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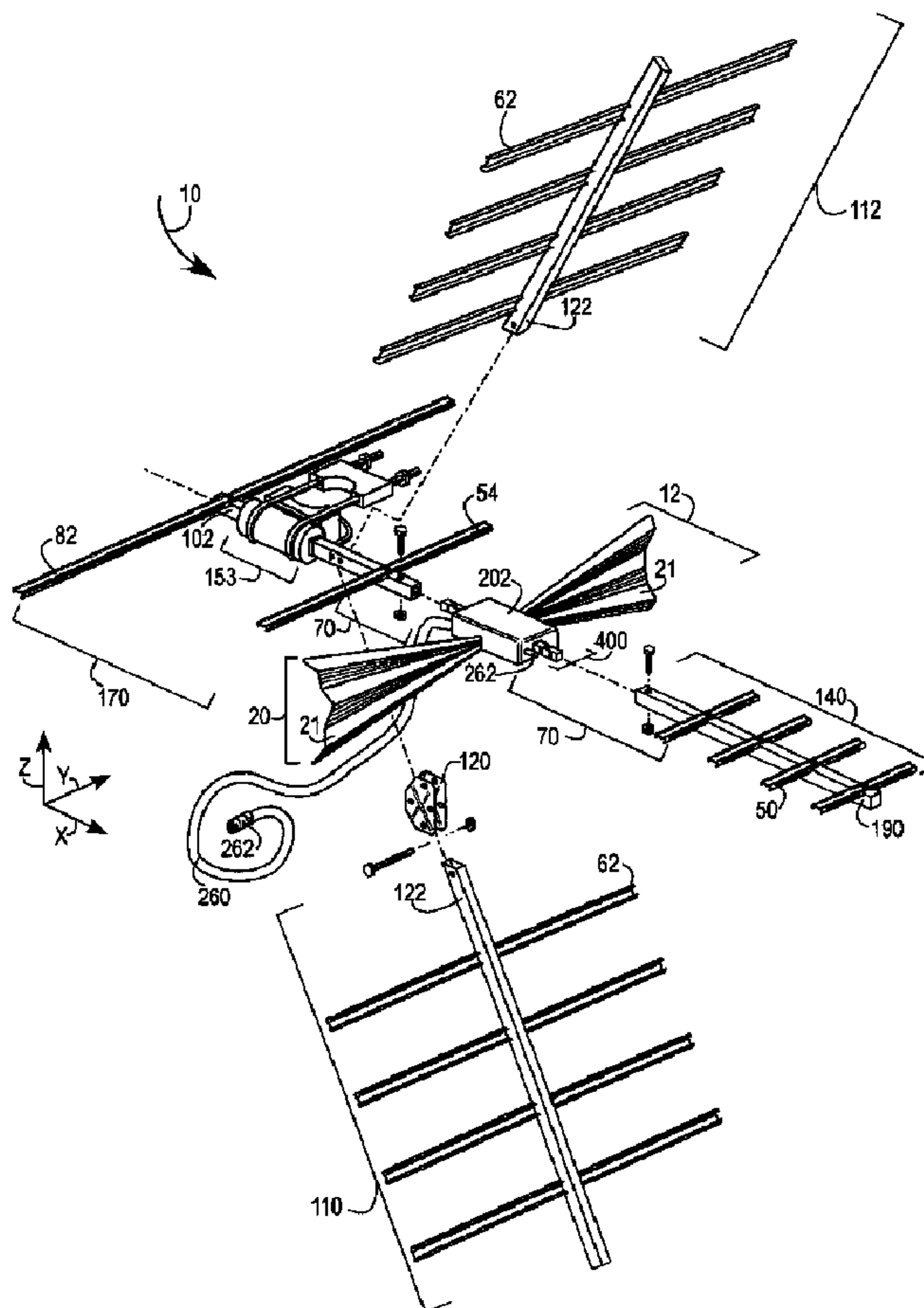
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(71) Demandeur/Applicant:
HAGEN, DAVID L., US

(72) Inventeurs/Inventors:
HAGEN, DAVID L., US;
ECKWIELEN, BRADLEY L., US;
JOOSER, RANDALL J., US

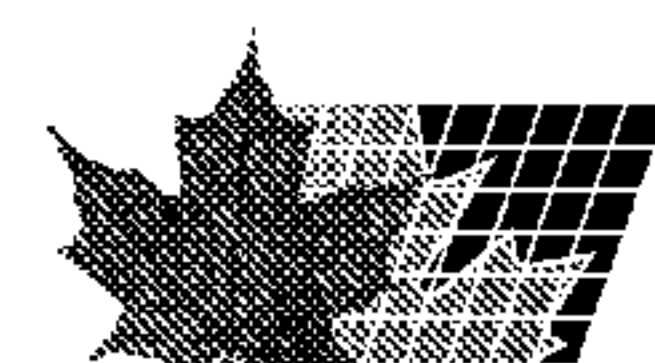
(54) Titre : ANTENNE NUMERIQUE VHF-UHF PERFECTIONNEE

(54) Title: ENHANCED DIGITAL UHF VHF ANTENNA



(57) Abrégé/Abstract:

The invention relates to Radio Frequency (RF) antennas suitable for receiving and/or transmitting digital signals in the Ultra High Frequency (UHF) and/or Very High Frequency (VHF) ranges. The invention comprises a modular driven DUV antenna comprising



(57) **Abrégé(suite)/Abstract(continued):**

a driven DUV element, an RF signal line RF communicatively connected to the driven DUV element, an antenna mount supporting the DUV element; and a modular RF signal enhancer, supported by the antenna mount and selected from: an RF amplifier and a passive RF enhancer positioned to enhance the RF performance of the DUV antenna and comprising one of: an RF director, an RF reflector, and an RF booster.

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Abstract of the Disclosure

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The invention relates to Radio Frequency (RF) antennas suitable for receiving and/or transmitting digital signals in the Ultra High Frequency (UHF) and/or Very High Frequency (VHF) ranges. The invention comprises a modular driven DUV antenna comprising a driven DUV element, an RF signal line RF communicatively connected to the driven DUV element, an antenna mount supporting the DUV element; and a modular RF signal enhancer, supported by the antenna mount and selected from: an RF amplifier and a passive RF enhancer positioned to enhance the RF performance of the DUV antenna and comprising one of: an RF director, an RF reflector, and an RF booster.

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Patent Title

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Enhanced Digital UHF VHF Antenna

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Inventors

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Brad Lee Eckwielen, David LeRoy Hagen, and Randall J. Joosse

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CROSS REFERENCE TO RELATED APPLICATIONS

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[0001] This application claims the priority of U.S. Patent Application 12/456,010 filed on June 10, 2010, entitled "Enhanced Digital UHF/VHF Antenna". The Digital UHF/VHF ("DUV") technology is further taught in Canadian Application 2604405 "Digital UHF/VHF Antenna" filed 1st Nov. 2007, from U.S. Patent Application issued as US Patent 7,626,557 on Dec. 1, 2009 (herein the "DUV application"), and in Canadian Application No: 2606930 "Modular digital UHF/VHF antenna" Filed on 1st November, 2007 (from US Patent Application #20080309573 filed March 31, 2007) herein the "Modular DUV application".

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BACKGROUND OF THE INVENTION

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Field of Invention

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[0002] This invention relates to Radio Frequency (RF) antennas suitable for receiving and/or transmitting digital signals in the Ultra High Frequency (UHF) and/or Very High Frequency (VHF) ranges.

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Description of the Related Art

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[0003] The Digital Television (DTV) broadcast causes pixilation with partial or complete loss of reception if the signal delivered by an antenna is near or below threshold reception performance. Over the air broadcast includes DTV, VHF and UHF band channels. Commercially available antennas that provide good VHF reception are large, complex, and expensive. They usually have numerous Radio Frequency (RF) phasing lines and RF contacts

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1 that are prone to corrosion, and/or fatigue, thus degrading their performance. Antennas are often
 2 delivered folded, and users or installers frequently forget to unfold them. Antennas advertised for
 3 “VHF UHF” reception are typically small with modest performance in the UHF and poor
 4 performance in the VHF bands. DTV signal varies from high in urban areas to very low in deep
 5 fringe areas. Yet relevant art antennas do not have the flexibility to have their gains configured
 6 according to local needs. Typical antennas are not suitable for bidirectional internet use.

7 **[0004]** Conventional relevant art typically uses 4:1 impedance matching balun's which
 8 may not provide good impedance matching between TV antennas and signal cables. Pre-
 9 amplifiers and/or amplifiers with antennas often use thin or fine leads and numerous
 10 components, increasing the prospects for failure.

11 **Summary of the Invention**

12 **[0005]** The Applicants’ previous “DUV” technology applications teach Digital
 13 UHF/VHF antennas and methods of configuring them which provide major improvements in
 14 wide band UHF and VHF performance while being relatively small and lightweight.
 15 Embodiments may be configured for the VHF range from 30 MHz to 300 MHz, and for the UHF
 16 from 300 MHz to 3 GHz. Larger stiffened driven antennas may be used with resonance in both
 17 prescribed VHF ranges and prescribed UHF ranges in some configurations. E.g., DUV antennas
 18 may have one half or five eighths waveform resonance from 174 MHz to 220 MHz in the VHF
 19 High band with full waveform or three halves waveform resonance in the UHF DTV band from
 20 470 MHz to 698 MHz. In some configurations, these driven antennas may be complemented by
 21 passive RF enhancers including one or more of RF directors in front of the driven antenna, axial
 22 RF reflectors behind the driven antenna, and off axis RF booster reflectors or “RF boosters”.
 23 Such passive RF enhancers improve RF performance without the complex phasing lines,
 24 numerous contacts, and the related contact and performance degradation with time typical of the
 25 prior art.

26 **[0006]** The present invention forms modules of these components that may be
 27 combined to facilitate configuration of Digital UHF/VHF (DUV) antennas for Indoor, Urban,

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1 Metro, Fringe, Deep Fringe and/or Extreme Fringe regions. In some embodiments, driven DUV
2 antennas may be configured for UHF, broadband UHF/VHF, VHF, and/or extended frequency
3 configurations. These may be complemented by passive (or “parasitic”) RF enhancer modules
4 comprising RF directors, RF axial reflectors and/or off axis RF boosters. In some embodiments
5 these passive enhancer modules may be complemented by modular RF amplifiers as needed.

6 **[0007]** In some embodiments, the RF directors may be configured into three to six RF
7 director modules comprising different numbers of UHF and/or VHF director elements. E.g., in
8 one configuration, selectable RF directors may be configured in a set for “City” (or “Urban”),
9 “Metro”, “Fringe, and/or “Deep Fringe” applications. In another configurations, selectable RF
10 directors may be configured into a set comprising “City” (or “Urban”), “Metro”, “Suburban”,
11 “Fringe, and/or “Deep Fringe” and “Extreme Fringe” applications. Selectable axial RF
12 Reflectors may be configured into two or three modules comprising VHF and UHF reflectors, to
13 provide increasing performance. In further embodiments, selectable off axis RF boosters may be
14 configured into sets of two or three modules comprising different numbers of RF booster
15 reflectors for “City” (“Urban”), “Metro”, and “Fringe” applications.

16 **[0008]** In some embodiments, such combinations of driven DUV antennas and passive
17 RF enhancer modules may be supported by antenna support modules comprising modular
18 antenna supports that facilitate configuring a wide range of combinations of the passive and
19 active modules described above. Antenna support modules may include antenna
20 housing/amplifier modules to mount the driven antennas and connect with RF signal lines. Some
21 antenna support modules may include modular amplifiers to boost performance as needed.
22 Modules may include multiple amplifiers diplexed or multiplexed together to better
23 communicate with multiple locations and/or multiple signal frequencies. E.g., some
24 configurations may duplex or multiplex specialized VHF and/or UHF channels. Satellite and/or
25 internet antenna connections and related filters may be included in some modules.

26 **[0009]** Some housing/antenna modules may include a major length of signal line or
27 cable with bonded connections to eliminate contact losses. Some housing/antenna modules may

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1 use fiber optic lines to further reduce signal loss and degradation. Driven antenna supports and
2 RF contacts, amplifier contacts and signal line contacts may be enclosed with epoxy and/or
3 electronic potting compound to minimize fatigue, water, and/or corrosion. Some antenna support
4 module configurations may include single and dual axis antenna boom to mast mounts for
5 exterior and indoor installations. Signal provision modules may include one or more passive
6 splitters, active distributors, and signal multiplexers, such as for two way internet and DTV.

7 [0010] Such embodiments of DUV antenna modules provide enhanced flexibility to
8 configure DUV antennas for a wide range of applications from “Urban” sites near DTV
9 transmitters, to “Metro” sites further away, to “Fringe” sites requiring major signal enhancement.
10 Yet they may use few RF connections, or only one user RF connection. This provides advantages
11 in higher sustained antenna performance over the system life.

12 [0011] Some embodiments may comprise off axis reflector booster elements with
13 booster to element ratio of booster lengths to dipole element lengths in the range from about 1.2
14 to 2.2, improving the DTV UHF band.

15 [0012] Some embodiments enhance performance using a DUV balun comprising an RF
16 transformer using 0.5, 1.5, or 2.5 turns for two transformer or four transformer windings. Some
17 embodiments provide enhanced performance using a DUV RF connector with direct connections
18 between the signal cable and the DUV dipole elements. Some configurations may amplify the
19 signal within the DUV housing. DUV dipoles with one or more of these enhancements may be
20 used to form modular indoor antennas.

21 [0013] The antenna UHF performance may be enhanced in some configurations by using
22 reflector booster elements with a booster to element ratio of booster element length to DUV
23 element length of between 2.5 and 4.4. These may be used to form a compact “Deep Fringe”
24 DUV antenna.

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26 **Brief Description of the Drawings**

27 [0014] Having thus summarized the general nature of the invention and some of its

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1 features and advantages, certain preferred embodiments and modifications thereof will become
 2 apparent to those skilled in the art from the detailed description herein having reference to the
 3 figures that follow, each having features and advantages in accordance with one embodiment of
 4 the invention, namely:

5 **List of Drawings**

- 6 FIG. 1 Exploded perspective view of a modular Digital UHV/VHF (DUV) antenna.
 7 FIG. 2A DUV dipole in perspective.
 8 FIG. 2B U-DUV dipole element in perspective.
 9 FIG. 2C M-DUV dipole element in perspective.
 10 FIG. 2D V-DUV dipole element in perspective.
 11 FIG. 2E X-DUV dipole element in perspective.
 12 FIG. 3A Base support module with cable in cutout perspective.
 13 FIG. 3B Amplified support module with cable in cutout perspective.
 14 FIG. 3C Dual diplexed amplified support module with cable in perspective.
 15 FIG. 3D Diplexed amplified support module with two external inputs.
 16 FIG. 3E Support module with solar shield.
 17 FIG. 4A Compact "City" director with one UHF director element in perspective.
 18 FIG. 4B Short "Metro" director with two UHF director elements in perspective.
 19 FIG. 4C Medium "Fringe" director with six UHF director elements in perspective.
 20 FIG. 4D Long "Deep Fringe" director with ten UHF director elements in perspective.
 21 FIG. 4E Very long "Extreme Fringe" UHF director with thirteen UHF director elements in
 22 perspective.
 23 FIG. 4F Long "Deep Fringe" U/V director with six UHF and one VHF director elements
 24 in perspective.
 25 FIG. 4G Very long "Extreme Fringe" U/V director with twelve UHF and two VHF
 26 director elements in perspective.
 27 FIG. 5A Boom to boom connection schematic in plan view.

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- 1 FIG. 5B Insert boom to boom connection schematic in plan view.
- 2 FIG. 5C Sleeve boom to boom connection schematic in plan view.
- 3 FIG. 5D Overlapping boom to boom connection schematic in plan view.
- 4 FIG. 5E Surround mounting bracket.
- 5 FIG. 5F Cap mounting bracket.
- 6 FIG. 6A Small UHF booster with one off axis UHF reflector element in perspective.
- 7 FIG. 6B Medium UHF booster with four UHF reflector elements in perspective.
- 8 FIG. 6C Large UHF booster with six UHF reflector elements in perspective.
- 9 FIG. 7A Exterior boom-mast mount in perspective.
- 10 FIG. 7B Exterior dual axis adjustable boom-mast mount in perspective.
- 11 FIG. 7C Indoor boom-mast mount in perspective.
- 12 FIG. 7D Indoor dual axis adjustable boom-mount in perspective.
- 13 FIG. 8A Signal splitter module with one input and two outputs.
- 14 FIG. 8B Active signal distributor with one input and four outputs.
- 15 FIG. 8C Active signal distributor with bi-directional and standard contacts.
- 16 FIG. 9A Short Urban RF Reflector with one VHF reflector in perspective.
- 17 FIG. 9B Medium Metro RF Reflector with VHF and UHF reflectors in perspective.
- 18 FIG. 9C Fringe RF Reflector with two VHF reflectors and one UHF reflector in
- 19 perspective.
- 20 FIG. 10 A DUV housing/amplifier module system for triply multiplexed DUV antennas.
- 21 FIG. 11 A DUV Balun enhanced DUV-D antenna in perspective.
- 22 FIG. 12 A DUV Balun in perspective.
- 23 FIG. 13A An RF core in plan view.
- 24 FIG. 13B AN RF core in elevation view
- 25 FIG. 14 Upper layer of a DUV balun circuit board.
- 26 FIG. 15 Lower layer of a DUV balun circuit board.
- 27 FIG. 16 Upper layer of a direct DUV RF connector board.

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- 1 FIG. 17 Upper layer of a filtered, buffered, or amplified DUV circuit board.
- 2 FIG. 18A Schematic of DUV balun with 2.5 turns of four windings.
- 3 FIG. 18B Schematic of DUV balun with 1.5 turns of four windings.
- 4 FIG. 18C Schematic of DUV balun with 0.5 turns of four windings.
- 5 FIG. 19A Perspective of DUV balun close coupled to Dipole elements.
- 6 FIG. 19B Perspective of DUV RF connector close coupling signal cable to dipole elements.
- 7 FIG. 20A Metro booster with one reflector booster element in perspective.
- 8 FIG. 20B Non-uniformly spaced four element Fringe booster in perspective.
- 9 FIG. 20C Non-uniformly spaced five element Deep Fringe booster in perspective.
- 10 FIG. 21 An "Indoor" Enhanced DUV-I antenna in perspective.
- 11 FIG. 22 A "City" Enhanced DUV-C antenna in perspective.
- 12 FIG. 23 A "Metro" Enhanced DUV-M antenna in perspective.
- 13 FIG. 24 A "Suburban" Enhanced DUV-S antenna in perspective.
- 14 FIG. 25 A "Fringe" Enhanced DUV-F antenna in perspective.
- 15 FIG. 26 A "Deep Fringe" Enhanced DUV-DF antenna in perspective.
- 16 FIG. 27 An "Extreme Fringe" Enhanced DUV-XF antenna in perspective.
- 17 FIG. 28 Multiple Signal Enhancement with DUV-S, DUV-F and DUV-XF Antennas in
- 18 perspective.
- 19 FIG. 29 Elevation view of DUV-W wind enhanced antenna support.
- 20 FIG. 30 Elevation view of reinforced VHF reflector.
- 21 FIG. 31 Graph of Enhanced DUV Antenna Gain performance.
- 22 FIG. 32 Graph of Enhanced DUV Antenna Front to Back Ratio performance.
- 23 FIG. 33 Compound Antenna with U-DUV, M-DUV and V-DUV dipoles.
- 24 **[0015] List of Tables**
- 25 **[0016]** Table 1 Antenna Front Gain in VHF Hi Band & DTV UHF
- 26 **[0017]** Table 2 Antenna VHF, UHF Gains, Gain/Mass and Wide band Comparisons
- 27 **[0018]** Table 3 Differences between DigiTenna and Relevant Art Antenna gains

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- 1 **[0019]** Table 4 Front/Back Ratio of DigiTenna and Relevant Art Antennas
- 2 **[0020]** Table 5 DigiTenna versus Relevant Art Front/Back Ratio Comparisons
- 3 **[0021]** Table 6 Comparisons of Outdoor Antenna Models
- 4 **[0022]** Table 7 Performance with DUV1.5 turn Balun and direct DUV RF connector
- 5 **[0023]** Table 8 Comparisons of Indoor Antenna Models
- 6 **[0024]** Table 9 Enhanced DUV Antenna Configuration and Gain Performance
- 7 **[0025]** Table 10 Front/Back Performance of Enhanced DUV Antennas
- 8 **[0026]** Table 11 DUV dipole element lengths
- 9

DETAILED DESCRIPTION

11 **[0027]** Modular UHF/VHF Antenna: With reference to FIG. 1, in one embodiment of
 12 the invention, a modular Digital UHF/VHF (DUV) antenna system comprises a DUV antenna **10**
 13 having a driven DUV antenna **12** having DUV element(s) **21** mounted to a DUV
 14 housing/antenna module **400**. The DUV antenna **10** may further comprise one or more modular
 15 driven DUV antennas **12** and/or a modular RF enhancer to increase the signal gain of one or
 16 more received and/or transmitted digital signals in the Ultra High Frequency (UHF), Very High
 17 Frequency (VHF), and/or Radio Frequency (RF) ranges. The RF enhancer modules comprise one
 18 or more of an RF director **140**, an RF reflector **170**, an RF booster **112**, and/or a DUV amplifier
 19 module **202**. At least one of these RF enhancer modules are preferably selected from a selection
 20 of discrete enhancer modules.

