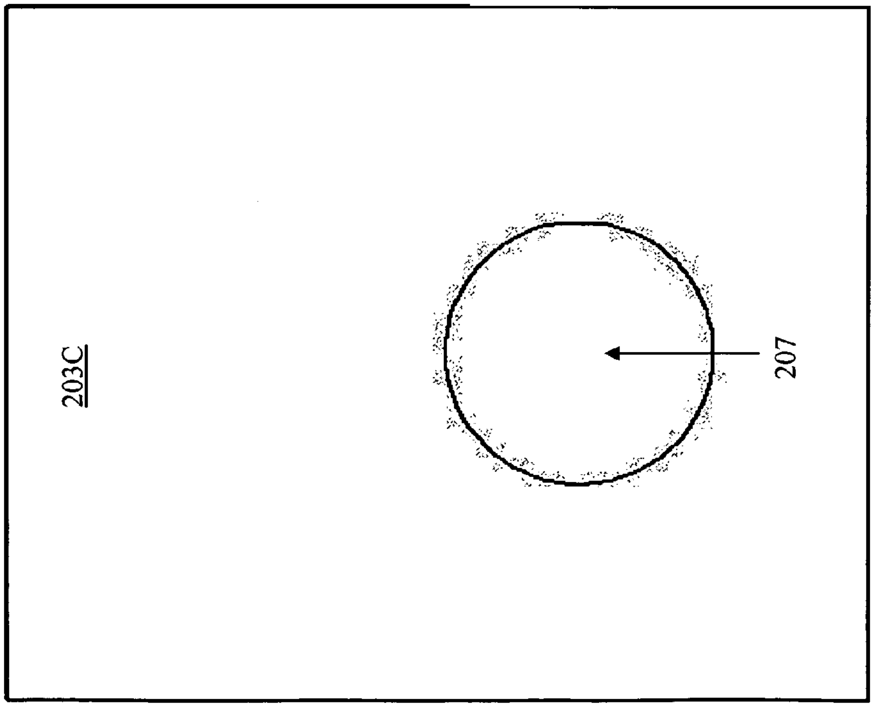


Figure 11A

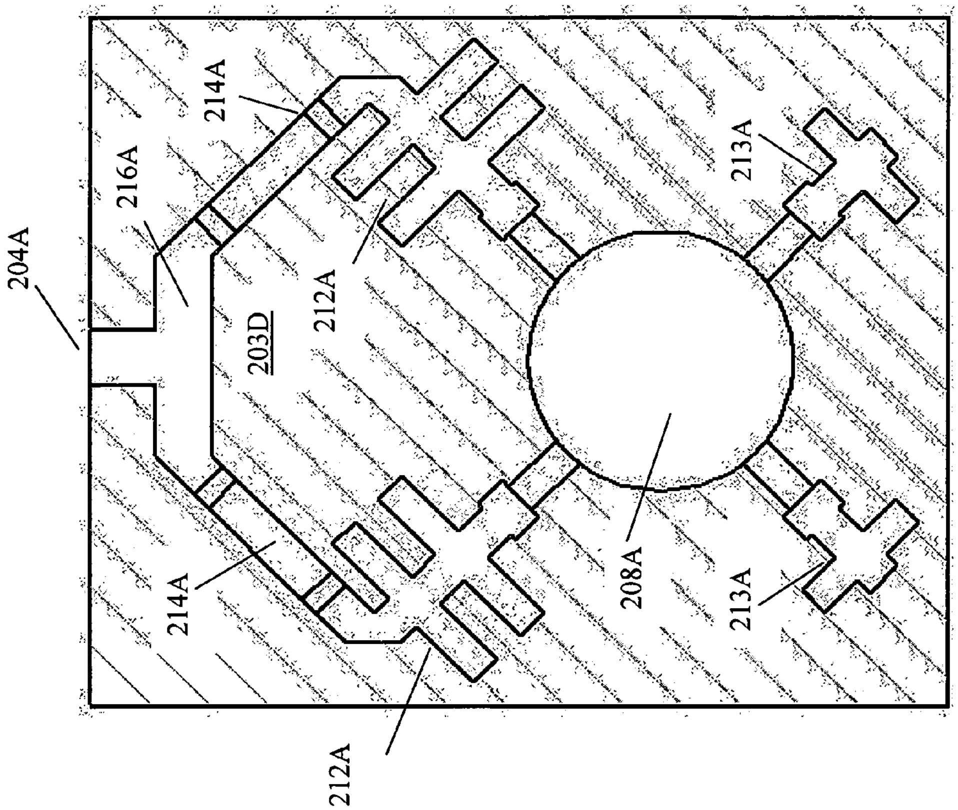


Figure 12B

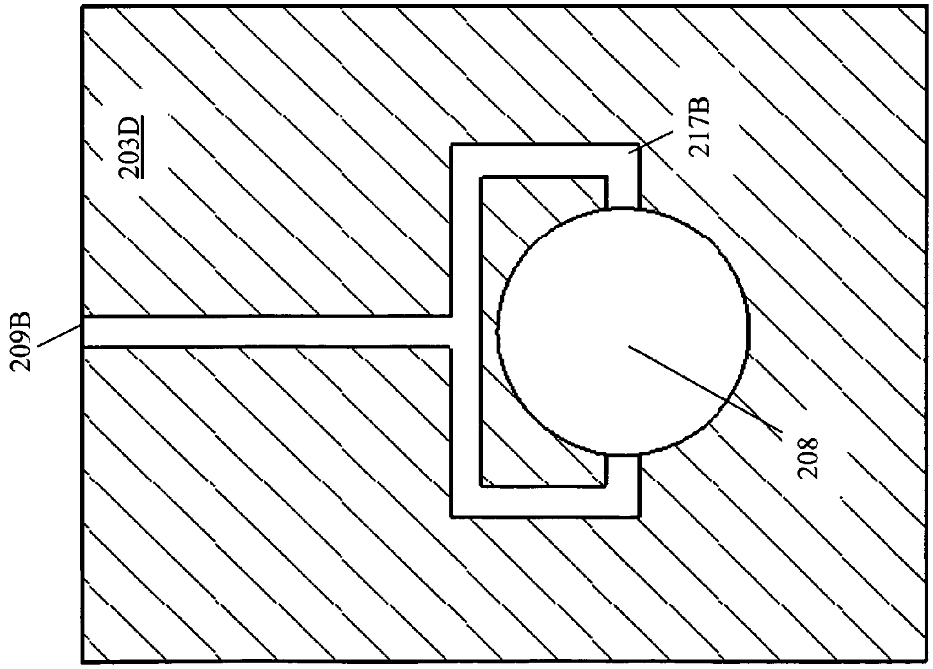
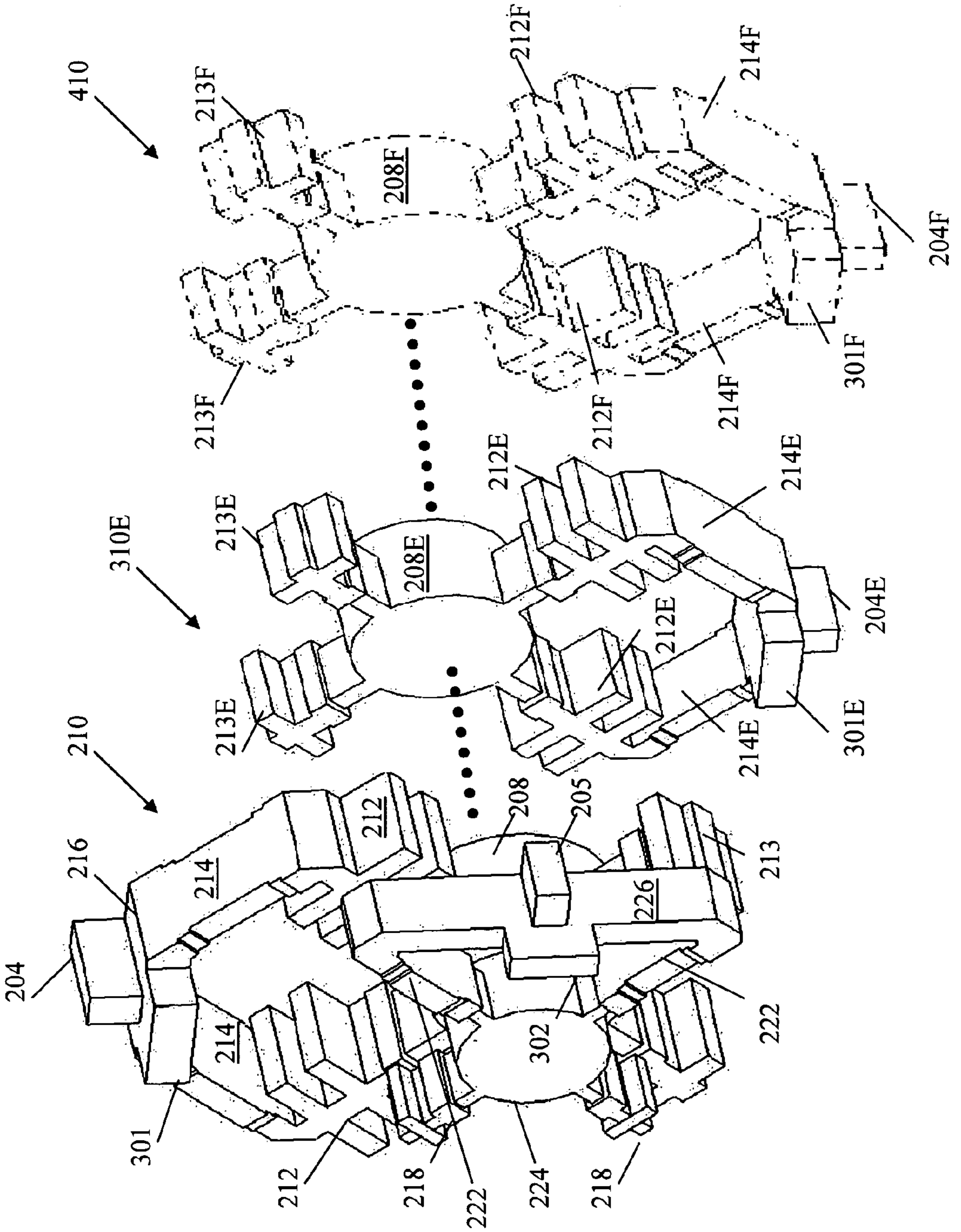


Figure 12A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204E
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Figure 13

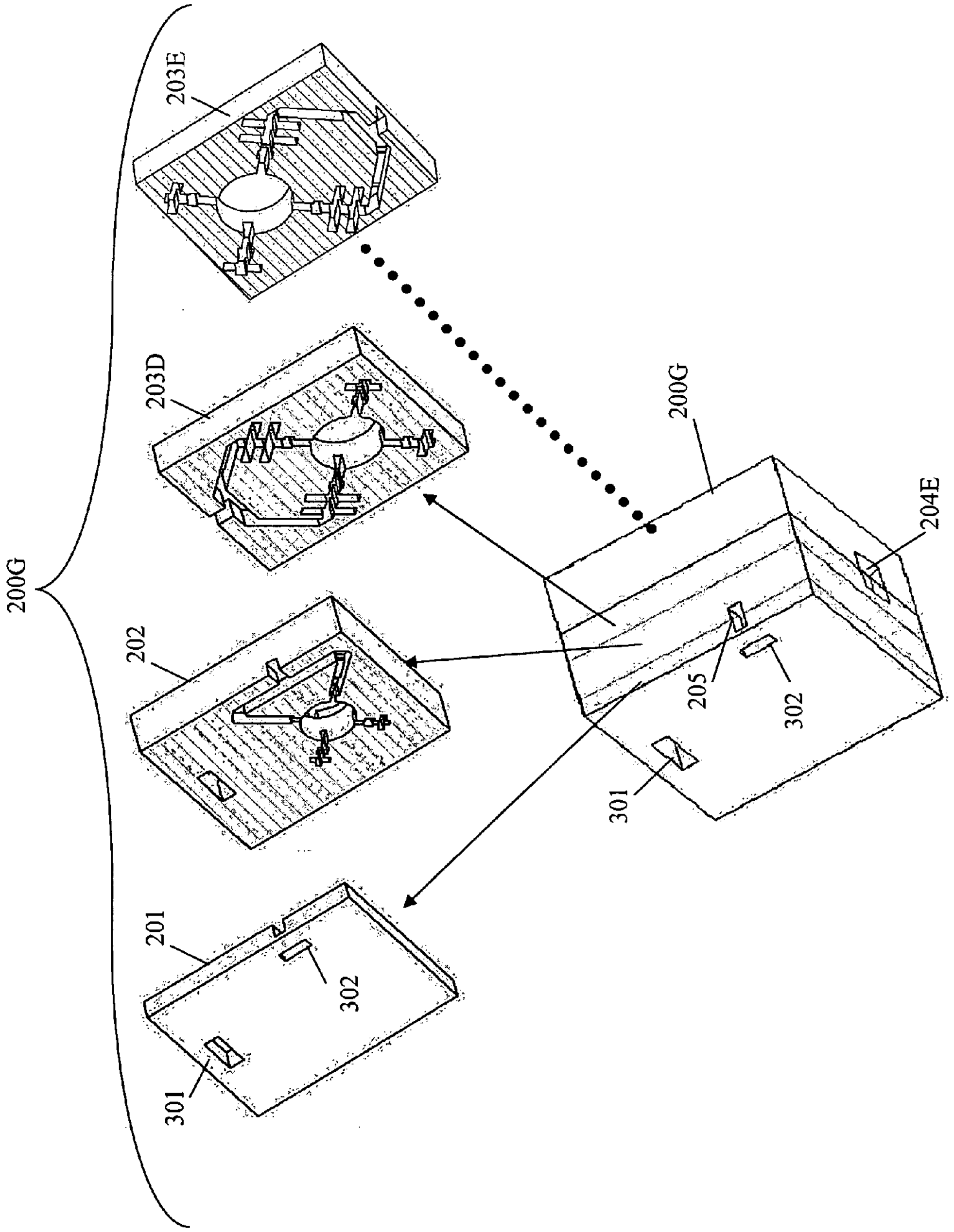

Figure 14

COMPACT MULTI-FREQUENCY FEED WITH/WITHOUT TRACKING

CROSS REFERENCE APPLICATIONS

This application is a non-provisional application claiming the benefits of provisional application No. 60/627,264 filed on Nov. 12, 2004.

FIELD OF THE INVENTION

The present invention relates to an efficient and compact layout of waveguide components for processing signals in multi-frequency band antenna feeds with single/dual linear/circular polarizations with/without tracking.

BACKGROUND OF THE INVENTION

Microwave signals are extremely high frequency (HF) signals, usually in the gigahertz range. They are used to transmit large amounts of video, audio, RF, telephone, and computer data over long distances. They are used in commercial and military applications, including communications to satellites, airplanes and the like. Frequencies are divided into various bands such as the S-band (2-3.5 GHz), Ku-band (10.7-18 GHz), Ka-band (18-31 GHz), and others such as the X-band etc.

Polarization is a characteristic of the electromagnetic wave. Four types of polarization are used in satellite and other transmissions: horizontal; vertical; right-hand circular (RHCP); and left-hand circular (LHCP). Horizontal and vertical polarizations are types of linear polarizations. Linear and circular polarizations are well known in the art. An example of linear polarization is shown in FIG. **1**A. A wave is made up of an electric field 'E' and a magnetic field 'M'. When a wave of wavelength 'k' is transmitted into free space from an antenna, the orientation of its electric field E with respect to the plane of the earth's surface determines the polarization of the wave. If the wave is oriented such that the E field is perpendicular to the earth, the wave is referred to as vertically polarized. If the 'E' field is parallel to the earth's surface, the wave is horizontally polarized, which is the orientation of the 'E' field shown in FIG. **1**A. Also shown is the magnetic field 'M'. In both of these cases, the wave polarization remains in the same orientation at all times and is, therefore, referred to as linear polarization. The wave travels in direction 'C' along the X-axis.