21 **[0028]** The DUV antenna system may comprise a modular supporting structure or
 22 antenna mount **100** and an RF signal cable **260** having a connector **262**. These modules and
 23 components beneficially facilitate antenna configuration, assembly and shipment. The DUV
 24 dipole may be configured for broadband reception or transmission in one or more of digital UHF
 25 and/or VHF signals. These may be in the range from about 55 MHz to 801 MHz and may
 26 comprise one or more of digital TV, digital Radio, and/or internet communications.

27 **[0029]** DUV Antenna: With reference to FIG. 1, in one embodiment of the invention, a

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1 DUV antenna **2** may comprise a driven DUV antenna **12** comprising DUV element **21**
 2 configured to be driven by a Digital UHF/VHF (DUV) signal preferably with a frequency within
 3 one of the UHF range of 300 MHz to 3 GHz, the VHF range of 30 MHz to 300 MHz, or the
 4 collective Radio Frequency (RF) range of 30 MHz to 3 GHz. E.g., the DUV element **21** may be
 5 configured to be driven by a digital television signal (DTV), a digital radio or FM signal, and/or
 6 a digital internet signal. The DUV element **21** is RF communicatively connected to a RF feed or
 7 signal line **260**.

8 **[0030]** Modular DUV Dipole: Referring to FIG. 1 and FIG. 2a, the driven DUV antenna
 9 **12** may comprise two DUV elements **21** collectively forming a DUV dipole **20** preferably
 10 configured for broadband reception over prescribed UHF and/or VHF ranges as described herein
 11 and in the previous DUV antenna applications. Referring to FIG. 2A, FIG. 2B, FIG. 2C, FIG.
 12 2D, and FIG. 2E, a DUV antenna may comprise one of a UHF enhanced U-DUV element **23**, a
 13 broadband M-DUV element **25**, a VHF enhanced V-DUV element **27** and an eXtended X-DUV
 14 dipole **29**. Similarly, the DUV dipole **20** may be selected from one of a broadband M-DUV
 15 dipole **24** comprising two U-DUV elements **25**, a UHF enhanced U-DUV dipole **22** comprising
 16 two U-DUV elements **23**, a VHF enhanced V-DUV dipole **26** comprising two V-DUV elements
 17 **27**, and an eXtended X-DUV dipole **28**, comprising two eXtended X-DUV elements **29**.

18 **[0031]** For example, in some configurations, the DUV elements may have one or more
 19 electrical lengths assuming a dipole end effect of 0.7 mounted with a central contact to contact
 20 spacing of about 32 mm (1.25") as follows: Referring to FIG. 2C, broadband M-DUV Dipole **24**
 21 (see also DUV application Fig. 15) may comprise two M-DUV elements **25** such as about 250
 22 mm (9.82 in) long; referring to FIG. 2B and FIG. 21, the U-DUV **22** dipole may comprise two
 23 U-DUV elements **23** such as each about 152 mm (6") long; referring to FIG. 2D, the V-DUV
 24 dipole **26** (see also DUV application FIG. 17) may comprise two V-DUV elements **27** such as
 25 about 305 mm (12 in); and referring to FIG. 2E, an X-DUV dipole **28** (see also DUV application
 26 FIG. 17) may comprise two X-DUV elements **29** such as about 356 mm (14 in) long. Other
 27 configurations may use other modular combinations in the range with actual electrical lengths of

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1 DUV element **21** selected from about 102 mm (4 in) to about 510 mm (20 in) long. DUV
 2 element lengths may be adjusted for different contact to contact distances to maintain similar
 3 dipole tip to tip lengths. E.g. with contact to contact distances may range from about 6 mm
 4 (0.25") to 102 mm (4"). In other configurations one or both of DUV element lengths and/or
 5 element contact to contact spacing may be adjusted.

6 **[0032]** Modular RF Director: Referring to FIG. 1, and FIG. 4A through FIG. 4G, in
 7 some embodiments the driven DUV antenna **12** may be enhanced by one or more modular RF
 8 Directors **140** selected from a plurality of UHF, VHF and/or RF enhancing directors comprising
 9 RF director elements **50** selected from UHF director elements **52** and VHF director elements **54**.
 10 E.g. The modular RF director **140** may be selected from one of a compact "City" UHF director
 11 **141**, a short "Metro" (or "Urban") UHF Director **142**, a medium "Fringe" UHF Director **144**, and
 12 a long "Deep Fringe" UHF Director **146**. Similarly, the RF modular director(s) **140** may be
 13 selected from one of a medium "Metro" U/V director **145** and a long "Fringe" U/V director **147**.
 14 The RF modular director(s) **140** may be selected from one of UHF and U/V directors **142**, **144**,
 15 **145**, **146**, and **147**.

16 **[0033]** Referring to FIG. 1, the RF Director Elements **50** may be mounted on modular
 17 UHF director boom **190**. Director elements **50** may be spaced along boom **190** about 76 mm to
 18 152 mm (3 in to 6 in) apart starting at about 25 mm to 76 mm (1 in to 3 in) from the YZ plane
 19 through the DUV element(s) **21**. RF Director Elements **50** may be streamlined, or stiffened into a
 20 U or an M shape to reduce drag and better withstand wind forces as well as reduce weight and
 21 cost. Director booms may be adjusted for joining options plus about 13 mm (0.5") for an end
 22 cap.

23 **[0034]** RF/UHF Director Elements: Referring to FIG. 1 and FIG. 4A and 4D through 4G
 24 (see also FIG. 19 in the DUV Antenna application), the conductive portion of UHF director
 25 elements **52** may be 152 mm to 216 mm (6 in to 8.5 in) long for 13 mm (0.5") to 51 mm (2")
 26 wide material which may be formed into a finished element width of 10 mm (0.38") to 38 mm
 27 (1.5"). e.g., in some DTV configurations, material 175 mm (6.88") long by 25 mm (1") wide may

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1 be stamped to a finished UHF director element **52** width of 19 mm (0.75") having an electrical
 2 resonant length to width ratio of about 9.2. For wide band DTV reception, UHF director
 3 elements **52** may have an electrical resonant length of about 184 mm (7.25 in) long and 13 mm
 4 (0.5 in) wide for an electrical length/width ratio about 14 (or a width/length ratio of about 0.07).

5 [0035] Referring to FIG. 4C, (and DUV Antenna application FIG. 21), director
 6 elements **52** may comprise elliptical or similarly streamlined elements of comprising conductive
 7 material to reduce horizontal wind drag compared to relevant art cylindrical director elements.
 8 Director elements **52** may be widened to more than 20 mm (0.8 in) with electrical lengths
 9 reduced to about 167 mm (6.6 in) for a length/width ratio of about 8.4 (or width/length ratio of
 10 0.12). e.g., as used in the prototype antennas. Director elements **52** may be about 42 mm (1.67
 11 in) wide with electrical lengths of about 132 mm (5.2 in) for a length/width ratio of 3.1 (or width/
 12 length ratio of 0.32). These may be configured stiffer in bending and more compact. Referring to
 13 FIG. 4B and 4G, director elements may be configured in a U shape to stiffen while reducing
 14 wind drag.

15 [0036] Compact "City" UHF Director: Referring to FIG. 4A, the compact "City" UHF
 16 Director **141** may comprise one RF or UHF Director element **52** mounted on a compact UHF
 17 support or director boom **191**. UHF boom **192** may be formed from square tubing. E.g., the UHF
 18 boom **191** may be formed from about 6 mm (1/4") to 37 mm (1.5") tubing. UHF boom **191** may
 19 be formed about 25 mm to 102 mm (1" to 4") long. e.g., UHF boom **191** may be about 64 mm
 20 (2.5") long from about 16 mm (5/8") or about 19 mm (3/4") square aluminum tubing. Boom **191**
 21 may use the same tubing as other director supports to reduce inventory and manufacturing costs.

22 [0037] Short "Metro" UHF Director: Referring to FIG. 4B, the short "Metro" UHF
 23 Director **142** may comprise two, or three medium UHF director elements **52** mounted on a Short
 24 UHF director boom or support **192**. The "Metro" UHF director **142** may have two short UHF
 25 director elements **52**.

26 [0038] Referring to FIG. 4B, a short "Metro" UHF director boom **192** may be about
 27 104 mm to 279 mm (4.1 in to 11 in) long with two, or three director elements **52** spaced about

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1 102 mm (4 in) apart, starting about 51 mm (2 in) from the YZ plane (through the DUV
2 element(s)). The short "Metro" UHF boom **192** may be about 152 mm to 165 mm (6 in to 6.5 in)
3 long supporting about two UHF director elements **52**.

4 [0039] Medium "Fringe" UHF Director: Referring to FIG. 4C, the medium "Fringe"
5 UHF Director **144** may comprise four to six UHF director elements **52** mounted on a medium
6 Metro UHF director boom **194** from 282 mm (11.1") to 546 mm (21.5") long. "Fringe" UHF
7 director **144** may have about six UHF director elements **52** mounted on the medium "Fringe"
8 UHF boom **194** about 546 mm (21.5 in) long, spaced as above.

9 [0040] Long "Deep Fringe" UHF Director: Referring to FIG. 4D, a long "Deep Fringe"
10 UHF director **146** may be formed with a "Deep Fringe" director boom **196** about 549 mm (21.6")
11 to 1054 mm (41.5") long. "Deep Fringe" UHF director **146** may have between seven to eleven
12 UHF director elements **52**. Director **146** may have about ten UHF direct elements **52** mounted on
13 a boom **196** about 953 mm (37.5 in) long.

14 [0041] Very Long "Extreme Fringe" UHF Director: Referring to FIG. 4E, a long "Deep
15 Fringe" UHF director **148** may be formed with a "Extreme Fringe" director boom **196** about
16 1056 mm (41.6") to 2438 (96") long. "Extreme Fringe" UHF director **146** may have between
17 twelve to twenty four UHF director elements **52**. Director **146** may have about thirteen UHF
18 direct elements **52** mounted on a boom **196** about 1257 mm (49.5 in) long.

19 [0042] "Deep Fringe" U/V Director: Referring to FIG. 4F, a long "Deep Fringe" U/V
20 director **145** may comprise a combination of medium UHF/VHF (U/V) director elements **54** and
21 short UHF director elements **52**. "Deep Fringe" U/V director **145** may have a medium U/V
22 director element **54** about 381 mm to 508 mm (15 in to 20 in) long spaced about 203 mm to 406
23 mm (8 in to 16 in) from the driven DUV antenna. "Deep Fringe" U/V director **145** may have
24 about four to nine short UHF director elements **52** on a Deep Fringe boom from 282 mm (11.1")
25 to 546 mm (21.5") long.

26 [0043] "Deep Fringe" U/V director **145** may have about six UHF director elements **52**,
27 mounted on a Deep Fringe U/V director boom **195**. The U/V director element **54** may be about

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1 432 mm (17 in) long and may be spaced about 235 mm (9.25 in) from the driven DUV antenna
 2 with the UHF director elements **52** spaced about 101 mm (4 in) from that.

3 [0044] "Extreme Fringe" U/V Director: Referring to FIG. 4G a long "Extreme Fringe"
 4 U/V director **147** may be formed comprising a combination of medium UHF/VHF director
 5 elements **54** and short UHF director elements **52**. "Extreme Fringe" U/V director **147** may have
 6 one to three medium U/V director elements **54** about 432 mm (17 in) long spaced about 203 mm
 7 to 356 mm (8 in to 16 in) apart. "Extreme Fringe U/V director **147** may have about ten to twenty
 8 short director elements **52** on an Extreme Fringe" director boom **196** about 1056 mm (41.6") to
 9 2438 (96") long. In some configurations, Extreme Fringe U/V director **147** may have two
 10 medium U/V director elements **54** spaced about 356 mm (14 in) apart with the first positioned
 11 591mm (23.25") from the DUV dipole YZ plane. It may have twelve UHF director elements **52**
 12 spaced about 101 mm (4 in) apart. Such Extreme Fringe UHF/VHF directors may enhance VHF
 13 performance by about 1 dB to 1.5 dB.

14 [0045] Modular Boom Connector: Referring to the embodiment shown in FIG. 1,
 15 modular RF Director **140** may be connected to the longitudinal boom **102** by a modular
 16 connection **70**. The fastening holes in connection **70** may be configured vertically to retain the
 17 greatest horizontal bending strength in modular connection **70**. E.g., against horizontal wind
 18 loading. This orientation may provide space for cable **260** and/or connector **262**. Referring
 19 further to FIG. 5B, the modular connection **70** may comprise a plug connector **72** which plugs
 20 into and connects the director boom **190** and the longitudinal boom **102**. In configurations using
 21 different dimensions for longitudinal boom **102** and director boom **190**, plug connector may be
 22 configured with differing size ends to match the respective booms. E.g., where the director boom
 23 **190** is smaller than the longitudinal boom **102**.

24 [0046] The plug connector **72** may be formed from a suitable structural material
 25 depending on the design stresses, e.g., an engineering plastic or metal. These booms **102** and **190**
 26 may be fastened to the plug connector **72** using fasteners inserted through the fastening holes **71**.
 27 The fastener may be a bolt, screw, rivet or pin connecting the longitudinal boom **102**, the plug

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1 connector **72** and the UHF director boom **190**, through respective fastening holes **71**. In other
 2 configurations the bolt may oriented horizontally.

3 [0047] Referring to FIG. 1 and FIG. 5A, in some configurations, the modular
 4 connection **70** may comprise a plug and socket connection. E.g., where a smaller UHF support
 5 boom **190** plugs into a larger longitudinal boom **102**. Referring to FIG. 1 and FIG. 5C, in some
 6 configurations, the modular connection **70** may comprise a sleeve connector **74** that forms two
 7 sockets into which the longitudinal boom **102** and UHF director boom **190** may be inserted. This
 8 beneficially provides greater bending strength at the joint where needed.

9 [0048] Referring to FIG. 5A, FIG. 5B, and/or FIG. 5C, the outer portion of the smaller
 10 boom or plug, and/or the inner portion of the larger boom or sleeve may be angled or chamfered
 11 for ease of insertion and assembly. Referring to FIG. 1 and FIG. 5D, the modular connection **70**
 12 may comprise overlapping ends on the longitudinal boom **102** and UHF director boom **190**. As
 13 before, these connectors may be fastened together with fasteners through fastener holes **71**. Other
 14 spring fasteners, cotter pins, glues, solders, welds, or similar mounting or bonding methods may
 15 be used to reliably assemble the modular connection **70**.

16 [0049] Modular DUV Mount: Referring to FIG. 1 and FIG. 5F, the driven DUV
 17 antenna **12** may be mounted over the longitudinal boom **102** using a U connector **76** and one or
 18 more suitable fasteners. E.g., using bolts, pins or screws through one or more fastener holes **71**.
 19 Referring to FIG. 1 and FIG. 5E, the DUV dipole **12** may be configured with a modular sleeve
 20 mount **73** that mounts securely around one of the longitudinal boom **102** and the UHF director
 21 boom **190**.

22 [0050] Modular DUV/boom mount: Referring to FIG. 1 and FIG. 5E, in another
 23 configuration, the modular mount **70** and the mount for the driven DUV antenna **12** may be
 24 combined. E.g., the driven DUV antenna **12** may be mounted on the sleeve **73** into which may be
 25 inserted the longitudinal boom **102** and UHF director boom **190**. The sleeve mount **73**,
 26 longitudinal boom **102** and UHF director boom **190** may be fastened together with fasteners
 27 through fastener holes **71**. Similarly, referring to FIG. 1 and FIG. 5F, a U connector **76** may be

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1 used with a complementary closing plate or bracket **77** to firmly mount the DUV antenna
 2 together with the longitudinal boom **102** and the UHF director boom **190**. Other fastening,
 3 snapping or bonding methods may also be used.

4 **[0051]** RF Reflector: With reference to FIG. 1 and FIG. 9A, FIG. 9B, and FIG. 9C, in
 5 some embodiments the DUV dipole antenna **12** may be enhanced by an RF Reflector **170**. The
 6 RF Reflector **170** may be modular and selected from an Urban Reflector **172**, a Metro Reflector
 7 **174**, and a Fringe Reflector **176**.

8 **[0052]** Urban reflector: Urban Reflector **172** may comprise a medium length VHF
 9 resonant/reflector element **82** preferably mounted transversely across the short Urban VHF
 10 longitudinal support or boom **102** and about parallel to and in line with the driven DUV dipole
 11 antenna **20**. The medium VHF reflector element **82** may be configured from about 612 mm (24.1
 12 in) to 915 mm (36 in) long depending on the desired frequency application. For a broadband
 13 DTV VHF enhancement configuration, this VHF reflector element **82** may be about 838 mm to
 14 864 mm (33" to 34") long in some configurations.

15 **[0053]** This broadband VHF reflector **82** may be positioned from about 27% to 60% of
 16 the length of the reflector from the YZ plane (through the DUV element **21** or dipole. It may be
 17 positioned about 40% of the length of the reflector **82** from the DUV element **21**, along the
 18 negative X direction. E.g., about 349 mm (13.75") from the YZ plane (DUV dipole) on the VHF
 19 side in this configuration. Referring to FIG. 30, Medium VHF reflectors **82** may be fastened or
 20 bonded longitudinal boom **102** by a reinforcing, stiffening or joining section **63** about 51 mm
 21 (2") long.

22 **[0054]** Metro RF Reflector: With further reference to FIG. 1 and FIG. 9B, some DUV
 23 antenna configurations with the RF reflector **170** may comprise a UHF resonant/reflective
 24 element **54** mounted about transversely across a longitudinal support boom **104**. In broadband
 25 configurations, UHF reflector **54** may be configured to resonate near the low end of the UHF
 26 band such as about 450 MHz. The UHF reflector **54** may range from 203 mm (8") to 610 mm
 27 (24") long. E.g., UHF reflector **54** may be about 432 mm (17") long. This beneficially improves

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1 UHF performance while not seriously degrading VHF performance. In other configurations UHF
 2 reflector **54** may be configured to resonate about in the mid UHF range or at prescribed
 3 frequencies.

4 **[0055]** Referring further to FIG. 1 and to FIG. 9B, UHF reflector **54** may be positioned
 5 about 20% to 33% of UHF reflector length from the YZ plane (DUV dipole). E.g., from 86 to
 6 142 mm (3.4 to 5.6 in) from the YZ plane in the negative X direction. UHF reflector **54** may be
 7 positioned at about 26% of the length of the UHF reflector **54** from the YZ plane. E.g., at about
 8 114 mm (4.5 in) behind the YZ plane for a 432 mm (17 in) UHF reflector. In some
 9 embodiments, a medium Metro RF reflector **174** may comprise both a UHF reflector **54** and a
 10 VHF reflector **82**.

11 **[0056]** Large Fringe RF Reflector **176**: Referring to FIG. 1 and FIG. 9C, in some DUV
 12 embodiments, RF reflector **170** may be configured as a large Fringe RF reflector **176** which may
 13 comprise multiple resonant VHF reflector elements. E.g., RF reflector **176** may comprise one
 14 medium VHF reflector **82** and one long VHF reflector **86**. Long VHF reflector **86** may range
 15 from about 917 mm (36.1 in) to 2.3 m (90.6 in) long and may be mounted from 20% to 50% of
 16 the length of VHF reflector **86**, from the YZ plane. E.g., the long VHF reflector **86** may be about
 17 1.67 m to 1.75 m (66" to 69") long and mounted about 40% of the length of VHF reflector **86** or
 18 about 670 mm to 698 mm (26.5" to 27.5") from the YZ plane (DUV dipole).