FIG. **1**B depicts the alternative to linear polarization, referred to as circular polarization. In this kind of electromagnetic emission, the 'E' field is no longer confined to a single plane, but consists of equal-amplitude horizontally and vertically polarized components, which are phase-shifted by 90°. It can be readily seen that the vectors of both the 'E' and 'M' fields are rotating in a clockwise direction (if viewed from behind an antenna). This rotation is called RHCP. For every cycle of the transmitted wave, the 'E' and 'M' fields will rotate a full 360°. An observer (standing behind the antenna) would "see" the rotation vector in this drawing rotating in a circular clockwise motion R and moving in direction C along the X-axis. The type of polarization is controlled by the design of the antenna feed assembly.

Multi-frequency band feeds exist that have the ability to send/receive more than one frequency and are usually designed for frequency bandwidths within one or more of the aforementioned bands.

A typical multi-frequency band feed without tracking (prior art) is shown in the block diagram of FIG. **2**A and consists of a waveguide assembly **20**A with the following components:

1. Multi-frequency band horn **22** to produce the desired radiation pattern characteristics, where an input signal is received or an output signal is transmitted.
2. Behind the horn, first common junction **24** with appropriate filters is used to separate out the two orthogonal linear polarizations of the lowest frequency band without impacting any of the higher frequency bands. Filters include first low pass filter **26** (LF filter) to filter the lowest frequency range and first high pass filter **36** (HF filter) to filter the higher frequency ranges. If circular polarization is required, first 90° polarizer **28** (low frequency (LF) polarizer) attaches to both first (LF) waveguide port right hand circular polarization (RHCP) **32** and LF waveguide port left hand circular polarization (LHCP) **34**. Ports **32**, **34** can also be used for horizontal or vertical polarization respectively if circular polarization is not required. In this case the 90° polarizer **28** is not required.
3. Second common junction **38** with appropriate filters is used to separate out the two orthogonal linear polarizations of the next lowest frequency band without impacting any of the higher frequency bands. Filters include second low pass filter **42** to filter the second lowest frequency range and second high pass filter **52** to filter the next higher frequency range. If circular polarization is required, second 90° polarizer **44** attaches to both second waveguide port RHCP **46** and second waveguide port LHCP **48**. Additional common junctions, not shown, are added for additional frequency band requirements. Ports **46**,**48** will also be used for horizontal or vertical polarization respectively if circular polarization is not required. In this case second 90° polarizer **44** is not required.
4. An Ortho-Mode Transducer (OMT) is used after the last common junction to separate the two orthogonal linear polarizations of the highest frequency bands. If circular polarization is required, a polarizer can be used immediately in front of the OMT. A combined OMT/Polarizer **54** (e.g. a Septum Polarizer) is shown instead of a separate OMT and polarizer. OMT/Polarizer **54** comprises high frequency RHCP port **56** and high frequency LHCP port **58**.
5. A four port feed would have one common junction whereas a six port feed would have two common junctions and so forth.
6. If a dual band feed were used, then OMT/Polarizer **54** would be placed after the first common junction and first high pass filter.
7. If additional frequency bands are present, OMTs, OMT/Polarizers, or more junctions are used in the proper sequence as described above to separate higher frequency bands.
8. If tracking is required, aforementioned waveguide assembly **20**A is modified to waveguide assembly **20**B as shown in FIG. **2**B. This modification adds a higher order mode coupler (e.g. TE21 or TM01) **25** placed between the Multi-frequency band horn **22** and the first common junction **24**, to extract a difference signal **23** used for tracking purposes. All other functions depicted in FIG. **2**B are as described above for FIG. **2**A.

Further references to a multi-frequency feed as noted herein imply a feed with single/dual linear/circular polarizations with/without tracking. The term "microwave" refers to signals with a frequency ranging from 1 giga hertz to 1,000 giga hertz.

The traditional way of producing a multi-frequency band feed system is to produce each component separately, and join them together by use of flanges, brazing or other techniques. An assembly of separate components can be expensive to produce, requires more space, and demands many flange connections, which can degrade the performance of the system.

Prior art of feed system designs are illustrated and described in U.S. Pat. No. 4,228,410 issued Oct. 14, 1980 to Kenneth R. Goudey, assigned to Ford Aerospace and Communications Corporation. Another design is illustrated and described in U.S. Pat. No. 6,700,548 B1 issued Mar. 2, 2004 to Ming Hui Chen, assigned to Victory Industrial Corporation.

The problem with the prior art feed U.S. Pat. No. 4,228,410 is that it requires many components, which result in a very long feed (several feet long for C-band) and is not cost effective to manufacture because of the complexity of the individual components. The large number of flange connections can also cause negative effects on electrical performances.

The problem with prior art feed U.S. Pat. No. 6,700,548 B1 is that the layout still results in a long feed. The assembly is made by joining four separate sections, which are not necessarily joined along the zero current line. Failure to join components along the zero current line can result in degraded electrical performance.

Large physical size of a feed assembly is a problem for many applications including satellites, airplanes, military craft, etc. The present invention solves the problems of size, for example the present invention would reduce the size of a C-band waveguide from over several feet long to less than one foot long. The present invention provides for ease of manufacture and optimizes the efficiency with respect to signal losses.

SUMMARY OF THE INVENTION

The main aspect of the present invention is to provide an efficient selection and layout of waveguide components for multi-frequency band antenna feeds.

Another aspect of the present invention is to provide an apparatus such that components can be machined (or otherwise manufactured) in a split block configuration.

Another aspect of the present invention is that it be applied to waveguide components with circular, rectangular, square, elliptical, co-axial, or any cross sections that can be created by making recesses in the split block.

Yet another aspect of the current invention is that the created blocks are joined at the zero current line of the components.

Another aspect of the present invention is very significant size reduction (especially axial length) realized by the proper choice and combination of waveguide components, which results in an efficient layout.

Another aspect of the current invention is the elimination of the need for flanges between different components.

Another aspect of the present invention is that the split block fabrication technique allows very cost effective manufacturing both during fabrication and assembly.

Another aspect of the present invention is that there is no limit to the frequency bands that can be applied to it as long as a practical method of fabrication is available.

Another aspect of the present invention is to provide a waveguide that can be manufactured with various fabrication methods, such as brazing, electroforming, machining, etc.

Yet another aspect of the present invention is that the layout provides the ability to incorporate waveguide components such as a mode coupler for extracting higher order modes for tracking purposes. These components although different in function are incorporated in a similar compact manner to the components for frequency band separation.

The present invention provides an efficient layout of waveguide components for multi-frequency band antenna feeds. It allows for compaction of components, maintains good electrical performance, is mechanically robust, eliminates flange connections between components, and is very cost effective to produce in small or large quantities.

The present invention allows waveguide components that can be machined in a split block configuration. The waveguide component(s) is/are produced by creating recesses in two pieces of material. The component(s) is/are formed after assembly of each split block. Assembly of the blocks can be done by any method that can effectively hold the blocks together such as bolts, brazing, soldering, and bonding. This process is very cost effective and significantly reduces the size of multi-frequency band antenna feeds.

The current invention is most effective when realized in a split block manufacture and assembly to create the unique structures used in multi-frequency band antenna feeds. For a dual frequency band feed only three blocks are required. A tri-band feed requires an assembly of four blocks. If tracking is required, an additional block assembly would be required between the horn and the first common junction. This technique can be used for as many unique frequency bands as are desired by the application for which they are intended for use. The present invention can be realized using any number of fabrication methods, such as brazing, electroforming, machining, etc.

Other aspects and advantages of the invention will become apparent from a consideration of the ensuing detailed description, drawings and appended claims, reference being made to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1**A is a prior art xyz plane view of a linearly polarized wave.