19 **[0057]** This long VHF reflector **86** may be configured as two half length VHF
 20 reflectors **88**. E.g., at about 900 mm (35.5") long that overlap in the middle by about 50 mm (2")
 21 and fastened or bonded together and mounted on boom 104. Long VHF reflectors **86** may be
 22 bonded or mounted on boom 104 with a reinforcing stiffening or joining section of about 102
 23 mm (4") long. In some configurations, Fringe RF Reflector **176** may comprise a UHF reflector
 24 **54**. In further configurations, Fringe RF Reflector **176** may comprise a UHF reflector **54**, a
 25 medium VHF reflector **82** and one long VHF reflector **86**.

26 **[0058]** DUV Performance: To demonstrate the unexpected UHF/VHF improvements of
 27 the smaller DUV antennas over the relevant art, three test examples of embodiments of DUV

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1 antennas were constructed as follows: a small “Urban DUV-U” antenna, a medium “Metro
 2 DUV-M” antenna, and a large “Fringe DUV-F” antenna. Cylindrical elements 9.5 mm (0.375 in)
 3 in diameter were used for the reflective and booster elements in these three DUV test
 4 embodiments. Directive elements were made of 13 mm (0.5 in) flat stamped material. The
 5 components and dimensions of these selected test embodiments were about as follows:

6 [0059] DUV-U “Urban” antenna: Referring to FIG. 1, Fig. 9A, in one example, a small
 7 “Urban” unamplified DUV-U antenna embodiment **10** about 0.68 m (27 in) long in the X axis,
 8 having a DUV dipole **20** with two DUV elements **21** about 0.24 m and 0.25 m (9.5 in, 10 in)
 9 long, with an unfolded height of about 152 mm (6") folded down to a folded height of 127 mm
 10 (5") high, a UHF director **140** with three UHF elements **50** each about 188 mm (7.4 in) long, a
 11 VHF reflector **82** about 864 mm (34 in) long, and two boosters **110** each having 2 booster
 12 reflector elements **62**, where the reflector element **62** closest to the X axis was about 597 mm
 13 (23.5 in) long, and the other three booster reflector elements **62** were about 432 mm (17 in) long.

14 [0060] In this example, a UHF reflector **54** about 432 mm (17 in) long was positioned
 15 about 104 mm to 114 mm (4.1" to 4.5") behind the DUV dipole (such as shown in FIG. 9B .)
 16 The typical mass for this DUV-U antenna was about 1 kg (2.2 lbs). In further configurations,
 17 DUV antennas may be configured with DUV elements 21 having an unfolded height of 152 mm
 18 (6") folded down to vertical height of about 102 mm to 108 mm (4.0" to 4.25").

19 [0061] DUV-M “Metro” antenna: With reference to FIG. 1, FIG. 2C, FIG. 4B, and FIG.
 20 6B, and FIG. 9B), in one example, a medium sized “Metro” unamplified DUV-M antenna
 21 embodiment was configured about 0.97 m (38 in) long, having a DUV dipole with 0.24 m and
 22 0.25 m (9.5 in, 10 in) DUV elements **25** with 152 mm(6") unfolded height folded down to about
 23 127 mm (5 in) high, an RF director **140** with 6 director elements **50** electrically about 188 mm
 24 (7.4 in) long, a UHF reflector **54** about 432 mm (17 in) long, a VHF reflector **82** about 864 mm
 25 (34 in) long, and two RF boosters **60** each having 4 reflective elements **62**, with the reflector
 26 element closest to the X axis about 597 mm (23.5 in) long, and the other three booster reflector
 27 elements were about 432 mm (17 in) long.

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1 **[0062]** The typical mass for this DUV-M “Metro” embodiment is about 1.2 kg (2.6 lbs).
 2 In further configurations, the DUV elements **21** may have an unfolded height of 152 mm (6")
 3 folded down to vertical height 102 mm to 108 mm (4.0" to 4.25"). The boosters **60** were
 4 configured at an angle of about 51 deg to 52 deg from, the longitudinal boom axis. In other
 5 configurations this boom angle may range from 45 deg to 60 deg.

6 **[0063]** DUV-F Fringe antenna: Referring to FIG. 1, FIG. 4B, FIG. 6C, and FIG. 25 in
 7 another example, a large “Fringe” unamplified DUV-F antenna **10** embodiment was configured
 8 about 0.97 m (38 in) long, having a DUV dipole **12** with 0.24 m and 0.25 m (9.5 in, 10 in) DUV
 9 elements, a director **140** having a boom **126** with six (6) director elements **52** each electrically
 10 about 188 mm (7.4 in) long, a UHF reflector **54** about 432 mm (17 in) long, a VHF reflector **86**
 11 about 864 mm (34 in) long, and two boosters **112** each having six (6) elements **64**, each element
 12 having an electric length about 864 mm (34 in). The mass for this DUV-F “Fringe” antenna
 13 example was about 1.4 kg (3 lbs).

14 **[0064]** In these “Urban,” “Metro” and “Fringe,” DUV embodiments, the booster boom
 15 **110** was configured with a length about 594 mm (23.38 in) and was mounted on the longitudinal
 16 boom **102** with a booster boom mount **120**. The outer back edge of the upper booster boom **110**
 17 was positioned about 222 mm (8.75 in) along the top of the longitudinal boom **102** from the YZ
 18 axis or DUV dipole. In this configuration, the outer forward tip of the booster boom was
 19 preferably positioned about 445 mm (17.5 in) from the top of the longitudinal boom, at an angle
 20 of about 52 degrees to the longitudinal boom.

21 **[0065]** In this configuration, the midpoint of the four booster reflector elements was
 22 positioned about in the YZ plane or about in line with the DUV reflector. E.g., the booster
 23 reflective elements **62** were cut to about 591 mm (23.25") long and positioned at about 168 mm,
 24 289 mm, 418 mm and 556 mm (6.63 in, 11.38 in, 16.44 in and 21.9 in) along the outer boom side
 25 up from its junction with the longitudinal boom. The measured performance of these test units
 26 includes DUV elements constructed with lengths differing by about 5%.

27 **[0066]** “Fringe” booster: In the DUV-F embodiment as shown in FIG. 18, a “Fringe”

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1 booster was used (similar to a large relevant art UHF “corner reflector”) with 6 booster reflective
 2 elements **64** about 838 mm (33 in) long on a booster boom about 594 mm (23 3/8 in) long. These
 3 booster elements **64** were positioned up from the junction with the longitudinal boom at about 70
 4 mm, 146 mm, 235 mm, 337 mm, 457 mm, and 581 mm (2.75 in, 5.75 in, 9.25 in, 13.25 in, 18.0
 5 in, 22.88 in). In these examples, the boom angle to the longitudinal boom was about 51 to 52
 6 degrees. This embodiment included elements near the longitudinal axis. By contrast, in a
 7 conventional Yagi/Log-Periodic antenna, these large booster elements would have been expected
 8 to cause a major reduction in the VHF gain.

9 **[0067]** Comparing this DUV-F test embodiment to the DUV-U and DUV-M test
 10 embodiments, the longer booster elements **64** and restored elements in these larger boosters **112**
 11 provided an unexpected increase in the VHF gain of about 1.8 dB at 220 MHz while reducing the
 12 VHF gain by 7.1 dB at 180 MHz. Further, this embodiment provide a major unexpected increase
 13 in VHF Front/Back ratio of 13.9 dB (from 4.9 dB to 18.8 dB.) With this excellent Front/Back
 14 ratio, an amplified DUV-F configuration with a 20 dB gain would provide a very good
 15 broadband gain of about 30 dB in the UHF, and good gain of about 15 dB in the VHF High
 16 Band. Yet this is a very compact light weight antenna 965 mm (38 in) long, with low wind drag,
 17 weighing only about 1.4 kg (3 lbs.)

18 **[0068]** Relevant Art Antenna Performance: To compare the relative benefits of the
 19 DUV antennas, five small “Urban”, medium “Metro”, and large “Fringe” commercially available
 20 Relevant Art antennas advertised as “VHF/UHF” were selected as follows (including some from
 21 the FCC Dec. 2005 report #05-199):

22 **[0069]** RU-WS antenna: A relevant art unamplified small “Urban” square VHF/UHF
 23 antenna about 0.45 m (18") on side, weighing some 4.5 kg (10 lbs) (Winegard “Squareshooter”
 24 model SS1000).

25 **[0070]** RU-AH antenna: A relevant art unamplified small “Urban” circular VHF/UHF
 26 antenna about 0.45 m (18") in diameter weighing some 2.3 kg (5 lbs) (Antennacraft model
 27 HDX1000).

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1 **[0071]** RM-WY antenna: A relevant art unamplified medium “Metro” Yagi VHF/UHF
 2 antenna about 1.27 m (50") long with a 6" dipole, 9 element director and a “corner reflector”
 3 with 8 elements, weighing about 1.2 kg (2.7 lbs) (Winegard Yagi model PR9018).

4 **[0072]** RM-C4 antenna: A relevant art unamplified medium “Metro” 4 bay bow tie +
 5 screen UHF antenna about 0.56 m x 0.86 m (22"x 34") weighing about 2.27 kg (5 lbs) (Channel
 6 Master model 4221).

7 **[0073]** RF-C8 antenna: A premium relevant art unamplified large “Fringe” 8 bay bowie
 8 + screen UHF antenna about 0.91 m x 1.02 m (36" x 40"), weighing about 6.8 kg (15 lbs)
 9 (Channel Master model 4228).

10 **[0074]** Antenna Performance Tests: The performance of these three DUV embodiments
 11 and five relevant art antennas was tested for DigiTenna, LLC by Georgia Tech Applied Research
 12 Corp. (GTARC) Atlanta GA, on January 29, 2007 as Project No. SEAL-07-1135. The antenna
 13 tests were performed in Georgia Tech’s indoor 6.1 m x 11.0 m (20 ft x 36 ft) RF anechoic
 14 instrumented Shielded Antenna Chamber. GTARC uses an FR 959 automated antenna
 15 measurement system with broadband HP synthesized sources and a HP 8510-based Vector
 16 Network Analyzer. The FCC certified instrumentation can test antennas from 200 MHz to 110
 17 GHz and was calibrated in November 2006. All antennas were tested under identical conditions.
 18 All gains were corrected upward by 0.20 dB to adjust for insertion loss, and had a standard
 19 deviation of about 0.17 dB.

20 **[0075]** Unamplified Antenna Performance: The measured Front gain of five
 21 unamplified DigiTenna antenna test embodiments are shown in Table 1 for three frequencies,
 22 (180 MHz, 200 MHz, and 220 MHz), representing the bottom, middle and top of the VHF High
 23 Band (near DTV Channels 7, 10 and 13). These include small Urban DUV-U, medium Metro
 24 DUV-M, and large Fringe DUV-F embodiments. Corresponding gains are shown for four UHF
 25 frequencies, (475 MHz, 550 MHz, 625 MHz, and 700 MHz), representing the bottom, middle
 26 and top of the US DTV UHF band (near DTV Channels 14, 27, 39, and 52). The gain of these
 27 DUV antenna embodiments is graphed in FIG. 31. Five major commercial relevant art

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- 1 unamplified antennas are shown for comparison. Note: All amplifiers in commercial antennas
 2 were removed for these tests. Each of these antennas was configured with a 4:1 TV balun.

3 **[0076]** Table 1 Antenna Front Gain in VHF Hi Band & DTV UHF

Frequency MHz	180	200	220	475	550	625	700
	dB	dB	dB	dB	dB	dB	dB
DigiTenna							
DUV-U	-0.75	-2.07	-3.50	7.56	7.21	7.99	8.39
DUV-UC	0.0	-0.3	-0.7	5.5	5.6	5.9	6.0
DUV-M	-1.41	-2.69	-3.63	8.66	8.01	9.86	10.50
DUV-MC	-0.6	-0.9	-0.8	8.9	8.6	9.7	10.3
DUV-F	-8.52	-4.90	-1.77	11.44	11.00	11.57	10.50
Relevant Art							
RU-WS SS1000	-36.23	-25.00	-25.67	2.55	3.49	5.48	1.41
RU-AH HDX1000	-17.70	-13.40	-10.62	8.86	7.58	8.96	8.94
RM-WY PR9018	-22.82	-25.11	-27.98	8.00	8.21	7.59	10.81
RM-C4 4221	-19.55	-11.62	2.35	9.51	10.70	10.96	12.51
RF-C8 4228	-2.60	6.64	3.28	13.77	13.62	13.14	12.19

- 4
 5 **[0077]** Relative Antenna Performance: The relative performance of these small Urban,
 6 medium Metro and large Fringe DUV antenna embodiments is shown in Table 1 compared to the
 7 corresponding five relevant art antennas. Table 2 lists the average gain in the VHF High Band,
 8 the UHF DTV band, and the Mean of the VHF and UHF gains. It lists the Mass, Mean
 9 Gain/Mass and the difference between the mean UHF and VHF gains.

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1 **[0078]** Table 2 Antenna VHF, UHF Gains, Gain/Mass and Wide band Comparisons

DigiTenna Model #	VHF Hi	UHF DTV	Mean dB	Mass	Gain/Mass	UHF-VHF
	Avg dB	Avg dB	(VHi+U)/2	kg	dB/kg	Avg dB
DUV-U	-2.11	7.79	2.84	1.0	2.8	9.89
DUV-UC	-0.3	5.8	2.7	0.9	3.0	6.1
DUV-M	-2.58	9.26	3.34	1.2	2.8	11.83
DUV-MC	-0.8	9.4	4.3	1.1	3.9	10.2
DUV-F	-5.06	11.13	3.03	1.4	2.2	16.19
Relevant Art						
RU-WS SS1000	-28.97	3.23	-12.87	4.5	-2.9	32.20
RU-AH HDX1000	-13.91	8.59	-2.66	2.3	-1.2	22.49
RM-WY PR9018	-25.30	8.65	-8.33	1.2	-6.9	33.96
RM-C4 4221	-9.61	10.92	0.66	2.3	0.3	20.53
RF-C8 4228	2.44	13.18	7.81	6.8	1.1	10.74

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3 **[0079]** Table 3 shows the difference between the gains of these DigiTenna embodiments

4 and gains of comparable relevant art antennas for the corresponding frequencies and averages.

5 The DigiTenna DUV antenna embodiments generally have comparable UHF performance to the
6 relevant art antennas. However, the DUV antenna showed VHF gains of about 7 dB to 26 dB
7 greater than the relevant art antennas for Urban and Metro configurations. The DUV antenna's
8 wideband Gain/Mass ratio was about 1 dB/kg to 10.8 dB/kg higher than these major competitors.

9 **[0080]** Table 4 shows the Front/Back Ratios of the three DUV embodiments together
10 with the five relevant art antennas. (Front/Back ratio in dB defined as the Forward gain at 0 deg
11 minus back gain at 180 deg.) Table 5 shows the differences between the Front/Back Ratios of the
12 three DUV embodiments with the corresponding Relevant Art antennas of similar size.

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[0081] Table 3 Difference in Gains between DigiTenna and Relevant Art Antennas

	VHF Hi	UHF DTV	Mean Gain dB	Mass	Gain/ Mass	UHF-VHF
	Avg dB	Avg dB	(Vhi+U)/ 2	kg	dB/kg	Avg dB
DUV-U vs RS-WS	26.86	4.56	15.71	-3.50	5.70	-22.31
DUV-U vs RS-AH	11.80	-0.80	5.50	-1.30	4.00	-12.60
DUV-UC vs RS-WS	29.3	2.6	15.6	-3.6	5.9	-26.4
DUV-UC vs RS-AH	14.2	-2.8	5.4	-1.4	4.2	-18.4
DUV-M vs RM-WY	22.73	0.61	11.67	0.00	9.72	-22.12
DUV-M vs RM-C4	7.03	-1.66	2.68	-1.50	2.54	-8.69
DUV-MC vs RM-WY	24.5	0.7	12.6	-0.1	10.8	-23.8
DUV-MC vs RM-C4	8.8	-1.5	3.6	-1.2	3.6	-10.3
DUV-F vs FL-C8	-7.50	-2.05	-4.78	-5.40	1.02	5.45

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[0083] Table 4 Front/Back Ratio of DigiTenna and Relevant Art Antennas

Frequency MHz	180	200	220	475	550	625	700	VHF	UHF
	dB	dB	dB	dB	dB	dB	dB	Avg	Avg
DigiTenna									
DUV-U	8.5	5.2	3.7	18.4	18.0	18.4	16.9	5.8	17.9
DUV-M	7.5	4.1	3.1	20.8	18.9	19.4	18.8	4.9	19.5
DUV-F	12.5	20.0	23.8	25.9	24.2	24.5	19.8	18.8	23.6
Relevant Art									
RS-WS	-14.8	-2.3	-7.7	5.4	10.9	16.4	23.0	-8.3	13.9
RS-AH	-2.2	-0.5	-0.4	15.2	21.9	23.0	18.0	-1.0	19.5
RM-WY	3.0	1.8	5.8	24.6	27.6	25.4	21.9	3.5	24.9
RM-C4	-5.3	-4.0	-3.1	20.5	21.6	24.5	23.0	-4.1	22.4
RF-C8	-0.7	14.8	11.6	25.1	37.7	30.0	25.8	8.6	29.7

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[0082] The DUV embodiments showed a little smaller but competitive UHF Front/Back

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1 ratios to most Relevant Art antennas. However, these DUV antenna embodiments showed an
 2 unexpected 5 dB to 23 dB higher Front/Back ratio across most of the DTV VHF High Band than
 3 most relevant art antennas. This beneficially assists in isolating and amplifying competing DTV
 4 signals. Individual performance is discussed below.

5 **[0084]** Table 5 DigiTenna versus Relevant Art Front/Back Ratio Comparisons

Frequency MHz	180	200	220	475	550	625	700	VHF	UHF
DUV-U vs RS-WS	23.3	7.6	11.4	13.0	7.1	2.0	-6.2	14.1	4.0
DUV-U vs RS-AH	10.7	5.7	4.1	3.3	-3.9	-4.6	-1.2	6.8	-1.6
DUV-M vs RM-WY	4.5	2.3	-2.8	-3.8	-8.7	-6.0	-3.1	1.3	-5.4
DUV-M vs RM-C4	12.9	8.0	6.1	0.4	-2.7	-5.1	-4.2	9.0	-2.9
DUV-F vs RF-C8	13.2	5.2	12.2	0.7	-13.5	-5.5	-6.1	10.2	-6.1

6

7 **[0085]** Urban DUV-U Antenna Performance: The small “Urban” DUV-U antenna
 8 showed a good average UHF gain of 7.7 dB. This was 4.4 dB higher than RU-WS and within 0.8
 9 dB of RU-AH. The DUV-U’s average UHF Front/Back ratio was a very good 17.9 dB, 3.9 dB
 10 higher than the FCC’s UHF plan of 14 dB. This was 4 dB higher than RU-WS and within 2 dB
 11 of RU-AH. This DUV-U Urban antenna’s average VHF gain was -2.2 dB. This was
 12 unexpectedly 27.3 dB higher than the relevant small antenna RU-WS and 11.7 dB higher than
 13 the RU-AH antenna. Yet, this DUV-U antenna only weighs about 1 kg (2.2 lbs). I.e., it weighs
 14 only 22% of the 4.5 kg (10 lbs) RU-WS antenna. This DUV-U antenna had much lower wind
 15 drag than both of the relevant RU-WS and RU-AH antennas. Unexpectedly, the DUV-U
 16 antenna’s VHF Front/Back ratio was 5.8 dB. This was 14.1 dB higher than RU-WS and 6.8 dB
 17 higher than RU-AH (which both have negative VHF F/B ratios.) This provides critical
 18 advantages under urban conditions with high multipath and strong interfering stations.

19 **[0086]** DUV-M “Metro” Antenna Performance: The medium sized “Metro” DUV-M
 20 embodiment had an average UHF DTV gain of about 9.1 dB. This UHF gain was beneficially
 21 about 0.6 dB higher than RM-WY, and within 1.6 dB of the RM-C4. This DUV-M’s UHF

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1 Front/Back ratio was a very good 19.5 dB, 5.5 dB higher than the FCC's 14 dB plan. This DUV-
 2 M antenna's F/B was 5.6 dB higher than the RM-WY and about equal to the RM-C4. The DUV-
 3 M antenna embodiment had a remarkably high VHF High Band gain, with an average VHF gain
 4 of about -2.5 dB. This was unexpectedly about 22.7 dB higher VHF gain than the relevant art
 5 medium RM-WY antenna.

6 **[0087]** This DUV-M antenna had a remarkable 18.2 dB higher VHF gain at 180 MHz
 7 (about DTV Channels 7-8) than the RM-C4, and 8.9 dB higher at 200 MHz. Yet this DUV-M
 8 antenna was only 965 mm (38 in) long. I.e., it was about 305 mm (12 in) shorter than the RM-
 9 WY, and similar to RM-C4. Furthermore, this DUV-M antenna had a VHF Front/Back ratio of
 10 4.9 dB. This was 1.4 dB higher than RM-WY, and 9 dB higher than RM-C4 (which had a
 11 negative F/B ratio). These higher F/B ratios give the DUV-M critical advantages under
 12 conditions with high multipath and strong interfering stations.

13 **[0088]** DUV-F "Fringe" Antenna Performance: The large DUV-F "Fringe" antenna
 14 embodiment had a UHF DTV gain of +11.1 dB, within 2 dB of the relevant art RF-C8. This
 15 DUV-F had an average VHF High Band gain of -5.1 dB which was nominally 7.9 dB lower.
 16 Unexpectedly, the DUV-F had an excellent average VHF Front/Back ratio of 18.8 dB. This
 17 Front/Back ratio is 6.8 dB above the FCC's 12 dB planning factor. This DUV-F antenna's F/B
 18 ratio was 10.2 dB higher than the premium 8 bay bow tie RF-C8's 8.6 dB VHF F/B. (This
 19 relevant art RF-C's performance appeared poor in major portions of the VHF High Band.)

20 **[0089]** This superior F/B performance enables an amplified DUV-F antenna to lock in
 21 to poor fringe broadcast signals (where an amplified RF-C8 might fail). Furthermore, the
 22 relevant art RF-C8 antenna has 22 unsealed connection points which often degrade severely over
 23 time due to corrosion and fatigue. This DUV-F antenna configuration with only 2 sealed
 24 connection points, making it much more likely to maintain its performance. At about 1.4 kg (3
 25 lb), this DUV-F antenna was only 20% as heavy as the relevant art RF-C8 antenna at 6.8 kg (15
 26 lb). Furthermore, this DUV-F may ship in a compact sturdy box at standard rates. By contrast,
 27 the RF-C8 antenna requires over sized shipping and often experiences shipping damage.

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1 **[0090]** Compact Urban DUV-UC Antenna: Referring to FIG. 1, 2C, 3A, 4A, and 6A,
 2 the small Urban DUV-U antenna embodiment described above was modified to form a compact
 3 Urban DUV-UC Antenna. The number of booster reflector elements **62** was reduced from two to
 4 one in reflective booster **113** above and below the XY plane. The the number of UHF director
 5 elements **52** was reduced from three to two to form director **142**. The length of booster reflectors
 6 **62** was reduced from about 584 mm (23 in) to about 438 mm (17 in) to about match the length of
 7 the UHF reflector 54 and round elements were used.

8 **[0091]** DUV-UC Compact “Urban” Antenna Performance: Referring to Table 1, this
 9 compact Urban DUV antenna configuration DUV-UC unexpectedly showed a substantial
 10 improvement in VHF performance by about 0.8 dB near 180 MHz, about 1.8 dB near 200 MHz,
 11 and about 2.8 dB near 220 MHz from internal comparative tests. The UHF performance also
 12 improved about 1.5 dB from channels 28 through about channel 51.

13 **[0092]** The configuration shows wideband performance in the VHF high band similar
 14 to a VHF dipole about 743 mm (29.25 in) long. E.g., at about 0 dB for 180 MHz and 220 MHz.
 15 It further showed wideband UHF performance with about 5 dB gain at about 475 MHz and 700
 16 MHz near the ends of the DTV band. This configuration maintained excellent front/back ratios
 17 of about 10 dB in the VHF High band and about 15 dB in the UHF DTV region. (Third party
 18 tests may eliminate most of the skewness coming from the asymmetric DUV elements in the
 19 earlier tests.)

20 **[0093]** DUV-MC Compact Metro Antenna: Referring to FIG. 1, 2C, 4B, and 6B, the
 21 medium “Metro” M-DUV antenna embodiment described above was modified to form a
 22 compact “Metro” DUV Antenna. The number of booster reflectors **62** on Booster 111 was
 23 reduced from two to one above and below the XY plane and reducing the length of round booster
 24 reflectors **62** from about 584 mm (23 in) to about 238 mm (17 in) to about match the length of
 25 the UHF reflector **54**.

26 **[0094]** DUV-MC Performance: Referring to Table 1, this compact Metro DUV antenna
 27 configuration unexpectedly showed a substantial improvement in VHF performance (relative to

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1 DUV-M) by about 0.8 dB near 180 MHz, about 1.8 dB near 200 MHz, and about 2.6 dB near
 2 220 MHz from internal comparative tests. This DUV-MC configuration showed wideband
 3 performance in the VHF high band similar to a VHF dipole about 743 mm (29.25 in) long. E.g.,
 4 at about 0 dB for 180 MHz and 220 MHz. The VHF performance of this DUV-MC example was
 5 within about 0.4 dB of the 743 mm (29.25 in) VHF dipole performance from 180 MHz to 220
 6 MHz. This compact Metro DUV antenna further showed wideband UHF performance with about
 7 9.4 dB gain across the DTV band from 475 MHz to 700 MHz.

8 **[0095]** Gain per Mass: The superiority of the DUV antenna configuration method is
 9 further shown by comparing the DUV antenna wideband Gain/Mass versus major competitors.
 10 Referring to Table 2, this wideband Gain/Mass parameter is evaluated as the mean of the average
 11 of the VHF High Band gain and DTV UHF gain for the 3 and 4 frequencies respectively shown
 12 in Table 1, divided by the mass M of the antenna. I.e., $(VH_i + U)$ divided by $(2 * M)$. See Table 1.

13 **[0096]** The DUV-U and DUV-M with a wideband Gain/Mass of 2.8 dB/kg were
 14 remarkably superior to commercial units having wideband Gain/Mass ranging from -6.9 dB/kg
 15 to 0.2 dB/kg. The compact DUV-UC and DUV-MC configurations showed even greater
 16 wideband Gain/Mass performance of 3.0 dB/kg and 3.9 dB/kg. Even the premium relevant art
 17 VHF/UHF Fringe eight bow tie antenna RF-C8 has a wideband Gain/Mass of only 1.1 dB/kg
 18 compared to 2.2 dB/kg for the Fringe DUV-F. None of the commercial units tested had a
 19 wideband Gain/Mass greater than 1.3 dB/kg, while all the DUV antennas tested had a wideband
 20 Gain/Mass greater than 2 dB/kg.

21 **[0097]** Wide band Gain Difference: The superior VHF UHF wideband performance of
 22 the “Urban” DUV-U and “Metro” DUV-M antennas is further shown by the difference between
 23 the average gains of the UHF DTV band and the VHF High Band, shown as UHF-VHF in Table
 24 1. These UHF vs VHF gain differences in the DUV-U and DUV-M antennas were within 10 dB
 25 and 12 dB. Compact DUV-UC and DUV-MC antennas showed even lower differences within 7
 26 dB and 11 dB. By contrast, relevant art small “Urban” and medium “Metro” competitors
 27 advertised as “VHF/UHF antennas” showed at least 20 dB UHF-VHF differences while some

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1 ranged up to a difference of 34 dB in the “Front” or 0 deg direction. The large DUV-F “Fringe”
 2 antenna configuration with a UHF-VHF wideband difference of 16.2 dB was within about 6 dB
 3 of the 10.7 dB difference of the premium large “Fringe” 8 bay bow tie RF-CS which weighed
 4 five times as much.

5 [0098] Housing/Amplifier Module: Referring to FIG. 1, and FIG. 3A through FIG. 3E,
 6 the DUV antenna system may comprise an amplifier/housing module **400** to support the driven
 7 DUV element(s) **21** and the RF signal connector **262** and/or RF signal line **260**. Referring to FIG.
 8 3A housing module **402** may comprise the RF signal line **260** which may be connected to the
 9 driven DUV elements **21**. It may be potted inside a housing **204**. Antenna mount **100** may
 10 comprise modular connector **70** which may comprise two mounting tongues **215** attached to
 11 housing module **402** to connect to one or both of longitudinal boom **104** and director boom **190**.
 12 Longitudinal boom **104** may be connected to mast **150** by mast-antenna mount **152**.

13 [0099] Amplified housing module: Referring to FIG. 3B, in some embodiments the RF
 14 enhancer may comprise an amplifier/housing module **404** comprising an RF amplifier **202**
 15 configured within housing **204**. Amplifier **202** may be RF communicatively connected to driven
 16 DUV dipole **20** and to an RF optical signal line **270** having optical connector **272**. Module **404**
 17 may have one or more signal connectors **262** diplexed or multiplexed to signal line **270**. E.g., in
 18 some configurations these may be configured for an RF satellite connection, a high UHF
 19 connection and/or an internet connection. Module **404** may comprise one or more mounting
 20 tongues **215**.

21 [0100] Dual amplifier/housing module: Referring to FIG. 3C, in some embodiments a
 22 dual amplifier/housing module **406** may comprise an amplified module **410** similar to amplified
 23 module **404**, and which may be RF communicatively connected to an extension amplified
 24 module **408** by an RF connecting line or by a DUV optic connecting line **271**. Like module **404**,
 25 dual amplifier module **406** may comprise one or more signal connectors **262** diplexed or
 26 multiplexed to RF signal line **270** having a connector **272**. Module **406** may comprise one or
 27 more mounting tongues **215**.

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1 **[0101]** Diplexed amplifier/housing module: Referring to FIG. 3D, in some embodiments
 2 an amplifier/housing module **412** is configured like amplifier/housing module **404** with an RF
 3 amplifier communicatively connected to driven dipole and signal outlet **264** which may be
 4 diplexed or multiplexed to two or more signal connectors **262**.

5 **[0102]** Solar shielded amplifier/housing module: Referring to FIG. 3E, a modular solar
 6 shield **360** may be configured to be mountable on one ore more housings **204** in
 7 amplifier/housing modules **404**, **408**, **410**, and **412**. Solar shield **260** may be configured with
 8 amplifier/housing module **412** to form shielded amplifier/housing module **414**. There may be an
 9 air gap between solar shield **360** and housing **204**. The outer surface of solar shield **360** may be
 10 configured with a reflective optical coating having a low absorptive reflective coating in the
 11 visible range. It may have a high infrared emissivity to radiate heat.

12 **[0103]** Internet Amplifier/Housing module: Referring to FIG. 3B through 3E, one of
 13 amplifier/housing modules **404**, **406**, **412**, and **414** may be configured for both transmitting and
 14 receiving RF signals to enable two way RF communications. E.g., this may include the high
 15 UHF range from 700 MHz to 801 MHz for internet communications. IP amplifiers and/or filters
 16 may be electrically bonded to and/or potted together with the respective DUV element contacts
 17 and signal line **270** or contacts **262**.

18 **[0104]** Antenna Mount: Referring to FIG. 1 and FIG. 7A through FIG. 7D, the DUV
 19 antenna system may comprise a modular antenna mount comprising one of an external mast-
 20 antenna mount or an internal antenna mount. Referring to FIG. 7A and FIG. 7B, the internal
 21 antenna mount may comprise one of a single axis mast-antenna mount **152** and a dual-axis
 22 orientable mast-antenna mount **154**. A single axis orientable mount may comprise a curvilinear
 23 bolt **162**, two clamping cams or nuts **161** and dual hole washer to clamp longitudinal boom **102**
 24 to antenna mast (not shown. See DUV antenna disclosure FIG. 1, FIG. 15). This enables
 25 positioning the antenna along and about the antenna mast. E.g., to be positioned vertically and to
 26 be moved about the vertical axis.

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1 **[0105]** Per FIG. 7B, dual axis antenna-mast mount **154** may enable orientation with
 2 three degrees of freedom including about an axis normal to the antenna mast. e.g., to adjust for
 3 polarization about the horizontal axis. As described in the DUV application, dual axis mount **154**
 4 may utilize two curvilinear bolts **162** to clamp curved boom support **156** against a bicurved
 5 mount **154** onto the antenna mast (not shown). e.g., with four cams or nuts **161** clamping two
 6 dual hole washers **160**.

7 **[0106]** Indoor Antenna Mounts: Referring to FIG. 7C and FIG. 7D, modular antenna
 8 mounts may include a standard indoor antenna mount **163** and dual axis antenna mount **164** to
 9 support driven DUV antenna **12** on indoor antenna base **165**, in a similar fashion to the external
 10 antenna mounts **152** and **154**.

11 **[0107]** Signal splitter: Referring to FIG. 8A, FIG. 8B and FIG. 8C, the modular DUV
 12 antenna system may comprise a modular signal junction box selected from a passive signal
 13 splitter **280**, an active signal distributor **282**, and an active signal multiplexer. Signal splitter **280**
 14 may be a passive splitter having one signal input **262** and multiple signal connectors **264**. Signal
 15 distributor **282** may comprise a power cable **292** and powered amplifier to distribute signals to
 16 multiple signal connectors **264** without major signal dilution and loss experienced by
 17 conventional passive splitters.

18 **[0108]** In some configurations, signal junction box may comprise signal multiplexer
 19 **284** which may provide for multiplexing signals through multiple signal connectors **264**. These
 20 may include input/output connectors for Internet signals and/or DTV signal outputs. Signal
 21 connectors **262** may be fiber optic connectors to fiber optic signal lines to reduce signal loss
 22 and/or to avoid adding noise in one or both of signal distributor **282** and signal multiplexer **284**.

23 **[0109]** Amplifier gains: Modular amplifiers may be configured to provide multiple gain
 24 configurations in some embodiments. e.g, low, medium, and high gain as needed. E.g., these
 25 may be from 6 dB to 10 dB, from 11 dB to 20 dB, and from 21 dB to 30 dB. A switch selectable
 26 amplifier may be provided.

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1 **[0110]** Potting Housing/Amplifier Combinations: With reference to FIG. 2A through
 2 FIG. 2E, and FIG 3A through FIG. 3E, the combinations of driven DUV elements, amplifier
 3 configurations, and amplifier gains may result in numerous combinations. The DUV modular
 4 antenna system may provide separate driven antenna elements of FIG. 2B through 2E, the
 5 housing options and mounts of FIG. 3A through 3E, the cable options of FIG 3A through 3C,
 6 and/or the amplifier modules with different gain options. Selections from these components may
 7 be configured and then bonded and/or potted together to form durable housing/amplifier modules
 8 with desired combinations of features.

9 **[0111]** Container: Referring to FIG. 1, the modular DUV antenna system **2** may be
 10 configured such that most combinations of modules fit into a common container or box. E.g., a
 11 container with about 1054 mm x 946 mm x 171 mm (41.25 in x 37.25 in x 6.75 in) inner
 12 dimensions may be used for common DUV Urban, Metro and Fringe models. In some
 13 configurations, the outer portions of the VHF reflector **80** may be folded back about 51 mm (2
 14 in) each along the X axis towards the DUV dipole **22**. This may reduce the width of the container
 15 by about 102 mm (4 in) from 946 mm to 844 mm (37.25 to 33.25 in) resulting in a more compact
 16 container. In further configurations, the VHF reflector may not be attached for shipping,
 17 reducing the container by about half while requiring minimal assembly.

18 **[0112]** Enhanced DUV-F with 4:1 balun: In the PT3 prototype DUV configuration of
 19 the previous DigiTenna application, the booster elements closest to the antenna boom or
 20 horizontal axis were about 635 mm (25") in length. See US Patent Application 2070262912,
 21 "Modular digital UHF/VHF antenna" filed March 31, 2007, herein the "Modular DUV
 22 application". The three outer booster elements were about 559 mm (22") in length.

23 **[0113]** A large DigiTenna "Fringe" DUV-F prototype **PT3** was assembled. A large
 24 prototype DigiTenna "Fringe" DUV-F antenna model **PT4** was formed like the DigiTenna
 25 "fringe" model DUV-F.

26 **[0114]** UHF/VHF Enhanced DUV-F with 4:1 balun: In one configuration of the current
 27 embodiment DUV-F, the off axis booster elements is shortened by about 32% to 23% down to

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1 about 432 mm (17"). The half angle from the booster boom to the horizontal boom is about 52
 2 degrees (or about 104 degrees included angle from upper to lower booster booms). Thus
 3 shortening the booster elements unexpectedly gained about 2 dB in the DTV VHF high band, as
 4 shown in Table 6 for digital channel 8. This DUV-F configuration further improved the DTV
 5 UHF high band by about 1 dB to 1.5 dB.

6 [0115] Comparative performance: Comparing the performance of DUV-F "PT4" with
 7 "PT3" in Table 6, this relative reduction in booster element length further improved DTV UHF
 8 high band by about 1 dB to 1.5 dB in the range of digital channels 33 to 40 with lesser
 9 improvements in the UHF bands above and below those channels.

10 [0116] Table 6 further compares the performance of DUV prototypes PT3 and PT4 with
 11 4:1 baluns against major commercial antennas 4BG26 from AntennaCraft and WS1747 from
 12 Winegard, both with 4:1 baluns. This reports internal measurements of relative signal strength
 13 gain measurements (in dB) of assorted locally available TV channels using a Sencore SA1454
 14 signal analyzer. Antennas were mounted 3.7 m (12') above ground in Oostburg, with
 15 measurements checked against a reference antenna for relative calibration. Measurements are
 16 nominally +/- 1 dB but usually below independent lab measurements.

17 [0117] This fourth prototype "PT4" configuration used a ratio of physical DUV-D
 18 dipole Y axial length to booster element Y axis physical length of about 0.8 (17"/21.25")
 19 compared to the previous ratio of about 1.04 (22"/21.25"). In this configuration, the booster to
 20 element ratio of the tip-tip booster element length divided by the physical DUV element Y tip to
 21 connector axial length was about 1.7 (e.g., 17"/10") compared to the previous ratio of about 2.2
 22 (e.g., 22"/10").

23 [0118] In this PT4 prototype configuration, the DUV element 21 had a folded height to
 24 tip to connector length ratio of 0.4 (4"/10"), or an unfolded height to tip - connector length ratio
 25 of 0.6 (6"/10"). In some DUV configurations, the unfolded height to tip - connector length for
 26 DUV element 21 may be in the range from about 0.1 to 1.2. e.g., with unfolded heights ranging
 27 from about 25 mm (1") to 304 mm (12") for a 25 mm (10") dipole element 21.

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1 **[0119]** In some booster enhanced configurations, a booster to dipole ratio of the physical
2 tip to tip booster element length to DUV-D Y axis tip-tip dipole element length may be in the
3 range from 0.95 to 0.67 where the DUV element unfolded height to length ratio may be in the
4 range from 0.31 to 0.62. e.g., the booster element length may range from 514 mm (20.3") to 360
5 mm (14.2") with tip to tip DUV dipole length of about 540 mm (21.25") for DUV dipole
6 elements **21** of about length 254 mm (10") each and with an element contact to contact distance
7 of about 32 mm (1.25").

8 **[0120]** In some configurations, the booster to element ratio of booster reflector element
9 length to DUV element **21** length may be in the range from about 1.4 to 2.1. e.g., booster lengths
10 may be in the range from about 356 mm (14") to 533 mm (21") for configurations having DUV
11 element lengths of about 254 mm (10"). Similarly, in configurations having booster element
12 lengths of about 432 mm (17"), DUV element lengths may range from mm (8.1") to 308 mm
13 (12.1").