FIG. **1**B is a prior art xyz plane view of a right handed circular polarization.

FIG. **2**A is a prior art block diagram showing the components of a multi-frequency band antenna feed without tracking.

FIG. **2**B is a prior art block diagram showing the components of a multi-frequency band antenna feed with tracking.

FIG. **3** is a perspective view of a prior art waveguide feed assembly.

FIG. **4**A is a solid rear left side perspective view of the assembly of the multi-frequency waveguide internal structure for an embodiment of the present invention.

FIG. **4**B is a simplified block diagram of the assembly of the multi-frequency waveguide internal structure of FIG. **4**A.

FIG. **4**C is a solid front left side perspective view of the assembly of the multi-frequency waveguide internal structure, with a higher order mode coupler added for tracking, an additional embodiment of the present invention.

FIG. **4**D is a simplified block diagram of the assembly of the multi-frequency waveguide internal structure of FIG. **4**C.

FIG. **4**E is a solid front left side perspective view of the assembly of the multi-frequency waveguide internal structure, with a Quadrature Hybrid replacing the 90° polarizers and hybrid tees, an additional embodiment of the present invention.

FIG. **4**F is a simplified block diagram of the assembly of the multi-frequency waveguide internal structure of FIG. **4**E.

FIG. **4**G is a simplified block diagram of an alternative embodiment of the assembly of the multi-frequency waveguide internal structure of FIG. **4**E.

FIG. **5**A is a left side frontal perspective view of the exterior portions of the antenna feed assembly of an embodiment of present invention as viewed from the horn side.

FIG. **5**B is a left side frontal perspective view also showing the interior of the antenna feed assembly of an embodiment of the present invention as viewed from the horn side.

FIG. **5**C is a left side rear perspective view of the exterior portions of the antenna feed assembly of an embodiment of present invention as viewed from the side opposite the horn.

FIG. **5**D is a left side rear perspective view also showing the interior of the antenna feed assembly of an embodiment of the present invention viewed from the side opposite the horn.

FIG. **6**A is an exploded right side frontal perspective view of the compact multi-frequency feed and its three blocks of an embodiment of the present invention.

FIG. **6**B is an exploded rear left side perspective view of the compact multi-frequency feed and its three blocks of an embodiment of the present invention.

FIG. **7**A is a front side view of frontal block section.

FIG. **7**B is a rear side view of frontal block section.

FIG. **8**A shows the front side view of the center block of the compact multi-frequency feed.

FIG. **8**B shows the rear side view of the center block of the compact multi-frequency feed.

FIG. **9**A shows the front side view of the rear block of the compact multi-frequency feed.

FIG. **9**B shows the rear side view of the rear block of the compact multi-frequency feed.

FIG. **10**A is an exploded right side frontal perspective view of the compact multi-frequency feed and its four blocks of an additional embodiment of the present invention with tracking.

FIG. **10**B is an exploded rear left side perspective view of the compact multi-frequency feed and its four blocks of an additional embodiment of the present invention with tracking.

FIG. **11**A is a front side view of the frontal block of an additional embodiment of the present invention with tracking.

FIG. **11**B is a rear side view of the frontal block of an additional embodiment of the present invention with tracking.

FIG. **12**A is a front side view of the frontal center block of an additional embodiment of the present invention with tracking.

FIG. **12**B is a rear side view of the frontal center block of an additional embodiment of the present invention with tracking.

FIG. **13** is a solid rear left side perspective view of the assembly of the multi-frequency waveguide internal structure having a third modular area for an additional frequency and extended for other additional frequencies.

FIG. **14** is an exploded right side frontal perspective view of the compact multi-frequency feed having a third modular section for an additional frequency and extended for other additional frequencies.

Before explaining the disclosed embodiment of the present invention in detail, it is to be understood that the invention is not limited in its application to the details of the particular arrangement shown, since the invention is capable of other embodiments. Also, the terminology used herein is for the purpose of description and not of limitation.

DETAILED DESCRIPTION OF DRAWINGS

The present invention provides an efficient selection and layout of waveguide components for multi-frequency band antenna feeds. Optimization of layout eliminates components otherwise needed in prior art configurations. The layout of components in a systematic fashion starting from the horn input area and progressing from the lowest frequency to the next highest frequency, and so forth, results in an optimization of layout, and the number of components required. This process leads to the ability to manufacture an apparatus such that components can be machined (or otherwise manufactured) in a split block configuration or produced by other manufacturing means including brazing, electroforming, machining, etc.

The optimization of layout is most effective and is able to be totally produced in a split-block construction, in which the waveguide components are formed in the recesses split about the zero current line. This layout results in a very compact feed, which has excellent electrical characteristics, is mechanically robust, eliminates flange connections between components, and is very cost effective to produce. An embodiment of the present invention will be described herein with a dual frequency, four port layout.

For comparison, a prior art layout of a typical waveguide feed assembly **60** of a four-port waveguide feed is shown as a perspective view in FIG. **3**. The waveguide feed can either transmit or receive microwave signals. The functions are as previously described in FIG. **2**A. The feed assembly consists of the horn (not shown), where an input signal is received or an output signal is transmitted. The horn is attached to flange **63**. Signals are transmitted or received through horn input/output area **86**. For an input signal, horn taper area **88** feeds a polarized input signal into first common junction **64**, which also contains first low pass filters **65**, only three of the four first low pass filters **65** are visible. Visible is the first high pass filter **66**. Tee sections **67** recombine both wave polarizations for the lowest frequency signal. The lowest frequency signal then moves through first 90° polarizer **72**. The 90° polarizer allows a 90° phase shift for circularly polarized signals. The signal then goes to receiver electronics through low frequency (LF) RHCP port **78** or LF LHCP port **82**. For vertical or horizontal polarization, 90° polarizer **72** is not required. High pass filter **66** moves the higher frequency through second 90° polarizer/OMT **74** and out through HF RHCP port **76** or HF LHCP port **84**. For vertical or horizontal polarization, second 90° polarizer/OMT **74** is replaced by a simple OMT. At a junction you can have two orthogonal polarizations, vertical and horizontal. A junction is used to obtain a power split or a power recombination of two orthogonal linear polarizations. The vertical polarization signal travels through one pair of low pass filters thus each filter is getting a power split of the vertical polarization. The signal is recombined with a Tee section to restore it to the full power of the vertical polarization signal. Likewise, the horizontal polarization travels through the other pair of low pass filters and is combined to get the full signal of the horizontal polarization. Thus a junction is separating the vertical and horizontal polarizations and a Tee section is recombining signals. Prior art waveguide feed assembly **60** has axial length L**1**.

As can be seen in FIG. **3**, there are various subassemblies with flanges and mounting bolts that add to the complexity of prior art waveguide feeds. This, in turn, adds to the cost of manufacture and assembly, and also adds to the physical size of waveguide feeds of prior art. The preferred embodiment of the present invention as described herein is compared to the prior art of FIG. **3**.

An embodiment of the present invention is described below and comprises:

a) a first common junction;

b) a lowest frequency modular area with lowest frequency components comprising: a lowest frequency filter, lowest frequency polarizers, a lowest frequency magic tee (hybrid tee), and lowest frequency ports;

c) a second junction to move the next higher frequency signals to a higher frequency filter with a modular area comprising: a next higher frequency filter, next higher frequency polarizers, a next higher frequency magic tee (hybrid tee), and next higher frequency ports;

d) if required, a third junction to move the next higher frequency signals to a higher frequency filter and a third modular area is added and so forth until the number of required frequency modular areas are included in the layout;

e) wherein all components of a,b,c,d are built in a modular split block configuration.

FIG. **4**A is a solid rear left side perspective view of the assembly of the multi-frequency waveguide internal structure **210**, an embodiment of the present invention, having two separate frequency sections. A simplified block diagram of multi-frequency waveguide internal structure **210** is found in FIG. **4**B. Multi-frequency waveguide internal structure **210** will be shown later in a three sectional split block configuration. It can be seen how the present invention provides a compact internal structure as a waveguide feed to transmit and/or receive microwave signals. The path will be described as receiving signals into horn input/output area **207** and exiting to receiver electronics within one of the four ports described herein. Multi-frequency internal structure **210** comprises horn input/output area **207**, where an input signal is received or an output signal is transmitted. An input signal passes into first common junction **208**, and into LF filters **212** as polarized. The lowest frequency signal then moves through LF 90° polarizer **214**. LF 90° polarizer **214** allows a 90° phase shift that is necessary for circularly polarized signals. Magic tee (hybrid tee) section **216** recombines the two orthogonal components for the lowest frequency signal. Magic tee (hybrid tee) **216** is a four port, 180 degree hybrid splitter, realized in a waveguide. The signal then goes to receiver electronics through LF RHCP port **301** or LF LHCP port **204**. For linear polarization, polarizer **214** and magic tee (hybrid tee) **216** are not needed. In this case, vertical and horizontal polarization ports would be placed directly after each LF filter **212**, extended to the sidewall of the split block. Dummy ports **213** are connected to common junction **208** when a symmetrical structure is needed to eliminate unwanted modes and to help axial ratio. Junction **224** moves higher frequency signals to HF filtering section **228**, which can be seen in FIG. **4**C, and then to HF 90° polarizer **222**. Dummy ports **218** are also connected to the junction and are required when a symmetrical structure is needed to eliminate unwanted modes and to help axial ratio. The two orthogonal components of the HF signal are recombined by magic tee (hybrid tee) **226** and then exit out through HF RHCP port **302** or HF LHCP port **205**. For linear polarization, polarizer **222** and magic tee (hybrid tee) **226** are not needed.

In this case, vertical and horizontal polarization ports would be placed directly after HF junction **224**, extended to the sidewall of the split block. Multi-frequency waveguide internal structure **210** has axial length L**2**.

As can be seen on FIG. **4**A, the present invention provides a compact subassembly without flanges or mounting bolts that add to the complexity of prior art waveguide feeds. This reduces the cost of manufacture and assembly, and also reduces the physical size of the waveguide feed. Multi-frequency waveguide internal structure **210** can easily be sectioned in a three split block configuration for ease of manufacture, which is described below. It should be noted that a dual band four-port waveguide feed is described but this layout can easily be expanded to accommodate additional frequency bands and associated waveguide ports.

An additional embodiment of the present invention, shown in FIG. **4**C, is a solid front left side perspective view of the assembly of the multi-frequency waveguide internal structure **210**A, with higher order mode coupler **217** added for tracking. FIG. **4**D contains a simplified block diagram of the assembly of the multi-frequency waveguide internal structure **210**A. Higher order mode coupler **217** with tracking port **209** is placed between horn input/output area **207** and first common junction **208**. Thus, the only difference between previously described multi-frequency waveguide internal structure **210** (FIG. **4**A) embodiment and the additional embodiment multi-frequency waveguide internal structure **210**A (FIG. **4**C) is the inclusion of the tracking function via the addition of higher order mode coupler **217**. Multi-frequency waveguide internal structure **210**A has axial length L**3**. Fabrication of multi-frequency waveguide internal structure **210**A is similar to that of multi-frequency waveguide internal structure **210** but requires an additional split block to accommodate higher order mode coupler **217**. This will be shown and described below in FIGS. **10**A, **10**B, **11**A, **11**B.

An additional embodiment of the present invention, shown in FIG. **4**E, is a solid front left side perspective view of the assembly of multi-frequency waveguide internal structure **210**B, with waveguide Quadrature Hybrid **211** in place of the polarizer **214** and magic tee (hybrid tee) **216**. FIG. **4**F contains a simplified block diagram of the assembly of multi-frequency waveguide internal structure **210**B. Quadrature Hybrid **211** performs the same electrically as the 90° polarizer and the magic tee (hybrid tee) with the added benefit of being able to adjust the amplitude balance of the input/output. An input signal passes into first common junction **208**, and into LF filters **212** as polarized. The lowest frequency signal then moves through LF Quadrature Hybrid **211** where it performs a 90° phase shift and recombines the two orthogonal components for the signal. The signal then goes to receiver electronics through LF RHCP port **301**B or LF LHCP port **204**B. For linear polarization, Quadrature Hybrid **211** is not needed. In this case, vertical and horizontal polarization ports would be placed directly after each LF filter **212**, extended to the sidewall of the split block. Junction **224** moves higher frequency signals to HF filtering section **228**, and then to HF Quadrature Hybrid **219**. The HF signal then exits out through HF RHCP port **302**B or HF LHCP port **205**B. For linear polarization, Quadrature Hybrid **219** is not needed. In this case, vertical and horizontal polarization ports would be placed directly after HF junction **224**, extended to the sidewall of the split block. Multi-frequency waveguide internal structure **210**B has axial length L**4**.

In another embodiment, multi-frequency waveguide internal structure **210**B could be modified to support additional frequency bands. For each additional frequency band needed, an additional module may be added. Each module may comprise a common junction, a set of dummy ports, a low pass filter, and a Quadrature Hybrid. By way of example and not of limitation, FIG. **4**G contains a simplified block diagram of multi-frequency waveguide internal structure **210**B modified to support three frequency bands. In order to support a third frequency band, module **500** may be added. Module **500** may comprise common junction **508**, dummy ports **513**, low pass filter **512**, and third Quadrature Hybrid **511**. High pass filter **528** may be formed by the junction of common junction **208** and common junction **508**. Third frequency band signals may exit through RHCP port **501** and LHCP port **504**.

FIGS. **5**A, **5**B show the left side frontal perspective views of the an embodiment of the present invention, which is a split block, three section compact assembly comprising all of the functions as previously described in FIG. **4**A above. Compact multi-frequency feed **200** is shown with a layout in a three split block structural configuration. Split block sections include center block **202**, which is between frontal block **203** and rear block **201**. Shown are horn input/output area **207**, LF LHCP port **204** and HF LHCP port **205**. FIG. **5**B is the identical perspective view as shown in FIG. **5**A and additionally shows multi-frequency waveguide internal structure **210** (ref. FIG. **4**A), which will be described in more detail below in FIG. **6**.

From FIGS. **5**A and **5**B it can be seen that the blocks are split about the zero current line for each of the waveguide structures in order to prevent degradation in electrical performance. The present invention could also comprise multiple central blocks as necessary to obtain the desired number of frequency bands for the waveguide feed.

FIGS. **5**C, **5**D, show the left side rear perspective views of an embodiment of the present invention as viewed from the side opposite the horn. In FIG. **5**C compact multi-frequency feed **200** is shown with center block **202**, frontal block **203**, and rear block **201**. Shown are HF RHCP port **302**, HF LHCP port **205**, LF LHCP port **204**, and LF RHCP **301**. FIG. **5**D shows the multi-frequency waveguide internal structure **210** (ref. FIG. **4**A), which will be described in more detail below in FIG. **7**.

To achieve any combination of single/dual linear/circularly polarized signals there are multiple ports in the antenna feed system. FIGS. **5**A, **5**B show that there are two ports on the sides (left front and top side respectively) of the blocks that contain the input/output of the antenna feed system. The LHCP input/output for the higher frequency band of the antenna feed system is from HF LHCP port **205**. The lower frequency LHCP band input/output for the antenna feed system is from LF LHCP port **204**. FIGS. **5**C, **5**D show that there are two more ports on the rear side section **201** opposite to the horn, or antenna area. All four ports are visible on FIGS. **5**C, **5**D. Ports on the rear are LF RHCP port **301** and HF RHCP port **302**. These both contain input/output of the antenna feed system for the RHCP polarization of the feed system.

FIG. **6**A is an enlarged right side frontal perspective view of the compact multi-frequency feed **200** and its three blocks; center block **202**, frontal block **203**, and rear block **201** of an embodiment of the present invention. Also shown is LF LHCP port **204** and horn input junction **207**. Inner sections will be described below in FIGS. **7**A, **7**B, **8**A, **8**B, **9**A, and **9**B.