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[0121] Table 6 Comparisons of Outdoor Antenna Models

Model & Balun	4BG26 Antenna- Craft 4:1 balun	WS1747 Winegard 4:1 balun	"PT3" 4:1 balun DigiTenna	"PT4" 4:1 balun DigiTenna	2016 Channel Master 4:1 balun	HD1080 Winegard 4:1 balun	DUV-S balun DigiTenna	DUV1.5 DigiTenna
Relative Gain (dB) assorted Digital broadcast TV channels								
Channel								
8	-7.4	-10.0	-18.5	-16.8	-14.9	-18.5		-11.7
22	0.6	-2.3	0.0	0.3	-3.8	-8.5		-5.2
25	12.8	10.4	11.9	11.8	10.2	6.1		9.7
28	10.4	6.8	9.4	10.0	8.3	2.5		7.6
33	7.6	5.1	7.0	8.4	7.1	2.6		5.3
34	6.0	4.2	6.0	7.1	5.1	1.5		4.0
35	9.2	8.1	9.1	10.2	8.6	6.2		7.5
40	14.7	14.0	14.4	15.4	13.2	12.1		13.6
46	12.3	11.6	11.2	13.0	9.6	10.3		10.1
61	10.5	11.9	9.6	10.2	4.2	7.4		7.3
Model & Balun	4BG26 Antenna- Craft 4:1 balun	WS1747 Winegard 4:1 balun	"PT3" 4:1 balun DigiTenna	DUV-F "PT4" 4:1 balun	2016 Channel Master 4:1 balun	HD1080 Winegard 4:1 balun	DUV-S DUV1.5 balun DigiTenna	
Relative Gain (dB) assorted Analog broadcast TV channels								
Channel								
10	2.1	0.5	-8.6	-6.9	-5.4	-7.9		-2.5
12	1.9	0.0	-9.9	-8.2	-6.5	-11.2		-4.0
18	13.5	12.2	12.6	12.7	7.0	4.8		8.9
24	7.8	6.0	7.2	7.4	3.7	-1.5		3.0
30	6.5	3.6	4.9	6.0	3.0	-1.0		2.0
36	18.0	16.9	18.0	18.9	16.6	14.0		15.2
41	-0.9	-2.0	-1.1	-0.4	-1.0	-2.7		-1.0
55	-17.0	-17.0	-19.0	-18.0	-21.0	-19.0		-18.0
58	20.4	20.5	19.2	19.8	14.5	16.8		18.1
63	-3.6	-3.3	-4.9	-4.3	-9.8	-7.1		-8.9
5/30/'08	5:00 PM	5:30 PM	4:40 PM	4:50 PM	5:05 PM	5:15 PM		5:20 PM
Y Width"	108.0	35.0	33.0	33.0	47.0	34.5		33.0
Z Height"	36.0	19.0	35.5	35.5	22.0	18.3		12.0
X Depth"	91.0	65.0	38.0	38.0	36.5	6.0		22.0
Mass lbs	7.0	6.0	1.4	1.4	3.0	4.4		1.2
Avg Gain	6.3	4.9	3.9	4.8	2.4	0.3		3.1
Gain/Mass	0.90	0.81	2.80	3.45	0.81	0.08		2.54

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1 **[0122]** Table 6 further compares measurements of this enhanced DUV-F type “PT4”
 2 prototype configuration against two major competitive VHF/UHF antennas. e.g., Model 4BG26
 3 from Antenna-Craft, and model WS1747 from Winegard, which are 239% to 171% of the PT4
 4 length along the X axis depth, and 327% to 106% of the Y-axis “width” of the “PT4”
 5 configuration. This PT4 antenna provides a remarkably high VHF high band performance for
 6 such a smaller simpler antenna while providing better performance in the digital UHF TV band
 7 compared to major competitors.

8 **[0123]** After the dimensions and mass, an average gain of all measurements shown is
 9 shown at the bottom of Table 1 to show relative performance. This “PT4” prototype
 10 configuration shows roughly comparable performance to the WS1747 and about 76% of the
 11 much larger 4BG26. The Gain/Mass for this “PT4” is higher than 350% of the Gain/Mass for
 12 these relevant art 4BG26 and WS1747.

13 **[0124]** DUV-F with impedance matching 4:1 balun: In the applicant's previously
 14 disclosed PT3 prototype DUV antennas, a conventional impedance matching 4:1 balun or
 15 transformer was used between the DUV dipole and the signal lead, as typical for TV antennas.
 16 E.g., as expected to convert from a typical 300 ohm TV antenna impedance to 75 ohm signal
 17 coax cable impedance. All previous third party measurements of the DUV antenna prototypes, as
 18 performed for DigiTenna, LLC by Georgia Tech Applied Research Corp. (GTARC) Atlanta Ga.,
 19 were conducted with such a relevant art impedance matching 4:1 balun.

20 **[0125]** DUV VHF Window: The DUV boosters may be mounted on a boom with
 21 booster reflector elements positioned to provide a DUV VHF “window” without booster
 22 reflective elements **62** above and below the antenna X axis. This window may be about the
 23 height of the DUV dipole unfolded. e.g. With a reflector boom at an angle of 52 degrees to the
 24 antenna X axis, the nearest booster reflective elements **62** may be about 432 mm (17”) long and
 25 positioned about 168 mm, 289 mm, 417 mm and 556 mm (6.63 in, 11.38 in, 16.44 in and 21.9
 26 in) along the outer boom side up from its junction with the longitudinal boom.

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1 **[0126]** DUV baluns: Novel DUV baluns were developed that markedly improve the
 2 performance of DUV antennas compared to the relevant art. A conventional relevant art
 3 impedance matching board with a 2.5 turn high frequency transformer thin leads and multiple
 4 capacitors strongly reduced the DUV antenna performance compared to a 4:1 balun. A DUV1.5
 5 balun was developed by modifying the circuit and signal traces resulting in substantial signal
 6 enhancements over a 4:1 balun.

7 **[0127]** In one configuration, a DUV2.5 balun may be configured for 2.5 turns with the
 8 balun windings going three times through the balun core and wrapping twice around the
 9 respective left and right balun cores. See schematic Fig. 18A. In a second configuration, a
 10 DUV1.5 balun may be configured for 1.5 turns with the balun windings going twice through the
 11 balun core with one wrap around the transformer cores. See schematic Fig. 18B. In a third
 12 configuration, a DUV0.5 balun may be configured for 0.5 turns with the balun windings going
 13 once through the balun core without wrapping around the transformer cores. See schematic Fig.
 14 18C.

15 **[0128]** These configurations may use similar wide leads **432** and **434** of about 3 mm
 16 lead width K, with lead to lead spacing J of about 9 mm. These form simpler more robust circuit
 17 boards compared to relevant art circuit boards with thin leads and numerous capacitors and
 18 resistors.

19 **[0129]** VHF Enhanced DUV-S with DUV balun: As shown in Table 6, a “Suburban”
 20 DUV-S configuration was formed with the novel DUV1.5 balun, as detailed below, in place of
 21 the traditional 4:1 balun. Changing to this DUV1.5 balun in this smaller DUV-S antenna
 22 configuration remarkably provided about a 7 dB improvement in the DTV VHF high band
 23 (channel 8) and about 6 dB in the analog VHF high band (channel 10) relative to the larger
 24 “PT4” prototype DUV-F with a conventional impedance matching 4:1 balun. This configuration
 25 used the 432 mm (17”) long booster elements used in the “PT4” prototype. While this DUV-S
 26 configuration’s UHF performance was somewhat lower than the PT4, the high front/back ratio

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1 enables adding an amplifier to boost the gain, in contrast with the difficult to achieve gain
 2 improvement in the VHF high band in such small antennas.

3 **[0130]** Table 6 shows preliminary relative performance of this “Suburban” DUV-S with
 4 a DUV1.5 balun configuration compared to competitive new Channel Master 2016 and
 5 Winegard HD1080. Channel Master's 2016 appears similar to 5646 (after removing the last three
 6 VHF driven dipoles), having both VHF and UHF dipoles with associated multiple connections.
 7 This DUV-S configuration shows 3 dB to 7 dB improved VHF high band performance (channel
 8 8 or 10) relative to CM 2016 and HD1080 respectively. This DUV-S configuration provides
 9 substantial front/back ratio (F/B) compared to no F/B ratio of the Channel Master 2016 and the
 10 negative F/B with the Winegard HD1080. Such DUV-S configurations provide much simpler
 11 more reliable connections than these competitive antennas.

12 **[0131]** The averaged gain of this DUV-S configuration is 0.7 dB to 2.8 dB higher. Gain/
 13 mass shows a remarkable 3 to 31 times higher performance for the DUV-S compared to these
 14 relevant art antennas. Note that all the competitors had a VHF and UHF average Gain/ Mass less
 15 than 1. By contrast, the DUV antennas had a VHF and UHF average Gain/Mass of at least 1.5.
 16 The DUV embodiments shown had VHF and UHF average Gain/Mass greater than 2.5.

17 **[0132]** Impedance matching DUV balun: Referring to Fig. 11, in some DUV
 18 embodiments such high frequency DUV baluns 420 may be provided between the DUV dipole
 19 elements **21** and the signal connector **282**. One embodiment of a DUV1.5 balun **420** in a DUV
 20 antenna **10** comprises a left DUV element **21** which may be mounted through housing **204** with a
 21 DUV connector **224** to a DUV contact **222** connecting to a left lead **432** on a circuit board **452**.
 22 Similarly, right DUV element **21** may be mounted to right lead **434** on circuit board **460**. Left
 23 lead **432** may be connected to impedance matching high frequency DUV transformer **421** to
 24 signal lead **260** connected to the cable connector **262**. Right lead **434** may be connected to
 25 impedance matching high frequency DUV transformer **421** to complementary signal lead **261**
 26 connected to the complementary contact of cable connector **262**.

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1 **[0133]** Fig. 12 shows a physical perspective and Fig. 18A shows a schematic diagram of
 2 one configuration of a DUV impedance matching UHF/VHF transformer **420** embodiment. In
 3 some configurations, transformer windings **442**, **444**, **446** and **448** connect the DUV element -
 4 transformer leads **432** and **434** to signal - transformer leads **472** and **474**. e.g., left element -
 5 transformer lead **432** may connect to left element -transformer contactor **436** which may connect
 6 to LL transformer winding **442** making one wrap around left transformer core **422** going through
 7 left transformer hole **426** which may connect to left signal - transformer contact **452** and thence
 8 to left signal lead **472** (connecting to signal connector **260** not shown). Similarly, left element -
 9 transformer contact **436** may be connected to LR transformer winding **444** which makes one
 10 wrap around right transformer core **424** through right transformer hole **426** to left signal -
 11 transformer connector **452**.

12 **[0134]** Similarly, right element - transformer lead **434** may be connected to right
 13 element - transformer contact **438** which may connect to RR transformer winding **448** making
 14 one wrap around right transformer core **424** through right transformer hole **426** to right signal -
 15 transformer contact **454** which may connect to right signal lead **474** which connects to
 16 complementary signal connector **261**. Similarly, right element - transformer connector **438** may
 17 connect to RL transformer winding **446** making one wrap around right transformer core **424**
 18 through transformer hole **426** to right signal - transformer connector **454**.

19 **[0135]** The DUV impedance matching balun **420** shown schematically in Fig. 18A may
 20 comprise transformer windings **442**, **444**, **446** and **448** nominally making 1.5 turns or wraps
 21 electrically around the left transformer core **422** and the right transformer core **424** respectively
 22 of the high frequency ferrite core **421**. In other configurations, electrically equivalent
 23 connections may be used. e.g. The transformer windings **442**, **444**, **446** and **448** may be extended
 24 to connect directly to the DUV element contacts **222**, **223** and/or the signal connector contacts
 25 **260**, **261**.

26 **[0136]** With reference to Fig. 13A and Fig. 13B, high frequency balun **420** comprises a
 27 transformer core **421** of thickness **C** and length **B** with width **A**, comprising a left core **422** and

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1 right core **424** spaced by **E**, with transformer holes **426** of diameter **H**. Fig. 13A shows the ferrite
 2 or Radio Frequency (RF)/high frequency transformer core **421** in plan view while Fig. 13B
 3 shows the transformer core **421** in elevation view. For example, this transformer core **421** may
 4 comprise a multi-aperture Fair-Rite model 2861001502 of ferrite material **61** of Fair-Rite
 5 Products Corp. of Wallkill, NY. In this configuration, dimensions may be width **A** about 13.3
 6 mm, length **B** about 6.6 mm, thickness **C** about 7.5 mm, spacing **E** about 5.7 mm and core
 7 diameter **H** about 3.8 mm. The impedance matching balun **420** gives similar performance when
 8 any one of the depth, width, or length dimensions of transformer core **421** is about doubled in
 9 size.

10 [0137] Fig. 14 shows the upper circuit layer **462** of one configuration of the circuit
 11 board for an impedance matching balun **421**. Fig. 15 shows the complementary lower circuit
 12 layer **464** for that configuration. Left DUV element contact **222** may connect DUV element to
 13 balun lead **432** terminating in balun winding contact **436**. Right DUV element contact **223** may
 14 connect DUV element to balun lead **434** terminating in balun winding contact **438**. Left balun
 15 winding contact **452** connects to balun to signal connector lead **472** which connects to signal
 16 connector contact **260**. Balun winding contact **454** connects through the board to balun to signal
 17 contactor lead **474** connecting to complementary signal connector contact **261** on the lower
 18 circuit layer beneath the board.

19 [0138] Fig. 16 shows one configuration of the upper circuit layer **462** for a DUV RF
 20 connector board directly connecting left DUV element connector **222** via DUV element to signal
 21 connector lead **433** to signal contact **260** on the signal connector. Similarly right DUV element
 22 connector **223** may connect DUV element to signal connector lead **434** to through board lead
 23 contact **454** and thence via lead **474** to complementary signal contact **261** on the signal
 24 connector. Leads **433** and **434** may have width **K** of about 3 mm and lead to lead spacing **J**
 25 between leads **433** and **435** of about 9 mm.

26 [0139] Fig. 17 shows the upper circuit layer **462** of one configuration of the circuit
 27 board for an amplifier **201**. The complementary lower circuit layer **464** for this configuration is

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- 1 similar to Fig 5 with lead termination spacing adjusted for the difference between the DUV1.5
 2 balun and the amplifier. e.g., left DUV element contact **222** may connect DUV element to balun
 3 left lead **432** terminating in amplifier contact **246**. Right DUV element contact **223** may connect
 4 DUV element to balun lead **434** terminating in amplifier contact **248**. Left amplifier contact **452**
 5 connects to amplifier to signal connector lead **472** which connects to signal connector contact
 6 **260**. Amplifier contact **454** connects through the board to amplifier to signal contactor lead **474**
 7 connecting to complementary signal connector contact **261** on the lower circuit layer beneath the
 8 board. Amplifier **201** may be configured to match impedance between the DUV element or DUV
 9 dipole connected to one or both of contacts **222** and **223**, and the signal cable connected contacts
 10 **260** and/or **261**. The amplifier **201** may be configured for a combination.
- 11 **[0140]** Impedance matching comparisons: Five impedance matching configurations for
 12 the DUV-F antenna are shown in Table 7. An impedance matching or isolation amplifier may be
 13 used in come configurations.

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1 [0141] Table 7 Performance with DUV1.5 Balun and direct DUV RF connector

Model & Option	DUV-F with 4:1 balun OB-1	DUV-F with 4:1 balun OB- 3	DUV-F with 4:1 balun 0089	DUV-F with DUV1.5 balun	DUV-F Direct no balun
Channel	Relative Gain (dB) assorted digital broadcast TV				
8	-16.6	-16.7	-16.2	-12.2	-12.3
22	1.0	0.9	0.7	0.5	0.5
25	13.4	13.2	13.4	14.4	14.1
28	10.4	10.3	10.0	10.7	10.8
33	8.9	8.3	8.7	9.4	9.5
34	8.2	7.7	7.6	8.6	8.3
35	11.4	10.7	11.2	12.5	11.4
40	16.5	16.2	16.0	17.2	16.7
46	12.9	12.7	12.7	14.1	13.0
61	8.0	8.1	8.9	10.0	8.4
Model & Option	DUV-F with 4:1 balun OB-1	DUV-F with 4:1 balun OB- 3	DUV-F with 4:1 balun 0089	DUV-F with DUV1.5 balun	DUV-F Direct no balun
Channel	Relative Gain (dB) assorted analog broadcast TV				
10	-6.1	-7.5	-7.1	-3.2	-3.1
12	-8.2	-8.5	-8.2	-4.2	-4.7
18	13.4	13.5	13.2	12.5	12.8
24	8.5	7.9	8.0	8.2	7.8
30	6.8	6.4	6.5	7.1	7.2
36	19.7	19.3	19.6	20.0	19.8
41	-0.3	0.0	-0.5	0.5	0.1
55	-18.0	-18.0	-17.0	-18.0	-17.0

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58	19.6	19.4	19.8	21.0	18.6
63	-9.0	-7.6	-7.4	-5.3	-8.2
05/30/'08	4:10 PM	4:20 PM	4:30 PM	4:00 PM	4:40 PM
Avg Gain	5.0	4.8	5.0	6.2	5.7

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[0142] The performance of this DUV-F configuration with a DUV 1.5 balun can be seen to provide an unexpected and remarkable 3.5 dB to 4 dB higher performance for DTV VHF high band channel 8 compared with the same DUV-F antenna using a commercially available 4:1 balun for VHF/UHF TV antennas. The DUV-F performance is shown with conventional TV 4:1 baluns. e.g., with an indoor 4:1 balun (Chinese model #OB-1), an outdoor 4:1 balun (Chinese model #OB-3), or another outdoor 4:1 balun (Channel Master model #0089.) Similarly analog channel 10 shows 2.9 dB to 3.5 dB improvement from the DUV1.5 balun over industry 4:1 baluns. This DUV1.5 balun further provided about 1 dB to 2 dB improvement in the upper UHF range from channels 35 to 61 in this DUV-F configuration.

[0143] Comparing the average of all measurements, the DUV1.5 balun in this configuration unexpectedly showed about 1.2 dB improvement over all the VHF and UHF channels measured compared to using the three industry 4:1 baluns.

[0144] Table 8 compares DUV-D indoor dipole antennas against other dipoles.

[0146] DUV-D with 4:1 balun: In one configuration, a DUV-D dipole (540 mm end to end width x 102 mm height x 171 mm depth, 21.25" x 4" x 6.75") had about 2 dB better performance in the DTV VHF high band (digital channel 8) and 2 dB to 3 dB better in the high DTV UHF (digital channels 46, 61) compared to a UHF dipole with 4:1 balun (2 elements each 254 mm x 25 mm, 10"x1" flat folded into a U channel), as shown in Table 8. This DUV-D's UHF performance showed an unexpected and remarkable 5 dB to 20 dB better in the high DTV UHF band than a VHF folded dipole (two elements each folded to 540 mm width x 10 mm diameter, 29.25" x 3/8") direct physical width with a 4:1 balun. The VHF dipole's electrical length wrapped tip to tip was about 2.17 m (85.5") with 54 mm (2.12") vertical spacing between

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- 1 wrapped elements. This DUV-D was within 3 dB of the VHF performance (digital channel 8) of
 2 the VHF folded dipole corresponding to its smaller size.

3 **[0145]** Table 8 Comparisons of Indoor Antenna Models

Model & Option	Dipole 2x10"x1" 4:1 Balun	VHF dipole 29.25"x1" 4:1 balun	DUV-D 4:1 balun	Dipole 2x10"x1" DUV1.5 balun	DUV-D DUV1.5 balun	Dipole 2x10"x1" direct	PHDTV1 Phillips no balun	DUV-D direct
Channel Relative Gain(dB) assorted Digital TV broadcast								
8	-30.0	-22.5	-27.9	-29.1	-25.0	-28.8	-40.0	-24.9
22	-14.5	-14.4	-14.1	-15.6	-14.7	-16.2	-16.9	-14.8
25	-5.5	-8.3	-4.9	-4.7	-4.0	-4.6	-5.4	-4.1
28	-9.6	-15.9	-9.0	-10.0	-9.4	-10.1	-6.5	-9.6
33	-6.6	-17.5	-6.0	-6.3	-5.3	-6.0	-11.7	-5.9
34	-6.7	-20.2	-6.2	-6.4	-6.2	-6.0	-8.6	-6.2
35	-7.2	-10.9	-6.8	-6.2	-5.6	-5.9	-6.0	-7.1
40	-1.4	-20.3	-0.2	-0.7	0.1	0.4	-3.1	0.3
46	-9.0	-20.7	-6.8	-7.5	-5.7	-7.0	-2.4	-5.8
61	-10.9	-27.1	-7.8	-9.5	-7.1	-12.7	-6.7	-9.7
Model & Option	Dipole 2x10"x1" 4:1 Balun	VHF dipole 2x29.3"x1" 4:1 balun	DUV-D 4:1 balun	Dipole 2x10"x1" DUV1.5 balun	DUV-D +DUV1. 5 balun	Dipole 2x10"x1" direct	PHDTV1 Phillips no balun	DUV-D direct
Channel Relative Gain (dB) assorted Analog TV broadcast								
10	-16.7	-11.7	-15.4	-14.5	-11.8	-14.6	-27.1	-11.7
12	-16.6	-12.8	-15.0	-13.2	-11.4	-13.4	-34.3	-11.5
18	-3.0	-6.8	-2.5	-4.8	-4.4	-4.9	-4.4	-4.5
24	-9.4	-10.0	-7.8	-9.4	-8.9	-8.4	-9.3	-7.8
30	-11.3	-19.3	-10.4	-11.9	-11.6	-11.0	-10.5	-10.7
36	1.0	-4.7	2.0	1.0	2.8	2.2	4.2	2.8
41	-15.3	-26.1	-14.5	-14.0	-14.9	-13.0	-15.8	-14.5
58	-0.9	-17.9	2.2	1.8	3.6	-1.0	5.2	1.5
63	-28.2	-30.5	-22.4	-26.4	-22.7	-27.0	-22.9	-23.8
05/30/'08	8:10PM	8:25PM	7:50PM	8:00PM	7:25PM	8:20PM	7:30PM	7:40PM
Length"	1"	0.375	6.75	6.75	6.75	1	13.5	6.75
Width"	10"	29.25	21.25	21.25	21.25	10	13	21.25
Height"	1"	1	4	4	4	1	1	4
Mass lbs							2	
Avg Gain	-10.6	-16.7	-9.1	-9.9	-8.5	-9.9	-11.7	-8.8

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1 **[0147]** DUV-D with DUV balun: The DVD-D was reconfigured with a DUV balun
 2 instead of the 4:1 balun. Table 3 compares this DUV-D with DUV1.5 balun configuration with a
 3 dipole having two 254 mm x 25 mm (10" x 1") elements with a similar DUV1.5 balun. The
 4 DUV-D's DTV VHF high band performance is about 4 dB higher in digital channel 8 and about
 5 2.7 dB higher in analog channel 10. In the high UHF range the DUV-D with DUV1.5 balun
 6 similarly shows 1.8 dB to 2.4 dB higher performance in channels 46 and 61. This configuration
 7 showed an average of 1.5 dB higher gain over all channels measured than the dipole with the
 8 same DUV1.5 balun. The DUV board with a DUV1.5 balun provides about 1 dB to 3 dB
 9 improvement in the VHF compared to the same DUV circuit board using a relevant art 2.5 turn
 10 transformer with 28 gauge wire(such as used on the Winegard #CB8269). The DUV balun may
 11 be use windings having a diameter of 0.33 mm (24 gauge) or greater.