FIG. **6**B is an enlarged rear left side perspective view of the compact multi-frequency feed **200** and its three blocks; center block **202**, frontal block **203**, and rear block **201** of an embodiment of the present invention. Also shown are HF RHCP port **302** and LF RHCP port **301**. Inner sections will be described below in FIGS. **7**A, **7**B, **8**A, **8**B, **9**A, and **9**B.

Center block **202** as shown above contains one half of the waveguide structures for each band of the two band antenna feed shown. The other half of each waveguide structure is contained in the opposing block. Outer block **203** will have the connection to horn input junction **207**, which can be designed with the properties that are necessary to obtain the desired performance of the system.

FIG. **7**A is a front view of frontal block section **203** showing horn input junction **207**. Horn input junction **207** will have a connection to an antenna horn. The antenna horn may be an integral part of the structure or an individual part.

FIG. **7**B is a rear view of frontal block section **203** with the recesses made into the block of material. All recesses will be described herein with suffixes ‘A’ or ‘B’ on previous numbering of FIGS. **4**A, **4**C, as the recesses form a function, which is completed by joining two or more adjacent block sections. For example, **212**A (FIG. **7**B) would mate with **212**B (FIG. **8**A) to form low pass filter **212** (FIG. **4**). Horn input junction **207** (FIG. **7**A) is continued to previously described first common junction **208**A. First common junction **208**A branches to connect filters **212**A to reject all higher frequency bands. After the filters there is waveguide polarizer **214**A. Waveguide polarizer **214**A can be any device that creates a 90° phase delay between the two liner signals traveling in the two orthogonal paths. Connected to the waveguide polarizer is a hybrid magic tee (hybrid tee) **216**A that combines the signals in such a way that one can obtain both LHCP and RHCP signals. LF LHCP port **204**A is shown at the top of frontal block section **203**. The LF LHCP signal will be produced at the LF LHCP port **204** and the RHCP signal is produced at LF RHCP port **301**, shown below in sections **201** and **202**. If the system does not require both LHCP and RHCP, a standard tee can replace hybrid magic tee (hybrid tee) **216**. If the signal is linearly polarized the vertical and horizontal polarization ports would be placed directly after each LF filter **212**, extended to the sidewall of the split block. Also attached to the first common junction **208**A are dummy ports **213**A, which are used when a symmetrical structure is required to eliminate unwanted modes and to help axial ratio. Axial ratio is related to an electromagnetic wave having elliptical polarization, the ratio of the magnitudes of the major axis and the minor axis of the ellipse described by the electric field vector.

Frontal block **203** and center block **202**, when combined, contain all structures of, and form in their recesses a complete waveguide structure for the lowest frequency band of compact multi-frequency feed **200**. Center block **202** (FIGS. **8**A, **8**B) contains a portion (junction **224**A) of HF junction **224** connecting to the higher frequency band of compact multi-frequency feed **200**. It also includes HF filtering section **228** that will allow only higher frequency signals to propagate to the higher frequency junction **224**.

FIGS. **8**A, **8**B show the front and the rear views of the center block **202** of the compact multi-frequency feed **200**. The front face of center block **202** (FIG. **8**A) will be attached to the rear face of frontal block **203** (FIG. **7**B) and the rear face of center block **202** will be attached to the front face of rear block **201** (FIG. **9**A).

FIG. **8**A shows HF filtering section **228** that allows only higher frequency signals to propagate to HF junction **224**. Shown are LF LHCP port **204**B, LF magic tee (hybrid tee) **216**B, LF polarizers **214**B, first common junction **208**B, LF low pass filters **212**B, and dummy ports **213**B.

FIG. **8**B is a detailed view of the rear of center block **202** with the internal recesses made into the material. HF junction **224**A is connected to waveguide polarizer **222**A. Waveguide polarizer **222**A can be any device that creates a 90° phase delay between the two liner signals traveling in the two orthogonal paths. If the signal is linearly polarized the vertical and horizontal polarization ports would be placed directly after the HF junction **224**A, and then extended to the sidewall of the split block. In this layer like the last, dummy port sections **218**A are required when a symmetrical structure is required to eliminate unwanted modes and to help axial ratio. The RHCP signal from the lower frequency band travels through LF RHCP port **301**A to its final destination in LF RHCP port **301**. Shown is HF LHCP port **205**A and hybrid tee **226**A.

Other center block sections similar to or containing various configurations can be repeated for as many unique frequency bands as are desired by the application for which they are intend for use.

FIGS. **9**A, **9**B show both front and rear views of rear block **201** section of compact multi-frequency feed **200**.

Since the FIG. **9**A is the second half of all the structures that are defined in FIG. **8**B, when the two block sections **201**, **202** are placed together they form in their recesses a complete wave guide structure for the highest frequency band of compact multi-frequency feed **200**. Rear block **201** also contains the input/output for the LF RHCP port **301**.

FIG. **9**A is a detailed view of the front of rear block **201** with the internal recesses made into material. HF junction **224**B, is connected to waveguide polarizer **222**B. Waveguide polarizer **222**B which is then connected to hybrid tee **226**B which, when combined with **226**A, will allow circular polarized signals to propagate to the input/output ports. If the signal is linearly polarized the vertical and horizontal polarization ports would be placed directly after HF junction **224**B, extended to the sidewall of the split block. In this layer like the last dummy port sections **218**B are required when a symmetrical structure is required to eliminate unwanted modes and to help axial ratio. The RHCP signal from the lower frequency band travels through LF RHCP port **301**B to its final destination in LF RHCP port **301**. Also shown is HF LHCP port **205**B.

FIG. **9**B shows the output ports for both of the RHCP signals for both bands, LF RHCP port **301** and HF RHCP **302**, of compact multi-frequency feed **200**. The HF RHCP port **302** is perpendicular to the LF RHCP port **301**. These ports can also be seen from FIGS. **5**C, **5**D.

It should be noted that although an embodiment of the present invention has been described above with four ports and two frequency bands, it also applies to addition of any required number of frequency bands with additional designed center sections.

FIGS. **10**A, **10**B show the additional embodiment multi-frequency waveguide with tracking **300** that has internal structure **210**A shown in FIG. **4**C. This structure accommodates the inclusion of the tracking function via the addition of higher order mode coupler **217** (ref. FIG. **4**C). Split block sections **203**C, **203**D accommodate tracking and will be described below in FIGS. **11**A, **11**B, **12**A, **12**B. Rear center block **202** and rear block **201** split block sections are identical to those previously described in FIGS. **8**A, **8**B, **9**A, **9**B and thus will not be described below.

FIG. **10**A is an enlarged right side frontal perspective view of the compact multi-frequency feed with tracking **300** and its four split blocks of an additional embodiment of the present invention. Shown are compact multi-frequency feed with tracking **300** and its four split blocks; frontal block **203**C, frontal center block **203**D, rear center block **202**, and rear block **201**. Also shown is LF LHCP port **204**, tracking port **209**, and horn input junction **207**.

FIG. **10**B is an enlarged rear left side perspective view of the compact multi-frequency feed with tracking **300** and its four blocks of the additional embodiment of the present invention. FIG. **10**B shows four split blocks; rear block **201**, rear center block **202** and front center block **203**D, and frontal block **203**C, for the additional embodiment of the present invention. Also shown are HF RHCP port **302** LF RHCP port **301**, and HF LHCP port **205**. Inner sections will be described below in FIGS. **11**A, **11**B, **12**A, and **12**B.

FIG. **11**A is a front side view of the frontal block section **203**C of an additional embodiment of the present invention with tracking showing horn input junction **207**. Horn input junction **207** will have a connection to an antenna horn. The antenna horn may be an integral part of the structure or an individual part.

FIG. **11**B is a rear side view of the frontal block section **203**C showing higher order mode coupler **217**A added for tracking. Higher order mode coupler **217**A with tracking port **209**A is placed between horn input/output area **207** and first common junction **208** (see FIGS. **4**A, **4**C).