12 **[0148]** Direct DUV-D RF connector: Referring to Fig. 11 and Fig. 12, in one
 13 embodiment, a DUV-D direct antenna 10 was formed using a circuit board **460** with a DUV RF
 14 connector providing direct leads between the DUV dipole element pair **20** and the signal
 15 connector **282**. e.g., a left DUV element **21L** was mounted on the circuit board **460** with a left
 16 fastener **224** providing direct electrical contact **222** with a circuit trace or left element lead **432** to
 17 a left signal connector **260**. A right DUV element **21R** was similarly mounted on the circuit
 18 board **460** with a similar right fastener **224** providing direct electrical contact with a circuit trace
 19 forming a right element lead **434** to the right signal connector **261** connected to the coax return
 20 or shield. These left signal lead **432** and right signal lead **434** traces were formed (similar to 300
 21 ohm leads) with circuit traces about 3 mm wide and spaced apart center to center by about 9 mm.

22 **[0149]** Dipole to transformer lead length: Referring to Fig. 11 and Fig. 14, reducing the
 23 dipole to balun length of these dipole element to transformer or balun leads **432** and **434** from a
 24 configuration 254 mm (10.0") to a configuration with about 29 mm (1.1") in other configurations
 25 (a ratio of 8.8) may improve the VHF hi-band by about 6 dB and the UHF gain by about 1 dB.

26 **[0150]** Reducing the length of the dipole element to transformer lead **432** and **434** from
 27 about 127 mm (5") in some configurations to about 29 mm (1.1") in another configuration using

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1 300 ohm wire, improved the VHF high band response by 2 dB to 3 dB. This 4.4 ratio of dipole to
 2 balun lead length 127 mm (5.0") to 29 mm (1.1") may improve the UHF gain by about 0 dB to
 3 2dB for the DTV UHF band channels 14 to 55.

4 [0151] Referring to FIG. 14, dipole to balun lead lengths I of leads **432** and **434** between
 5 Dipole Element Pair **20** and transformer **421** may be about 51 mm (2") or less in some
 6 configurations. In some configurations, dipole to balun lead lengths I may be less than about 29
 7 mm (1.1"). e.g., In one configuration, the length of left lead **432** and right lead **434** from dipole
 8 elements **21L** and **21R** to the edge of transformer core **421** may be about 28 mm and 32 mm
 9 respectively as shown in Fig. 11 and Fig. 14.

10 [0152] Lead to lead spacing: Referring to Fig. 14 in some configurations, the lead to
 11 lead spacing J between the center of left lead **432** to the center of right lead **434** (from DUV
 12 element **21** to transformer **421**) may be about 9 mm (0.38"). Similarly, referring to Fig. 16, lead
 13 to lead spacing J between dipole element to signal connector leads **433** and **435** may be about 9
 14 mm (0.38").

15 [0153] Reducing the lead to lead spacing J from about 51 mm (2") in some
 16 configurations to about 9 mm (0.38") improved VHF high band and UHF band performance
 17 ranging from 2 dB to 3 dB to as much as 4 dB to 6 dB. Similarly, compared to configurations
 18 with lead to lead spacing J of about 25 mm (1"), reducing the spacing J to about 9 mm (0.38")
 19 improved antenna performance by about 1 dB to 3 dB across the VHF high band and UHF band.

20 [0154] In some configurations, the lead to lead spacing J may be between 3 mm (0.11")
 21 and 25 mm (1"), for one of the: dipole to core leads, core to signal connector leads, and dipole to
 22 signal connector leads. In further configurations, the lead to lead spacing J may be between 5
 23 mm (0.2") and 18 mm (0.7"), for one of the: dipole to core leads, core to signal connector leads,
 24 and dipole to signal connector leads.

25 [0155] Lead width: Referring to Fig. 14, Fig. 16, and Fig. 17 in some configurations
 26 increasing the width K of dipole to core leads **432** and **434** from about 0.3 mm (0.01") to about 3
 27 mm (0.11") was found to improve performance by 4 dB or greater in the DTV UHF band. This

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1 further improves ruggedness and reliability by eliminating a common source of lead cracking
2 and board failure in relevant art antenna circuit boards.

3 [0156] In some configurations, lead width **K** may greater than about 0.5 mm (0.02") for
4 one of: dipole to core lead **432**, **434**, core to signal connector lead **472**, **474**, dipole to amplifier
5 leads **432** and **434**, amplifier to signal connector leads **472**, **454**, and dipole to signal connector
6 lead **433**, **435**. In further DUV configurations, lead width **K** may greater than about 0.9 mm
7 (0.035") for one of: DUV element to signal connector leads **433**, **435**, DUV element to core leads
8 **432**, **434**, DUV element to amplifier leads **432**, **434**.

9 [0157] Transformer to signal connector lead length: Referring to Fig. 12 and Fig. 14, in
10 some configurations, the balun core to connector lead length **L** may be less than about 51 mm
11 (2"). e.g., some configurations may have a lead length **L** of about 38 mm (1.5") or less, about 28
12 mm (1.1") or less, or about 16 mm (0.6") or less. In some configurations, shortening balun core
13 to connector lead length **L** from about 51 mm (2") to about 28 mm (1.1") or less strongly
14 improved DUV performance by 8 dB to 10 dB or more, where the balun core to connector lead
15 length **L** is the mean length measured from connector contact **260** and/or **261** at the inner end of
16 the signal or lead connector to the center of the outer edge of transformer or balun core **421**.
17 Similarly, shortening the balun core to connector lead length **L** from about 38 mm (1.5") in some
18 configurations to about 28 mm (1.1") or less in other configurations improved performance by
19 about 5 dB.

20 [0158] Lead length **L** may include lead **472** between signal lead connection **260** to
21 contactor 452, and a portion of transformer winding **442** or **444**, **446** to the edge of core **421**.
22 Similarly, including lead **474** from complementary signal connector contact **261** to contactor **454**
23 and transformer winding lead **446** and/or **448** to the edge of core **421**.

24 [0159] In some configurations the center of transformer core **421** may be connected to
25 signal lead contact **282** separated by about 28 mm (1.1") from the center edge of the transformer
26 core **421** to the inner end of connector **282**. e.g., connector **282** may have signal connection **260**
27 and complementary signal connection **261** and be connected by lead **472** about 15 mm (0.6") to

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1 contact **452**. Signal connection **260** may be connected by left signal lead **472** to connector **452**
 2 which connects to transformer windings **442** and **444**.

3 **[0160]** DUV-D direct performance: Referring further to Table 8, the directly connected
 4 DUV-D with the DUV RF connector shows about a 4 dB improvement over a directly connected
 5 10" x 1" dipole in VHF high band channel 8. High UHF band performance improves 1.2 dB to 3
 6 dB in digital channels 46 and 61. Table 8 compares the DUV-D direct performance with DUV
 7 RF connector against the Silver Sensor (classic) (Phillips PHDTV1/Zenith ZHDTV1). That
 8 consumer antenna appears to be a log-periodic antenna of "width" of 335 mm (13.2"), length 335
 9 mm (13.2") and height 51 mm (2") with no impedance matching balun and no amplifier.

10 **[0161]** The DUV-D direct with DUV RF connector shows a remarkable increase of
 11 about 15 dB in VHF high band performance in digital channel 8 and 2 dB higher in channel 22
 12 over the relevant art Silver Sensor. High UHF range performance is also 3 dB to 3.4 dB higher in
 13 channels 40, 46 and 61. The overall average of all channels measured shows about 3 dB higher
 14 performance for the DUV-D direct compared to the Silver Sensor.

15 **[0162]** DUV-D antenna with DUV1.5 balun shows about 1.2 dB to 2.6 dB improved
 16 performance over the DUV-D direct with DUV RF connector in the high UHF digital channels
 17 46 and 61. Conversely, the DUV-D direct with RF connector shows 1.5 dB better performance in
 18 the mid UHF range channel 35. Overall, the DUV-D with DUV1.5 balun shows about 0.3 dB
 19 higher average performance than the DUV-D direct with DUV RF connector in this indoor
 20 configuration with two 254 mm (10") DUV elements.

21 **[0163]** DUV-D close balun: Referring to Fig. 19A, in another embodiment, the DUV
 22 balun may be close coupled to the DUV dipole. e.g., the left transformer windings **442** and **444**
 23 of a DUV1.5 balun may be attached directly to contact **222** of the left DUV element **21**.
 24 Similarly the right transformer windings **446** and **448** may be attached to contact **223** of the right
 25 DUV element **21R**. In other configurations the transformer windings **442**, **444**, **446** and **448** may
 26 be bonded directly to the DUV elements. These windings may be attached to element contact

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1 **222** positioned on board **450** in some configurations. In further configurations, the windings may
 2 be attached to connectors **436** and **438** located near to or near the axis of the DUV dipole.

3 **[0164]** Further to Fig. 19A, the signal lead may be brought up to and close coupled with
 4 the DUV balun. e.g., by connecting transformer windings **442** and **444** to the signal lead **260**, and
 5 windings **446** and **448** to the complementary signal lead **262**, without any intermediary
 6 connector. This beneficially removes a connector loss of 0.3 to 0.5 dB. In other configurations,
 7 both transformer windings **442** and **444** and signal lead **260** may be connected to an intermediary
 8 contact **452** with windings **446** and **448** connected to a similar intermediary contact **454**. The
 9 signal lead cable may be fixed with a fastener or cable mount **268**. It may have a strain relief **476**
 10 provided in a housing cable opening **209** in the housing **204**.

11 **[0165]** DUV close direct: Referring to Fig. 19B, the DUV-D dipole may have the DUV
 12 RF connector provide close coupling between signal cable **260** and DUV elements **21**. e.g., with
 13 short left and right signal leads **432** and **434** less than 38 mm (1.5") from the end of signal cable
 14 **260** without an intermediary balun. In some configurations, the signal lead **260** may be
 15 connected directly to the left DUV element **21L** with the complementary signal lead **261**
 16 connected to the right DUV element **21R** without an intermediate connector or balun and with
 17 left and right signal leads **432** and **434** being less than 18 mm (0.7") from the contacts **222** and
 18 **223** of DUV elements **21**.

19 **[0166]** Module encapsulation: The DUV module housing may be filled with an epoxy,
 20 "potting" or sealant material. This may encapsulate or hermetically seal of one or more of a
 21 portion of the DUV dipole elements **21**, the connecting leads **432** and **434**, RF core **421**,
 22 amplifier **201**, and signal connector **282**. Such hermetic sealing material reduces corrosion. The
 23 potting further improves rigidity and strength to attach front and/or back booms to the end
 24 connectors. This improves fatigue strength under wind loading conditions. This beneficially
 25 enhances system life and provides consistent reliable DTV performance over the life of the
 26 antenna.

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1 **[0167]** Enhanced DUV Antennas: Referring to Fig. 1, some enhanced indoor DUV-D
 2 dipoles may be configured with a regular or amplified housing **202**, two dipole elements **21** and
 3 one of a DUV RF connector, a DUV Balun, a DUV filter, and a DUV amplifier module.

4 **[0168]** Fringe DUV-DF: Referring to Fig. 1 and to Fig. 20C, in one embodiment, a UHF
 5 enhanced reflector booster was formed comprising five reflectors having length D about 838 mm
 6 (33") long on each of the upper and lower reflector booms. Referring to Fig. 20C, in some
 7 configurations, a non-uniform incremental spacing of booster reflector elements **64A**, **64B**, **64C**,
 8 **64D** and **64E** may be used along the outer edge of the reflector boom **128**. In some
 9 configurations, at least four booster elements are configured with outward increasing incremental
 10 spacing along the booster boom. e.g., incremental spacing along the outer booster boom **128** may
 11 be about 98 mm, 98 mm, 117 mm, 124 mm and 140 mm (starting from the top of the longitudinal
 12 boom). Cumulative spacing along the outer booster boom **128** may be about 98 mm, 197 mm,
 13 314 mm, 438mm and 578 mm from its longitudinal boom junction.

14 **[0169]** By doubling the booster reflector length relative to the dipole elements
 15 (compared to the DUV-M), and by adding an inner 5th reflector, this Deep Fringe DUV antenna
 16 (DUV-DF) provided about 2 dB to 3.5 dB improvement across the UHF in a very compact
 17 antenna (while reducing the VHF high band by 3B to 5 dB) compared to the DUV-F.

18 **[0170]** In some configurations, the booster to element ratio of the to end to end or tip-tip
 19 booster element length D divided by the physical DUV element Y tip to connector axial length
 20 was selected to be about 3.3 (e.g., 33"/ 10") compared to the previous ratio of about 2.2 (e.g.,
 21 22"/10"). In DUV-DF configurations, this booster to element length ratio may be within a range
 22 of about 2.5 to 4.8. e.g., with booster reflector lengths **64** from about 635 mm (25") to 1.9 m
 23 (48") with an DUV element length of 254 mm (10"). In some configurations the medium VHF
 24 reflector **64** was selected to have a length of about 838 mm (33").

25 **[0171]** Boosted modular DUV antennas: Referring to Fig. 1, Fig. 20A, Fig. 20B, and
 26 Fig. 20C, in some embodiments, boosted modular DUV configurations may include a "Metro"
 27 booster **113** having one medium reflective booster element **62** of length on boom **24** bonded by

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1 one or more booster attachments **58** and **59** and fastener holes **71**, a “Fringe” booster **115**
 2 comprising four medium booster elements **62** of length **B**, and a “Deep Fringe” booster **119**
 3 comprising five long booster elements **64** of length **D**. In these boosted modular DUV
 4 configurations, the deep booster ratio of long booster length to medium booster length may be in
 5 the range from 1.5 to 2.5. Length **A** of element **62** in Metro Booster **113** may be similar to length
 6 **B** of booster element **62** in Fringe Booster **115**. e.g., to provide commonality of parts.

7 **[0172]** Other boosted DUV configurations may comprise, a “Metro” booster **113** having
 8 one or two reflective booster elements **62** of length **A**, a “Fringe” booster **115** having three or
 9 four booster elements **62** of length **B**, and a “Deep Fringe” booster **119** having five to seven
 10 booster elements **64** of length **C**, wherein the deep to fringe ratio of the length **D** of the deep
 11 fringe elements **64** to the length **B** of fringe booster elements **62** may be in the range of 1.0 to
 12 3.0. Booster boom **126** for the Fringe booster of FIG. 20B may be configured about equal to
 13 booster boom **128** for the Deep Fringe booster of Fig. 20C. e.g., to facilitate commonality of
 14 parts.

15 **[0173]** Multiplexed DUV antennas: Referring to Fig. 3C, some embodiments may
 16 comprise a doubly multiplexed DUV antenna comprising two DUV-D antennas multiplexed (or
 17 “diplexed”) together. e.g., a first DUV-D extension amplifier/housing module connected via
 18 signal cable **271** to a second amplifier/housing module **410**. Some multiplexed DUV antennas
 19 may have signal cable **271** directly connect amplifier/housing module **408** to amplifier/housing
 20 module **410** without an intervening connector. This may reduce insertion losses and increase
 21 reliability.

22 **[0174]** Referring to Fig. 10, one triply multiplexed DUV antenna may comprise three
 23 DUV-D antennas multiplexed together. e.g., a first DUV-D may be connected by a signal cable
 24 **270** to a multiplexed DUV-D antenna, and a second DUV-D may be connected by signal cable
 25 **271** to the multiplexed DUV-D antenna, to form a multiplexed triple DUV antenna. In some
 26 configurations, one of the multiplexed DUV-D antennas may be amplified. In some
 27 configurations, one of the multiplexed DUV-D antennas may be filtered to reduce one or more of

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1 FM interference and/or a strong adjacent UHF or VHF signal. In further configurations, two or
 2 three of the multiplexed DUV-D antennas may be amplified.

3 [0175] In some configurations, the doubly or triply multiplexed DUV antenna may
 4 comprise a DUV-D Dipole **20** configured as one or more of U-DUV dipole **22**, M-DUV dipole
 5 **24**, V-DUV dipole **26** or X-DUV dipole **28**, comprising DUV dipole elements **21**, **23**, **34** **25**, **27**
 6 or **29** as shown in Fig. 2A, Fig. 2B, Fig. 2C, Fig. 2D, and Fig. 2E. In some configurations, the
 7 multiplexed DUV-D antenna may comprise one DUV-D dipole enhanced with one of directors
 8 **142**, **144**, **146**, **145**, and **147**, referring to Fig. 4A, 4B, 4C, 4D, and 4E. In some configurations,
 9 the multiplexed DUV antenna may comprise one of boosters **113**, **115**, and **119** referring to Fig.
 10 20A, Fig. 20B, and Fig. 20C. In some configurations, the multiplexed DUV antenna may
 11 comprise one DUV-D antenna enhanced with one of reflectors **172**, **174**, or **176** referring to Fig.
 12 9A, Fig. 9B, and Fig. 9C.

13 [0176] Relevant art antennas typically use 152 mm (6") UHF directors. In some
 14 configurations, enhanced DTV DUV antennas configurations may use enhanced UHF directors
 15 **52** by extending the length from to between 168 mm to 183 mm (6.6" and 7.2") in length. E.g.,
 16 the performance of enhanced DUV configurations of Fig. 22 to Fig 27 is shown in Table 9 and
 17 Table 10, using 175 mm (6.88") long UHF directors **52**. These enhanced UHF directors **52** may
 18 be formed from 25.4 mm (1") material with two stiffening ridges giving increased performance
 19 and enhance rigidity giving a finished width of about 175 mm (6.88"). This improved the UHF
 20 performance by about 0.5 to 1.0 dB. It also unexpectedly improved the VHF High Band
 21 performance by about 0.5 dB.

22 [0177] Combinations of DUV-D antennas may be similarly enhanced. E.g., in one
 23 embodiment of the enhanced modular DUV system may comprise the following enhanced DUV
 24 antennas: an "Indoor" DUV-I antenna **3** as shown in FIG. 21; a "City" DUV-C antenna **4** as
 25 shown in FIG. 22; a "Metro" DUV-M antenna **5** as shown in FIG. 23; a "Suburban" DUV-S
 26 antenna **6** as shown in Fig. 24; a "Fringe" DUV-F antenna **7** as shown in FIG. 25; a "Deep
 27 Fringe" DUV-DF antenna **8** as shown in FIG. 26; and an "Extreme Fringe" DUV-XF antenna **9**

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- 1 as shown in FIG. 27. For example, Table 9 shows the configuration and performance of one set
 2 of seven Enhanced DUV UHF/VHF Antennas in such an embodiment.