FIG. **12**A is a front side view of the frontal center block **203**D of an additional embodiment of the present invention with tracking. Shown in FIG. **12**A, off of first common junction **208**, is higher order mode coupler **217**B and tracking port **209**B. FIG. **12**B the rear side view of frontal center block **203**D and is identical to FIG. **7**B as previously described.

Frontal block **203**C and frontal center block **203**D, when combined, contain all structures of higher order mode coupler **217** and tracking port **209** to accommodate the addition of tracking in an additional embodiment of the present invention.

FIGS. **13**, **14** below represent yet additional embodiments of the present invention to accommodate additional frequencies.

FIG. **13** is a solid rear left side perspective view of an additional embodiment of the present invention showing the assembly of the multi-frequency waveguide internal structure showing previously described module **210** and having additional third modular area **310**E for an added frequency and can be further extended for additional frequency module areas, **410** i.e. Each module added would have a common junction **208**E, dummy ports **213**E connected to the junction, filters **212**E, polarizers **214**E and ports **301**E, **204**E. Additional frequencies can be added in frequency order by the addition of module areas similar to modular area **310**. Module area **410** is shown with similar components as module area **310**E using 'F' suffixes for each like element.

FIG. **14** is an exploded right side frontal perspective view of the compact multi-frequency feed **200**G having additional modular section block **203**E to accommodate a third frequency. For each additional frequency added, another block section is needed. For example, aforementioned modular area **310** (for one additional frequency) would be accommodated in one side of block **203**D (not shown) and the visible side of block **203**E. All components and layouts are easily concluded from the aforementioned discussions. Additional modular sections are easily added to accommodate additional added frequencies by adding sectional blocks.

The present invention in various embodiments provides an efficient layout of waveguide components, compared to prior art, for multi-frequency band antenna feeds. It allows for compaction of components, maintains good electrical performance, is mechanically robust, eliminates flange connections between components, and is very cost effective to produce in small or large quantities. It can be applied to waveguide components with circular, rectangular, square, elliptical, coaxial, or any cross sections that can be created by making recesses in the split block.

The present invention allows waveguide components that can be machined in a split block configuration. Recesses are created in two pieces of material to produce the waveguide components. The components are formed after assembly of each respective split block. It eliminates the need for flanges between different components. Assembly of the blocks can be done by any method that can effectively hold the blocks together such as bolts, brazing, soldering, and adhesive bonding. Various layouts can be realized using any number of fabrication methods, such as brazing, electroforming, and machining. The apparatus and method of the present invention would reduce size by a factor of about two or more, especially in the dimension of axial length. For example, a multi-frequency waveguide in the range of the Ka-band (18-31 GHz), would typically be about 4" depth×4.5" width by 8" long in prior art, whereas it has been demonstrated that the present invention, in the same frequency range, would reduce the size to about 2" by about 2.5" by about 3" length. Typical split block sections are in a range of about 2" by 2.5" with a depth of about 0.4" to about 1.2". The significant reduction in axial length is a major advantage of the present invention, especially in packaging waveguides in small compartments aboard satellites, aircraft etc. This process is very cost effective and significantly reduces the size of multi-frequency band antenna feeds. The present invention can be applied to waveguide components with circular, rectangular, square, elliptical, co-axial, or any cross sections that can be created by making recesses in the split block. Split block fabrication techniques allow very cost effective manufacturing both during fabrication and assembly regardless of quantities involved.

Split block manufacturing and assembly is used to create the unique structures used in multi-frequency band antenna feeds. For a dual frequency band feed only three blocks are required. A tri-band feed requires an assembly of four blocks. This technique can be used for as many unique frequency bands as are desired by the application for which they are intended for use.

Elimination of the need for flanges between the different components required by the feed eliminates the risk of electrical performance degradation due to flange misalignments and imperfections.

Created blocks are joined at the zero current line of the components, which practically eliminates electrical performance degradation that may arise due to misalignment between two adjacent blocks. There is no limit to the frequency bands that can be applied to it as long as a practical method of fabrication is available. The layout provides the ability to use standard tracking systems.

Although the present invention has been described with reference to preferred embodiments, numerous modifications and variations can be made and still the result will come within the scope of the invention. No limitation with respect to the specific embodiments disclosed herein is intended or should be inferred.

PARTIAL GLOSSARY

ITEM NAME	ITEM NUMBER
Waveguide Asm	20
Multi-frequency horn	22
First Common Junction	24
Low pass filter	26
First 90 degree polarizer	28
First waveguide port RHCP	32
First waveguide port LHCP	34
First High pass filter	36
Second common junction	38
Second low pass filter	42
Second 90-deg polarizer	44
Second waveguide port RHCP	46
Second waveguide port LHCP	48
Second High pass filter	52
OMT/Polarizer	54
High frequency RHCP port	56
High frequency LHCP port	58
Prior art waveguide asm.	60
Horn flange	63
first common junction	64
First low pass filter	65
High pass filter	66
Magic (hybrid) Tee	67
High pass filter	68
First 90 deg polarizer	72
second 90 deg polarizer	74
high freq RHCP port	76
low freq RHCP port	78
Low freq LHCP port	82
High freq LHCP port	84
Horn input/output area	86
Horn taper area	88
Compact multi-freq feed	200
rear block	201
center block	202
frontal block	203
low frequency LHCP	204
high frequency LHCP	205
multifreq waveguide internal structure	210
horn input junction	207
first common junction	208
LF filter	212
dummy ports	213
LF Magic (hybrid) Tee	216
Higher order mode coupler	217
LF 90 deg polarizer	214
Dummy ports	218
HF 90 deg polarizer	222
High freq junction	224
HF magic (hybrid) Tee	226
HF filtering section	228
Low freq RHCP port	301
High freq RHCP port	302
Module	500
Common junction	508
Dummy ports	513
Low pass filter	512
High pass filter	528
3rd Quadrature Hybrid	511
RHCP port	501
LHCP port	504

We claim:

1. A multilayered assembly forming a microwave feed network, the assembly comprising:

a first common junction means functioning to send/receive microwave signals;

the first common junction means connected to a second junction and to a low frequency modular area;

wherein the low frequency modular area comprises a low pass filter and low frequency ports;

wherein an interface between the first common junction means and the second junction functions as a high pass filter;

the second junction connected to the first common junction means and to a high frequency modular area;

wherein the high frequency modular area comprises high frequency ports;

wherein all components of the first common junction means, the second junction, the low frequency modular area, and the high frequency modular area are built in a modular split block configuration; and

wherein the modular split block configuration comprises a plurality of split blocks.

2. The assembly of claim **1**, wherein all components of the first common junction means, the second junction, the low frequency modular area, and the high frequency modular area are split along respective zero current lines when the split blocks are separated.

3. A multilayered assembly forming a microwave feed network, the assembly comprising:

a first common junction means functioning to provide an input/output area;

the first common junction means connected to a second junction, a first set of dummy ports, and to a low frequency modular area;

wherein the low frequency modular area comprises a low pass filter, a low frequency polarizer, a low frequency hybrid tee, and low frequency ports;

wherein an interface between the first common junction means and the second junction functions as a high pass filter;

the second junction connected to the first common junction means, to a high frequency modular area, and to a second set of dummy ports;

wherein the high frequency modular area comprises a high frequency polarizer, a high frequency hybrid tee, and high frequency ports;

wherein all components of the first common junction means, the second junction, the first set of dummy ports, the second set of dummy ports, the low frequency modular area, and the high frequency modular area are built in a modular split block configuration; and

wherein the modular split block configuration comprises a plurality of split blocks.

4. The assembly of claim **3**, wherein all components of the first common junction means, the second junction, the first set of dummy ports, the second set of dummy ports, the low frequency modular area, and the high frequency modular area are split along respective zero current lines when the split blocks are separated.

5. A multilayered assembly forming a microwave feed network, the assembly comprising:

a first common junction means functioning to send/receive microwave signals;

the first common junction means connected to a higher order mode coupler, a second junction, a first set of dummy ports, and to a low frequency modular area;

wherein the higher order mode coupler comprises a tracking port;

wherein the low frequency modular area comprises a low frequency filter, a low frequency polarizer, a low frequency hybrid tee, and low frequency ports;

wherein an interface between the first common junction means and the second junction functions as a high pass filter;

the second junction connected to the first common junction means, to a second set of dummy ports, and to a high frequency modular area;

wherein the high frequency modular area comprises a high frequency polarizer, a high frequency hybrid tee, and high frequency ports;

wherein all components of the higher order mode coupler, the first common junction means, the second junction, the first set of dummy ports, the second set of dummy ports, the low frequency modular area, and the high frequency modular area are built in a modular split block configuration; and

wherein the modular split block configuration comprises a plurality of split blocks.

6. The assembly of claim **5**, wherein all components of the higher order mode coupler, the first common junction means, the second junction, the first set of dummy ports, the second set of dummy ports, the low frequency modular area, and the high frequency modular area are split along respective zero current lines when the split blocks are separated.

7. A multilayered assembly forming a microwave feed network, the assembly comprising:

a first common junction means functioning to provide an input/output area;

the first common junction means connected to a second junction, a first set of dummy ports, and to a low frequency modular area;

wherein the low frequency modular area comprises a low pass filter, and a first quadrature hybrid;

wherein an interface between the first common junction means and the second junction functions as a high pass filter;

the second junction connected to the first common junction means, a high frequency modular area, and a second set of dummy ports;

wherein the high frequency modular area comprises a second quadrature hybrid;

wherein all components of the first common junction means, the second junction, the first set of dummy ports, the second set of dummy ports, the low frequency modular area, and the high frequency modular area are built in a modular split block configuration; and

wherein the modular split block configuration comprises a plurality of split blocks.

8. The assembly of claim **7**, wherein all components of the first common junction means, the second junction, the first set of dummy ports, the second set of dummy ports, the low frequency modular area, and the high frequency modular area are split along respective zero current lines when the split blocks are separated.

9. A multilayered assembly forming a microwave feed network, the assembly comprising:

a lowest frequency module comprising a lowest frequency common junction means, a lowest set of dummy ports, a lowest pass filter, a lowest frequency polarizer, a lowest frequency hybrid tee, and lowest frequency ports;

a highest frequency module comprising a highest frequency junction, a highest set of dummy ports, a highest frequency polarizer, a highest frequency hybrid tee, and highest frequency ports;

one or more intermediate modules connected in series between the lowest frequency module and the highest frequency module;

wherein each said intermediate module is tuned to operate at a pre-selected frequency range;

wherein each said intermediate module comprises a common junction means, a set of dummy ports, a low pass filter, a polarizer, a hybrid tee, and ports;

wherein an interface between each said intermediate module functions as a high pass filter;

wherein the lowest frequency module, the highest frequency module, and the one or more intermediate modules are built in a modular split block configuration; and

wherein the modular split block configuration comprises a plurality of split blocks.

10. The assembly of claim **9**, wherein all components of the lowest frequency module, the highest frequency module, and the one or more intermediate modules are split along respective zero current lines when the split blocks are separated.

11. A multilayered assembly forming a microwave feed network, the assembly comprising:

a lowest frequency module comprising a lowest frequency common junction, a lowest set of dummy ports, a lowest pass filter, and a lowest frequency quadrature hybrid;

a highest frequency module comprising a highest frequency junction, a highest set of dummy ports, and a highest frequency quadrature hybrid;

one or more intermediate modules connected in series between the lowest frequency module and the highest frequency module;

wherein each said intermediate module is tuned to operate at a preselected frequency range;

wherein each said intermediate module comprises a common junction, a set of dummy ports, a low pass filter, and a quadrature hybrid;

wherein an interface between each said intermediate module functions as a high pass filter;

wherein the lowest frequency module, the highest frequency module, and the one or more intermediate modules are built in a modular split block configuration; and

wherein the modular split block configuration comprises a plurality of split blocks fastened together without flanges.

12. The assembly of claim **11**, wherein all components of the lowest frequency module, the highest frequency module, and the one or more intermediate modules are split along respective zero current lines when the split blocks are separated.

13. A microwave feed network comprising:

a plurality of plates each having planar surfaces;

a contiguous joining of a plurality of co-planar surfaces forming recesses in the plates;

wherein the recesses form the microwave feed network;

the microwave feed network comprising:

a first common junction for receiving/sending microwave signals;

the first common junction connected to a second junction and to a low frequency modular area;

wherein the low frequency modular area comprises a low pass filter and low frequency ports;

wherein an interface between the first common junction and the second junction functions as a high pass filter;

the second junction connected to the first common junction and to a high frequency modular area; and

wherein the high frequency modular area comprises high frequency ports.

14. A contiguous joining of co-planar surfaces of adjoined plates forming a microwave feed network in recesses in the plates, wherein the microwave feed network comprises:

a first common junction;

the first common junction connected to a second junction, to a first set of dummy ports, and to a low frequency modular area;

wherein the low frequency modular area comprises a low pass filter and a first quadrature hybrid;

wherein an interface between the first common junction and the second junction functions as a high pass filter;

the second junction connected to the first common junction, a second set of dummy ports, and to a high frequency modular area; and

wherein the high frequency modular area comprises a second quadrature hybrid.

15. A multilayered assembly forming a microwave feed network, the assembly comprising:

a plurality of blocks having recesses;

wherein the blocks are joinable to each other in a coplanar manner;

wherein the recesses form a plurality of waveguides when the blocks are joined in the coplanar manner; and

wherein the assembly comprises one or more common junctions, a junction, one or more dummy ports, one or more filters, one or more polarizers, one or more hybrid tees, and one or more ports.

16. The assembly of claim **15**, wherein the plurality of waveguides are split along zero current lines when the blocks are separated from each other.

17. A multilayered assembly forming a microwave feed network, the assembly comprising:

a first common junction means functioning to route microwave signals;

a low pass filter means functioning to pass a predetermined low frequency range of microwave signals;

a high pass filter means functioning to pass a predetermined high frequency range of microwave signals;

a first dummy port means functioning to create a first symmetrical structure;

wherein the first common junction means is connected to the low pass filter means, the first dummy port means, and the high pass filter means;

a first quadrature hybrid means functioning to polarize and combine microwave signals;

wherein the first quadrature hybrid means is connected to the low pass filter means;

a second junction means functioning to route microwave signals;

a second dummy port means functioning to create a second symmetrical structure;

a second quadrature hybrid means functioning to polarize and combine microwave signals;

wherein the second junction means is connected to the high pass filter means, the second dummy port means, and the second quadrature hybrid means;

wherein all components of the first common junction means, the second junction means, the first dummy port means, the low pass filter means, the first quadrature hybrid means, the high pass filter means, the second junction means, the second dummy port means, and the second quadrature hybrid means are built in a modular split block configuration; and

wherein the modular split block configuration comprises a plurality of split blocks.

18. A process of producing a microwave feed network with a minimal axial length, the process comprising the steps of:

selecting waveguide components to be produced in a modular split block configuration;

wherein the modular split block configuration comprises a plurality of split blocks;

grouping the waveguide components into frequency modular areas;

wherein each said frequency modular area comprises a filter and a port;

arranging a layout of the frequency modular areas within the split blocks such that the frequency modular areas are placed in an ascending order with respect to a frequency modular areas' frequency range;

placing the frequency modular area with a lowest frequency range closest to a horn connection point;

forming the split blocks such that the split blocks may be joined together without the use of flanges; and

forming the split blocks such that the waveguide components are split along their respective zero current lines when the split blocks are separated.

19. The process of claim **18**, wherein the waveguide components to be produced in the modular split block configuration further comprise one or more common junctions, one or more low pass filters, one or more polarizers, one or more hybrid tees, one or more high pass filters, one or more dummy ports, and one or more junctions.

20. The process of claim **18**, wherein the waveguide components to be produced in the modular split block configuration further comprise one or more common junctions, one or more low pass filters, one or more quadrature hybrids, one or more high pass filters, one or more dummy ports, and one or more junctions.

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