3 **[0178]** Table 9 Enhanced DUV Antenna Configuration and Performance

	Indoor	City	Metro	Subur- ban	Fringe	Deep Fringe	Extreme Fringe
Model	DUV- I	DUV -C	DUV- M	DUV-S	DUV-F	DUV- DF	DUV- XF
DUV Dipole	1	1	1	1	1	1	1
DUV-1.5 balun	1	1	1	1	1	1	1
UHF Directors	0	1	2	2	6	10	13
UHF Reflectors	0	1	1	1	1	1	1
VHF Reflectors	0	0	1	1	1	1	1
Boosters	0	0	0	1&1	4&4	4&4	5&5
Mass kg	0.34	0.45	0.57	0.82	1.22	1.45	1.59
Performance Gain dB							
VHF Ch 7 180 MHz dB		-3.5	2.5	2.5	2.0	2.5	3.0
VHF Ch 10 200 MHz dB		-1.89	3.6	3.6	3.3	4.0	4.8
VHF Ch 13 220 MHz dB		-1.8	3.2	3.0	2.5	3.2	4.5
UHF Ch 14 475 MHz dB		3.0	4.0	5.4	8.5	9.0	10.4
UHF Ch 27 550 MHz dB		4.0	5.0	6.3	9.3	10.5	12.2
UHF Ch 39 625 MHz dB		4.1	6.2	6.6	10.8	12.8	14.5
UHF Ch 51 700 MHz dB		3.0	5.0	5.6	10.9	11.3	12.9
VHF Average dB		-2.40	3.10	3.03	2.60	3.23	4.10
UHF Average dB		3.53	5.05	5.98	9.88	10.9	12.5
Avg (VHF + UHF)/2 dB		0.56	4.08	4.50	6.24	7.07	8.30
Gain/Mass dB/kg		1.24	7.19	5.52	5.09	4.87	5.23
UHF - VHF gain dB		5.9	1.9	2.9	7.3	7.7	8.4

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[0179] Table 10 Front/Back Performance of Enhanced DUV Antennas

	Indo or	City	Metro	Subur- ban	Fringe	Deep Fringe	Extreme Fringe
Model	DU V-I	DUV- C	DUV- M	DUV-S	DUV-F	DUV- DF	DUV- XF
VHF Ch 7 180 MHz dB		0.0	13.1	14.2	13.1	13.1	13.1
VHF Ch 10 200 MHz dB		0.0	11.0	11.9	9.6	9.6	9.6
VHF Ch 13 220 MHz dB		0.0	5.1	5.1	6.8	6.8	6.8
UHF Ch 14 475 MHz dB		10.0	13.0	16.8	22.4	24.4	25.0
UHF Ch 27 550 MHz dB		15.0	18.0	22.3	20.0	20.5	22.0
UHF Ch 39 625 MHz dB		11.5	14.5	16.0	20.0	20.0	21.5
UHF Ch 51 700 MHz dB		10.0	13.0	13.6	18.0	18.0	20.0
VHF Average dB		0.0	9.73	10.4	9.83	9.83	9.83
UHF Average dB		11.6	14.6	17.2	20.1	20.7	22.1
Avg F/B (UHF-VHF)/2 dB		5.8	12.2	13.8	15.0	15.3	16.0

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[0180] The performance of Enhanced DUV antennas was measured internally relative to the DUV antenna prototype performance as measured by Georgia Institute of Technology. The DUV prototype performance in the VHF 170-230 MHz was calibrated by Georgia Tech at each frequency against S-A model 15-115 and model 15-200 reference dipoles. The DUV prototype UHF 450-700 MHz performance was similarly calibrated against a Satimo model SH 400 double ridge horn.

[0181] The Enhanced DUV antennas shown in Table 9 have a remarkable improvement in performance over the performance of the prototype DUV configurations shown in Table 2 and Table 4, and corresponding improvement over the relevant art antennas. The performance enhancement incorporates benefits from the DUV 1.5 balun, enhanced director 52

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1 and improved booster reflector spacing. E.g., the enhanced Fringe DUV-F VHS Hi-band
 2 improved 7.6 dB from -5.1 dB to 2.6 dB with a small 1.2 dB reduction in UHF from 11.1 to 9.9
 3 dB. The Gain/Mass increased by 2.9 dB from 2.2 dB/kg to 5.1 dB/kg. The five largest enhanced
 4 DUV antennas showed a performance of 4.9 dB/kg to 7.2 dB/kg is a remarkable 4 dB/kg to 6
 5 dB/kg higher Gain/Mass over the five relevant art antennas.

6 [0182] These DUV antennas showed such enhanced performance that a simplified
 7 DUV-C City version was similarly provided with one UHF reflector 54, with none or one UHF
 8 director 52, and without the off axis booster elements of the DUV-U or DUV-UC. Even with
 9 these simple enhancements, the DUV-C antenna showed an average VHF and UHF gain of 0.56
 10 dB, comparable to the second best RM-C4 4221 relevant art antenna at 0.66 dB. This simple
 11 DUV-C achieved a Gain/Mass of 1.25 dB/kg compared -2.9 dB/kg for the RU-WS SS1000, and
 12 1.1 dB/kg for the premier relevant art RF-C8 4228 antenna. With the higher power urban DTV
 13 transmitters, an Indoor model DUV-I was added having just a DUV Dipole on an indoor stand.

14 [0183] In one example, an enhanced "Deep Fringe" DUV-DF antenna was configured
 15 with ten UHF directors 52 and four booster elements 62 above and below the antenna
 16 longitudinal pointer axis. The average broadband VHF + UHF gain for this DUV-DF
 17 configuration was 7.7 dB. This broadband gain is a remarkable 0.9 dB higher than the premier
 18 Relevant Art eight bay RF-C8 4228 antenna. This DUV-DF configuration's Front/Back VHF
 19 ratio was 9.83 dB compared to -4.1 dB for four bay RM-C4 and 8.6 dB for the premier eight bay
 20 RF-C8.

21 [0184] In another example, an enhanced Extreme Fringe DUV-XF configuration was
 22 configured with thirteen UHF directors 52 and five 432 mm (17") UHF booster elements 62
 23 above and below the axis. In this configuration, these five booster elements were spaced apart
 24 about 121 mm, 127 mm, 137 mm, and 143 mm (4.75", 5.0", 5 3/8" and 5 5/8"). These were
 25 complemented by an axial UHF reflector 54 and medium axial VHF reflector 82. This enhanced
 26 DUV-XF model had an average VHF Hiband performance of 4.1 dB, 1.5 dB higher than the
 27 much larger premium eight bay RF-C8 4228 relevant art antenna. The UHF performance of 12.5

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1 dB was within 0.7 dB of the RF-C8 4228 model. This enhanced DUV-XF achieved a Gain/Mass
 2 of 5.23 dB/kg compared to the 1.1 dB/kg for the premier RF-C8 4228. The Front/Back ratio of
 3 this DUV-XF configuration was 9.83 dB compared to the Front/Back ratio of 8.6 for the RF-C8.

4 **[0185]** Multiple DUV Antennas: Referring to FIG. 28, in some embodiments, multiple
 5 DUV antennas may be configured together to pick up multiple signals from stations in differing
 6 geographic locations. For example, this embodiment shows an Extreme Deep Fringe DUV-XF
 7 antenna 9 pointing towards a distant station, a Suburban DUV-S antenna 5 pointing towards a
 8 regional station, and a Fringe DUV-F antenna 7 pointing towards an intermediate station.
 9 Referring to FIG. 10, these multiple antennas may be configured together with a multiplexed
 10 DUV amplifier system 404.

11 **[0186]** Dipole Element Length: Referring to FIG. 2A, in some configurations, the tip 98
 12 to contact 44 (near inner end 99) electrical length LE of DUV elements 21 (together with half the
 13 contact distance LC) may be configured for half wave dipole resonance about in the VHF High
 14 Band and for three halves resonance in the UHF DTV range. (e.g., VHF High Band of 180 MHz
 15 to 220 Mhz, and UHF ban of about 470 MHz to 698 MHz). LE is measured from about the DUV
 16 element RF contact 44 near the inner end 99 to the outer conductive tip near the element end 98.
 17 The contact distance LC is measured from one element contact 44 to the other element contact
 18 44. To resonate at or near a prescribed frequency, driven DUV dipoles 20 may be configured
 19 using a dipole end effect factor of about 91%. (i.e., the factor to multiply the theoretical dipole to
 20 obtain the actual resonance frequency). Referring to FIG. 2 and FIG. 3, DUV fan or dipole
 21 elements 21 deeper folded sections typically use lower dipole end effect factors. E.g., using
 22 dipole end effect of about 70% of the theoretical dipole element for the desired resonant
 23 wavelength.

24 **[0187]** Referring to FIG. 2A, in some embodiments, a broadband DTV UHF/VHF
 25 DUV dipole 20 may be configured with two dipole elements 21 having element lengths LE from
 26 about 218 mm to 302 mm (8.6 in to about 11.9 in) with a contact to contact length LC from one
 27 element contact 44 to the other element contact 44 of about 13 mm to 64 mm (0.5" to 2.5").

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1 **[0188]** M-DUV dipoles: Referring to FIG. 2A and FIG. 2C, some embodiments may
 2 configure an M-DUV dipole 24 with two M-DUV dipole elements 25 having DUV element
 3 lengths LE of about 249 mm to 254 mm (9.75 in to 10 in) with about a 32 mm (1.25") center
 4 contact to contact distance LC. This gives an overall physical tip to tip DUV dipole length LD of
 5 about 527 mm to 540 mm (20.75 in to 21.25 in). E.g., in some tests, an M-DUV dipole 24 with
 6 249 mm (9.75") long elements 21 (at an LC of 32 mm) gave a 3 dB higher performance in the
 7 VHF high band than a VHF dipole with dipole elements of the same length made of 13 mm
 8 (0.5") diameter conductive copper rod. This M-DUV dipole 24 further gave 1.5 dB to 2.2 dB
 9 higher gain than the VHF rod dipole across the DTV UHF range.

10 **[0189]** Referring to FIG. 2B, A shorter UHF enhanced U-DUV dipole 22 may be used
 11 in some configurations. E.g., with UHF three halves resonance about from 660 MHz to 860
 12 MHz, with VHF half wave resonance above about 220 MHz. U-DUV elements 23 may have
 13 lengths LE from about 172 mm to 218 mm (6.8 in to 8.6 in) long. Such U-DUV dipoles enhance
 14 higher UHF reception with some reduction in VHF reception.

15 **[0190]** V-DUV dipoles: Referring to FIG. 2D, other configurations may use VHF
 16 enhanced V-DUV dipoles having V-DUV elements 27 with longer lengths. E.g., using V-DUV
 17 elements with electrical lengths LE of about 267 mm to 330 mm (10.5 in to 13 in) long. Such V-
 18 DUV elements beneficially enhance VHF reception while still giving good UHF reception.

19 **[0191]** X-DUV dipoles: Referring to FIG. 2E, in further configurations, an X-DUV
 20 extended dipole 28 may be used having dipole elements 29 with a longer electrical length. E.g.,
 21 in some configurations the X-DUV element 29 electrical length LE may be about 330 mm to 508
 22 mm (13 in to 20 in) from outer end 98 to inner contact 44. Some X-DUV configurations may
 23 have a length LE of about 356 mm (14 in). This larger X-DUV dipole may beneficially enhance
 24 both VHF reception and UHF reception above the broadband M-DUV dipole.

25 **[0193]** Further examples of DUV element configurations are shown in Table 11. These
 26 assume an element contact to contact spacing LC of 32 mm (1.25 in). Center to center distance
 27 LC may vary from 13 mm to 76 mm (0.5 in to 3 in) with the same tip to tip length LD. These

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1 DUV element configurations are shown for nominal half wave resonance frequencies MHz
 2 assuming a dipole end effect factor of about 0.7. The corresponding nominal three half wave
 3 resonance is shown along with the five eighths wave resonance. Resonant frequencies within or
 4 near the UHF DTV band and the VHF High band are underlined.

5 **[0194]** Compound DUV Antenna Configurations: Referring to FIG. 33, some
 6 embodiments may comprise multiple DUV dipoles to form a compound DUV antenna. E.g., in
 7 some embodiments, the compound DUV antenna may comprise one or more U-DUV dipoles **22**,
 8 M-DUV dipoles **24**, and/or V-DUV dipoles **26**, with one or more DUV housing/amplifiers **204**.
 9 These may be configured with one or more UHF directors **52** and/or VHF Directors **178**
 10 mounted on or bonded to short booms **102**, medium booms **104** or long booms **106** with
 11 fasteners or bonds **148**. One or more booms **102**, **104** or **106** may be mounted to a mast **150** with
 12 mount **152** or to an intra antenna boom **108**. One or more RF directors **140** may be positioned
 13 behind one or more of DUV antennas **22**, **24** and/or **26** to enhance performance and increase
 14 their Front/Back ratio.

15 **[0195]** For example, RF Directors may comprise reflective screens **136** mounted on one
 16 or more Intra Antenna Spars **107** connected to the Intra Antenna Boom **108** by one or more Intra
 17 Antenna Standoffs **109**. DUV element leads **290** supported by cable mounts **268** may multiplex
 18 DUV antennas **22**, **24** and **26** to housing **204**. One or more antennas **22**, **24** and **26** may be
 19 connected by a DUV balun, direct connection or an impedance matching or amplifying amplifier
 20 in housing **204** to signal line **260**. The DUV antenna **2** may be powered by a Renewable Power
 21 Supply **302** such as a Solar Panel **304** with energy storage **306** connected via power cable **292** to
 22 amplifiers in housing **204**.

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1 [0192] Table 11 DUV dipole element configurations

Model	Length LE*		End Factor	Resonant Frequencies		
	mm	in		L/2	5L/8	3L/2
				MHz	MHz	MHz
U-DUV-300	159	6.3	0.7	300	375	900
U-DUV-290	165	6.5	0.7	290	363	870
U-DUV-280	172	6.8	0.7	280	350	840
U-DUV-270	178	7.0	0.7	270	338	810
U-DUV-260	186	7.3	0.7	260	325	780
U-DUV-250	194	7.6	0.7	250	313	750
U-DUV-240	203	8.0	0.7	240	300	720
U-DUV-233	210	8.3	0.7	233	291	<u>698</u>
U-DUV-230	212	8.4	0.7	230	288	<u>690</u>
M-DUV-220	223	8.8	0.7	<u>220</u>	275	<u>660</u>
M-DUV-210	234	9.2	0.7	<u>210</u>	263	<u>630</u>
M-DUV-200	246	9.7	0.7	<u>200</u>	250	<u>600</u>
M-DUV-190	260	10.2	0.7	<u>190</u>	238	<u>570</u>
V-DUV-180	276	10.9	0.7	<u>180</u>	225	<u>540</u>
V-DUV-170	293	11.5	0.7	<u>170</u>	<u>213</u>	<u>510</u>
V-DUV-160	312	12.3	0.7	160	<u>200</u>	<u>480</u>
V-DUV-157	335	13.2	0.7	157	<u>196</u>	<u>470</u>
X-DUV-150	334	13.1	0.7	150	<u>188</u>	450
X-DUV-140	359	14.1	0.7	140	<u>175</u>	420
X-DUV-120	421	16.6	0.7	120	150	360
X-DUV-100	509	20.0	0.7	100	125	300
X-DUV-80	640	25.2	0.7	80	100	240

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*@Length LC= 31.8 1.25

1
2 **[0196]** The U-DUV dipole embodiments and configurations may be configured with
3 multiple U-DUV dipoles 22, M-DUV dipoles 24, and/or V-DUV dipoles 26. These may be
4 positioned adjacent to each other. E.g., U-DUV dipoles 22 may be positioned adjacent to a V-
5 DUV dipole 26 or vice versa.

6 **[0197]** Enhanced Wind Performance: Commercial tower applications often have higher
7 winds and problems of interference or multi-path reflections off of metal tower components.
8 DUV antenna embodiments are substantially smaller than conventional antennas for the same
9 performance. A DUV-W embodiment for high wind commercial applications is shown in FIG.
10 29. Such a commercial DUV-W antenna may use two tower standoff booms 502 mounted to the
11 tower mast 501 by a mast-tower mount 512. These bracing and mounting booms may be
12 configured suitable tubing such as from 13 mm to 37 mm (0.5" to 1.5") tubing. E.g. some
13 configurations may use 19 mm (0.75") square tubing.

14 **[0198]** This DUV-W high wind configuration may include a vertical boom-booster
15 support 506 between the upper and lower booster arrays attached to the booster booms by
16 vertical support-boom connectors 506. Referring to FIG. 30, the VHF reflector may be provided
17 with reflector stiffener to connect the reflector 82 to the boom 102. E.g. this may use a 51 mm
18 (2") stiffener for 838 mm (33") reflectors 82 and a 102 mm (4") stiffener for long 1.75 m (69")
19 VHF reflectors. To accommodate further wind a medium reinforcing reflector brace 514 from
20 the bottom of boom 102 out to about midway along each side of the medium VHF reflector 82.

21 **[0199]** A similar long reinforcing reflector brace may be used with a long VHF reflector
22 (not shown) to withstand higher wind loadings. Such DUV-W configurations provide
23 unexpectedly higher performance to mass ratios compared to relevant art antennas and
24 correspondingly lower drag. Such DUV-W wind enhanced configurations may be configured to
25 accommodate winds greater than 145 km/h (90 mph). Relevant art antennas must be much more
26 heavily reinforced to survive such winds. This difference in mass results in further major

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1 reductions in the labor required to install the DUV-W vs very large heavy relevant art antennas
2 such as the eight bay RF-C8.

3

4 **Generalization**

5 [0200] From the foregoing description, it will be appreciated that a novel approach for
6 forming Modular Digital UHF / VHF antennas has been disclosed using one or more methods
7 described herein. While the components, techniques and aspects of the invention have been
8 described with a certain degree of particularity, it is manifest that many changes may be made in
9 the specific designs, constructions and methodology herein above described without departing
10 from the spirit and scope of this disclosure.

11 [0201] Where dimensions are given they are generally for illustrative purpose and are
12 not prescriptive. As the skilled artisan will appreciate, other suitable materials and components
13 may be efficaciously utilized, as needed or desired, giving due consideration to the goals of
14 achieving one or more of the benefits and advantages as taught or suggested herein.

15 [0202] While certain modular antenna configurations, driven elements, director
16 elements, reflector elements, resonant elements, amplifiers, lines, baluns, bonds, supports and/or
17 mounts are shown in some configurations for some embodiments, further combinations of those
18 configurations may be efficaciously utilized. Similarly, variations in the active and/or passive
19 element lengths, heights, spacings, and other element, component, and structural dimensions and
20 parameters for antenna systems may be used.

21 [0203] Where the terms RF, VHF, UHF, FM, DTV, Internet, driven, active, passive,
22 reflector, and director have been used, the methods are generally applicable to other
23 combinations of those elements. Where streamlined and/or tapered elements are described, other
24 stamped and/or cylindrical elements may be used. Configurations described utilizing stiffened
25 elements may use unstiffened elements.

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1 **[0204]** Where assembly methods are described, various alternative assembly methods
2 may be efficaciously utilized to achieve configurations to achieve the benefits and advantages of
3 one or more of the embodiments as taught or suggested herein.

4 **[0205]** Where longitudinal, axial, transverse, vertical, orientation, Left, Right, or other
5 directions are referred to, it will be appreciated that any general coordinate system using
6 curvilinear coordinates may be utilized. Similarly, the antenna element orientations may be
7 generally rearranged to achieve other beneficial combinations of the features and methods
8 described.

9 **[0206]** While the components, techniques and aspects of the invention have been
10 described with a certain degree of particularity, it is manifest that many changes may be made in
11 the specific designs, constructions and methodology herein above described without departing
12 from the spirit and scope of this disclosure.

13 **[0207]** Various modifications and applications of the invention may occur to those who
14 are skilled in the art, without departing from the true spirit or scope of the invention. It should be
15 understood that the invention is not limited to the embodiments set forth herein for purposes of
16 exemplification, but includes the full range of equivalency to which each element is entitled.

CLAIMS

WE CLAIM

1 A matched DUV antenna comprising:

2 a first driven DUV element; and

3 a second driven DUV element;

4 wherein the first and second driven DUV elements each have

5 a Z height to Y length ratio greater than 0.1; and

6 an UHF/VHF impedance matcher comprising

7 a first connecting lead connected to the first DUV element,

8 a second connecting lead connected the second DUV element;

9 wherein the UHF/VHF impedance matcher is configured as one of:

10 a DUV connection,

11 wherein the first and second connecting leads

12 each has a length less than 254 mm; and

13 wherein the first and second connecting leads have

14 a lead to lead spacing J between about 1 mm and 100 mm;

15 and

16 a DUV balun having an RF core that is not configured as a 4:1 TV balun,

17 wherein each connecting lead is configured with one of;

18 2.5 turns, 1.5 turns, and 0.5 turns around the RF core; and

19 wherein the matched DUV antenna has

20 a gain improvement of at least 1 dB

21 at a frequency in the VHF range from 30 MHz to 300 MHz, and

22 a gain improvement of at least 1 dB

23 at a frequency in the UHF range between 300 MHz to 3 GHz;

24 compared to a dipole antenna having two driven elements of

25 equal Y length having a height to length ratio of 0.1

- 1 and configured with a 4:1 TV balun.
- 2 2 The matched DUV antenna of claim 1 wherein one of the first connecting lead and the
3 second connecting lead comprises two windings passing through a hole in the RF core.
- 4 3 The matched DUV antenna of claim 2 wherein the first connecting lead comprises an **LL**
5 winding passing through a first RF core hole, and an **LR** winding passing through a second RF
6 core hole, and the second connecting lead comprising an **RL** winding passing through the first
7 RF core hole, and an **RR** winding passing through the second RF core hole.
- 8 4 The matched DUV antenna of claim 3 wherein the **LL** winding and the **RL** winding each
9 makes 1.5 turns passing through the first RF core hole, and the **LR** winding and the **RR** winding
10 each makes 1.5 turns passing through the second RF core hold.
- 11 5 The matched DUV antenna of claim 2 wherein the diameter of first connecting lead and
12 the second connecting lead are greater than 0.33 mm.
- 13 6 The matched DUV antenna of claim 1 wherein the lead to lead spacing **J** between the
14 first connecting lead and the second connecting lead is less than about 51 mm.
- 15 7 The matched DUV antenna of claim 6 wherein the lead to lead spacing **J** is between
16 about 3 mm and about 25 mm, for a portion of the connecting leads.
- 17 8 The matched DUV antenna of claim 6 wherein the lead to lead spacing **J** is between
18 about 5 mm and 18 mm.
- 19 9 The matched DUV antenna of claim 1 wherein the lead width **K** of one of the first
20 connecting lead and the second connecting lead is greater than about 0.6 mm.
- 21 10 The matched DUV antenna of claim 9 wherein the lead width **K** is greater than about 0.9
22 mm.
- 23 11 The matched DUV antenna of claim 1 wherein the connection to core length **L**, of one of
24 the first connecting lead and the second connecting lead, is less than about 51 mm.
- 25 12 The matched DUV antenna of claim 11 wherein the connection to core length **L**, of one
26 of the first connector lead and the second connecting lead, is less than about 38 mm.

1 13 The matched DUV antenna of claim 1 wherein the element to core length **I**, of one of the
2 first connector lead and the second connecting lead, is less than about 51 mm.

3 14 The matched DUV antenna of claim 13 wherein the element to core length **I**, of one of
4 the first connector lead and the second connecting lead, is less than about 25 mm.

5 15 The matched DUV antenna of claim 1 wherein the length **M** of each connecting lead is
6 less than about 127 mm.

7 16 The matched DUV antenna of claim 1 wherein the impedance matcher comprises an
8 amplifier connected to the first and second connecting links.

9 17 The matched DUV antenna of claim 1 wherein a portion of the first driven DUV element,
10 a portion of the second driven DUV element and the impedance matcher are encapsulated.

11

12 18 An enhanced DUV antenna having a pointing axis comprising:

13 a driven dipole having a plurality of driven DUV elements;

14 a UHF/VHF impedance matcher RF communicatively connected to the plurality of
15 driven elements, excluding a 4:1 balun;

16 a signal cable RF communicatively connected to the impedance matcher;

17 a RF enhancer comprising

18 an RF booster having a plurality of reflective booster elements;

19 wherein the unfolded driven element height to length ratio is greater than 0.1;

20 wherein the booster elements are displaced from the pointing axis by a distance greater
21 than one half the length of the driven DUV element; and

22 wherein the booster to element ratio of booster element length to the DUV
23 element length within the range from about 1.4 to 2.1.

24 19 The enhanced DUV antenna of claim 18 wherein the RF enhancer comprises a UHF
25 director having a plurality of elements positioned along the point axis ahead of the driven DUV
26 dipole.

1 20 The enhanced DUV antenna of claim 18 wherein the RF enhancer comprises a VHF
2 director positioned along the pointing axis ahead of the driven DUV dipole.

3 21 The enhanced DUV antenna of claim 18 wherein the RF enhancer comprises a VHF
4 reflector positioned along the pointing axis behind the driven DUV dipole.

5 22 The enhanced DUV antenna of claim 18 wherein the UHF/VHF impedance matcher
6 comprises a first and second connecting leads, each having a length less than 254 mm; wherein
7 the first and second connecting leads have a lead to lead spacing **J** between about 1 mm and 100
8 mm; and wherein the enhanced DUV antenna has a gain improvement of at least 3 dB at a
9 frequency in the VHF range from 30 MHz to 300 MHz compared to a dipole antenna having two
10 driven elements of equal **Y** end to connector length as the DUV elements, having a height to
11 length ratio of 0.1 and configured with a 4:1 TV balun.

12 23 The enhanced DUV antenna of claim 18 wherein the UHF/VHF impedance matcher
13 comprises:

14 a first connecting lead connected to the first driven DUV element;

15 a second connecting lead connected to the second driven DUV element; and

16 a DUV balun having an RF core that is not configured as a 4:1 TV balun;

17 wherein each connecting lead is configured with one of 2.5 turns, 1.5 turns, and 0.5 turns around
18 the RF core.

19 24 The enhanced DUV antenna of claim 23 wherein the first connecting lead comprises an
20 LL winding passing through a first RF core hole, and an LR winding passing through a second
21 RF core hole, and the second connecting lead comprising an RL winding passing through the
22 first RF core hole, and an RR winding passing through the second RF core hole.

23 25 The enhanced DUV antenna of Claim 24 wherein the **LL** winding and the **RL** winding
24 each makes 1.5 turns passing through the first RF core hole, and the **LR** winding and the **RR**
25 winding each makes 1.5 turns passing through the second RF core hold.

26 26 A modular Digital UHF/VHF (DUV) antenna system comprising:

27 a modular driven DUV antenna comprising

- 1 a first driven DUV element and a second driven DUV element,
2 an RF signal line RF communicatively connected to the first and second driven DUV
3 elements, and
4 an antenna mount supporting the DUV element; and
5 a modular RF signal enhancer, supported by the antenna mount and selected from:
6 a DUV RF connector; a DUV balun; an RF amplifier; and an RF filter; and
7 a passive RF enhancer positioned to enhance the RF performance of the DUV antenna and
8 comprising one of:
9 an RF director, an RF reflector, and an RF booster.
- 10 27 The modular DUV antenna of claim 26 wherein the RF enhancer comprises an RF amplifier
11 having one signal connection communicatively connected to the DUV dipole, and a second
12 signal connection communicatively connected to the RF signal line, wherein the RF amplifier
13 signal gain is selectable for multiple gains between 6 dB and 30 dB.
- 14 28 The modular DUV antenna of claim 26 comprising a plurality of DUV-D dipoles
15 multiplexed together.
- 16 29 The modular DUV antenna of claim 26 comprising a plurality of RF amplifier modules.
- 17 30 The modular DUV antenna of claim 27 wherein the RF enhancer comprises an RF
18 amplifier module diplexed to a satellite feed.
- 19 31 The modular DUV antenna of claim 27 wherein the RF enhancer comprises an extension
20 RF amplifier module diplexed to the RF amplifier module.
- 21 32 The modular DUV antenna of claim 27 wherein the signal line comprises a coax cable
22 having a length between 1 m (3 ft) and 70 m (230 ft) bonded between the RF amplifier and the
23 connector.
- 24 33 The modular DUV antenna of claim 27 wherein the signal line comprises a fiber optic
25 line having a length between 1 m (3 ft) and 70 m (230 ft) bonded between the RF amplifier and
26 the connector.

1 34 The modular DUV antenna of claim 26 wherein the RF booster is selected from: an small
2 Urban booster, a medium Metro booster, a large Fringe booster and a very large Deep Fringe
3 booster.

4 35 The modular DUV antenna of claim 34 wherein the small Urban booster and/or the
5 medium Metro booster has not more than one reflective element per side above and/or below the
6 antenna XY plane.

7 36 The modular DUV antenna of claim 26 further comprising a driven DUV dipole,
8 comprising two driven DUV elements connected to the RF signal line, selected from a UHF U-
9 DUV dipole, a broadband UHF/VHF M-DUV dipole, a VHF V-DUV dipole, and an extended
10 UHF/VHF X-DUV dipole.

11 37 The modular DUV antenna of claim 26 wherein the modular RF director is selected from:
12 an Urban UHF director comprising one to three UHF director elements; a Metro UHF
13 director comprising four to nine UHF director elements; a Fringe UHF director comprising ten to
14 twenty UHF director elements; a Metro U/V director comprising a VHF director element and
15 four to nine UHF director elements; and a Fringe U/V director comprising a VHF director
16 element and ten to twenty UHF director elements.

17 38 The modular antenna of claim 37 wherein the UHF directors have a width/length greater
18 than 0.12.

19 39 The modular antenna of claim 26 wherein the RF enhancer comprises an RF reflector
20 selected from an Urban reflector, a Metro RF reflector, and a Fringe RF reflector.

21 40 The modular antenna of claim 26 wherein the RF enhancer comprises a VHF reflector.

22 41 The modular antenna of claim 26 further comprising a mount selected from an interior
23 standard mount, an interior elevation/polarization mount, and exterior standard mount, and an
24 exterior elevation/polarization mount.

25 42 The modular antenna of claim 26 further comprising a modular signal junction selected
26 from: a signal splitter, a signal distributor, and a signal multiplexer.

1 43 The modular antenna of claim 26 wherein multiple combinations of DUV dipoles, RF
2 amplifiers, RF directors, RF reflectors and RF boosters fit into a common container.

3 44 The modular antenna of claim 26 further comprising a lightning attractor and grounding
4 cable.

5 45 The modular antenna of claim 26 further comprising a container configured to contain
6 one of multiple driven DUV antennas and multiple RF enhancers.

7 46 The modular antenna of claim 26 wherein the driven DUV dipole comprises a DUV
8 balun.

9 47 The modular antenna of claim 26 wherein the driven DUV dipole comprises a DUV RF
10 connector.

11 48 The modular antenna of claim 26 wherein the driven DUV dipole comprises a DUV
12 filter.

13 49 The modular antenna of claim 26 wherein the dipole to booster ratio of the tip to tip
14 length of the DUV-D dipole to the tip to tip booster element length is in the range from about
15 1.05 to 1.5 with the folded DUV dipole height to length ratio in the range from about 0.15 to
16 0.30.

17 50 The modular antenna of claim 26 wherein the board modules comprise a plurality of a
18 plain circuit board connecting the DUV dipole elements directly to the signal connector; a
19 matched circuit board connecting the DUV dipole elements to a impedance matching transformer
20 and thence to the signal connector; and an amplified circuit board connecting the DUV dipole
21 elements to an amplifier and thence to the signal connector.

22 51 The modular antenna of claim 26 wherein boosted DUV configurations comprise, a
23 “Metro” booster **113** having one or two reflective booster elements **62**, a “Fringe” booster **115**
24 having three or four booster elements **62**, and a “Deep Fringe” booster **119** having five or six
25 booster elements **64** wherein the ratio of the length of the deep fringe elements **64** to fringe
26 booster elements **62** is about in the range from 1.0 to 3.0.

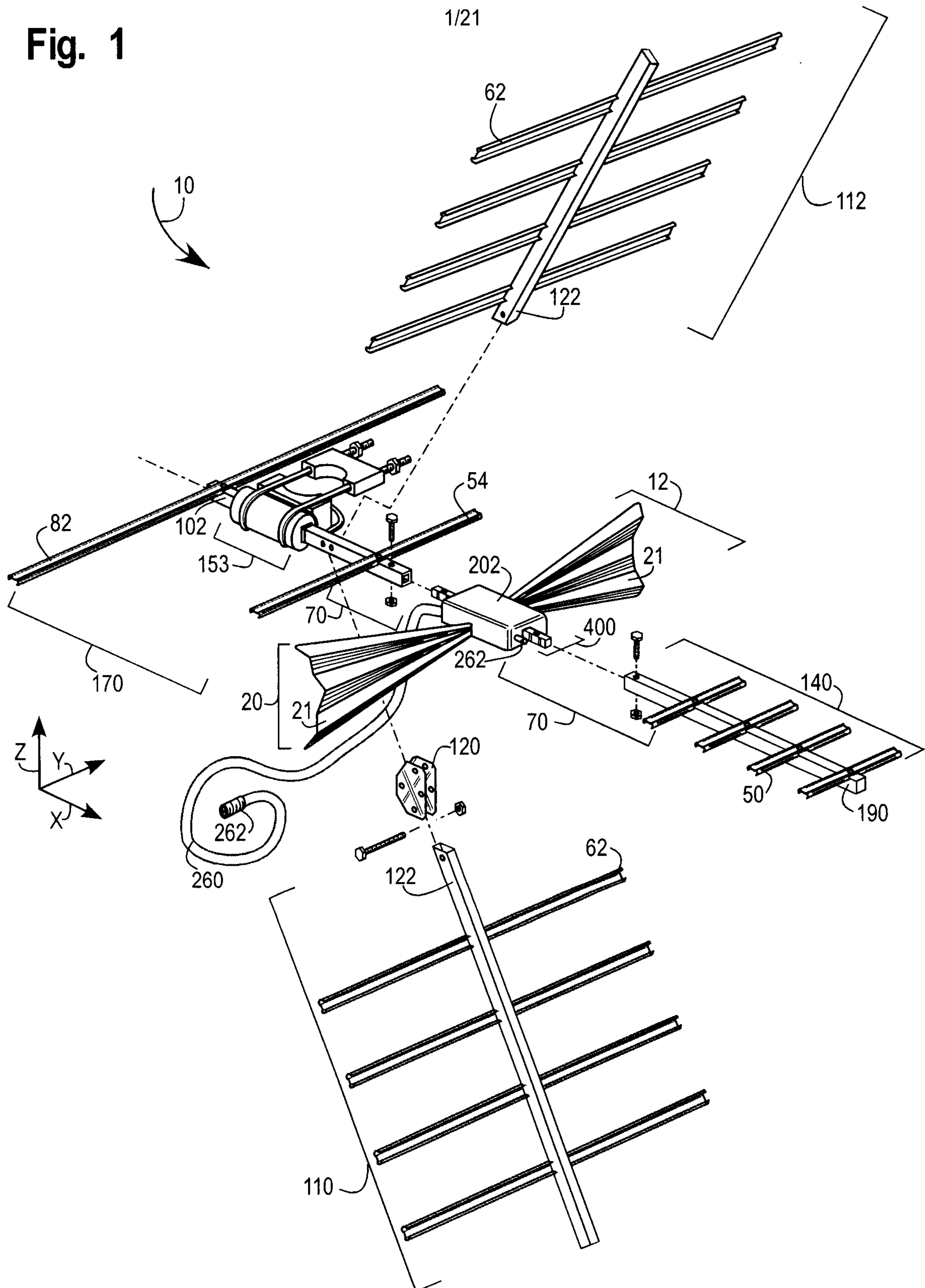
1 52 The modular antenna of claim 51 wherein boosted DUV configurations comprise, a
2 “Metro” booster **113** having one reflective booster element **62**, a “Fringe” booster **115** having
3 four booster elements **62**, and a “Deep Fringe” booster **119** having five booster elements **64**
4 wherein the length of the deep fringe elements **64** to fringe booster elements **62** is the range from
5 about 1.5 to 2.5.

6 53 The modular antenna of claim 51 wherein at least three booster elements **62** are
7 configured with nonuniform spacing along the booster boom.

8 54 The modular antenna of claim 51 wherein at least four booster elements **64** are
9 configured with outward increasing incremental spacing along the booster boom.⁵⁵

10 The modular antenna of claim 26 wherein the RF enhancement modules comprise
11 reconfigurable fasteners wherein RF modules may be exchanged to enhance one or more
12 UHF or VHF channel performance.

13 56 The modular antenna of claim 26 comprising a plurality of standoff booms connected to
14 the upper and lower booster booms to support the modular antenna, and a stiffener brace
15 fastened between the upper booster boom, the longitudinal boom, and the lower booster
16 boom.

Fig. 1

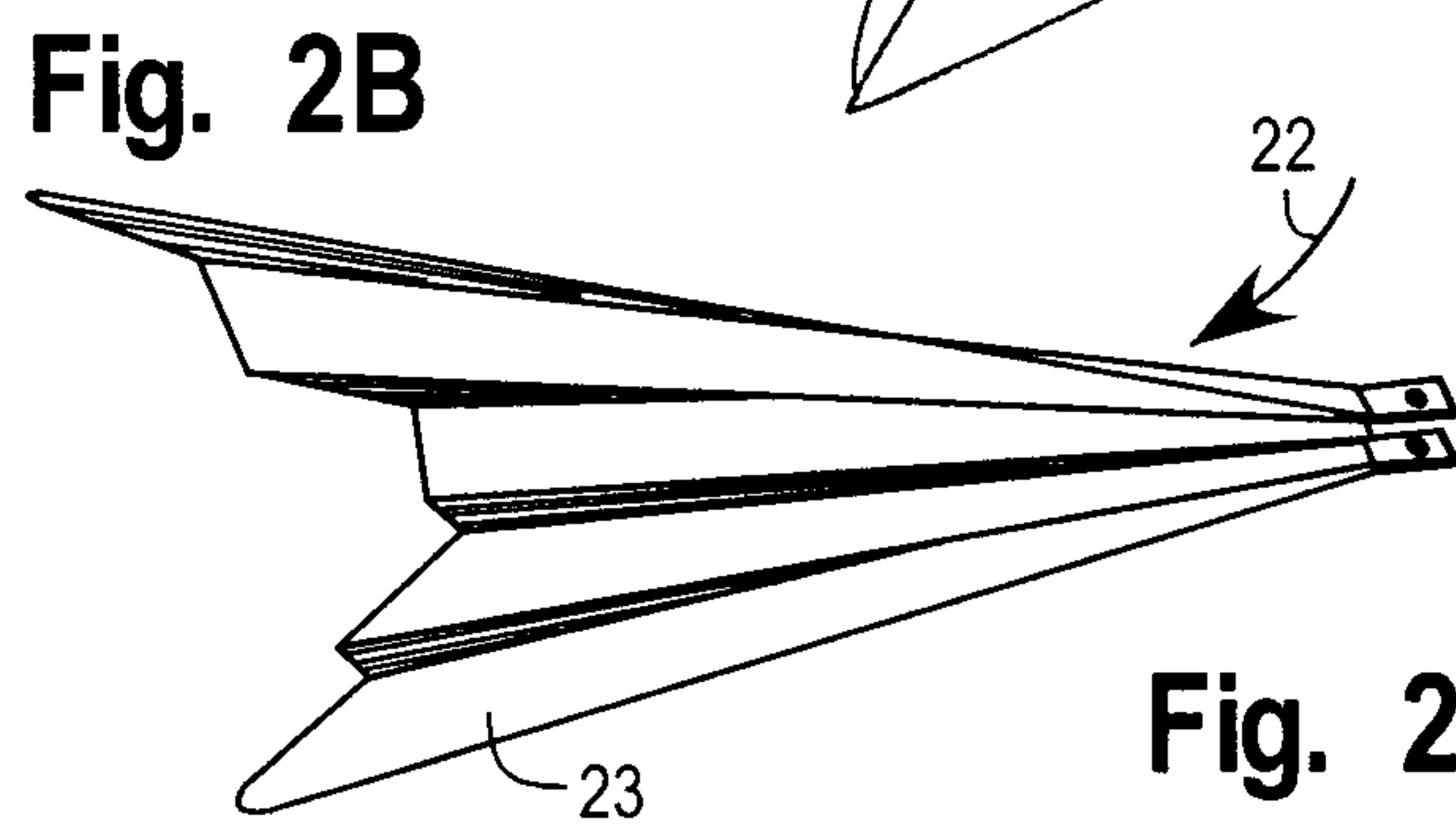
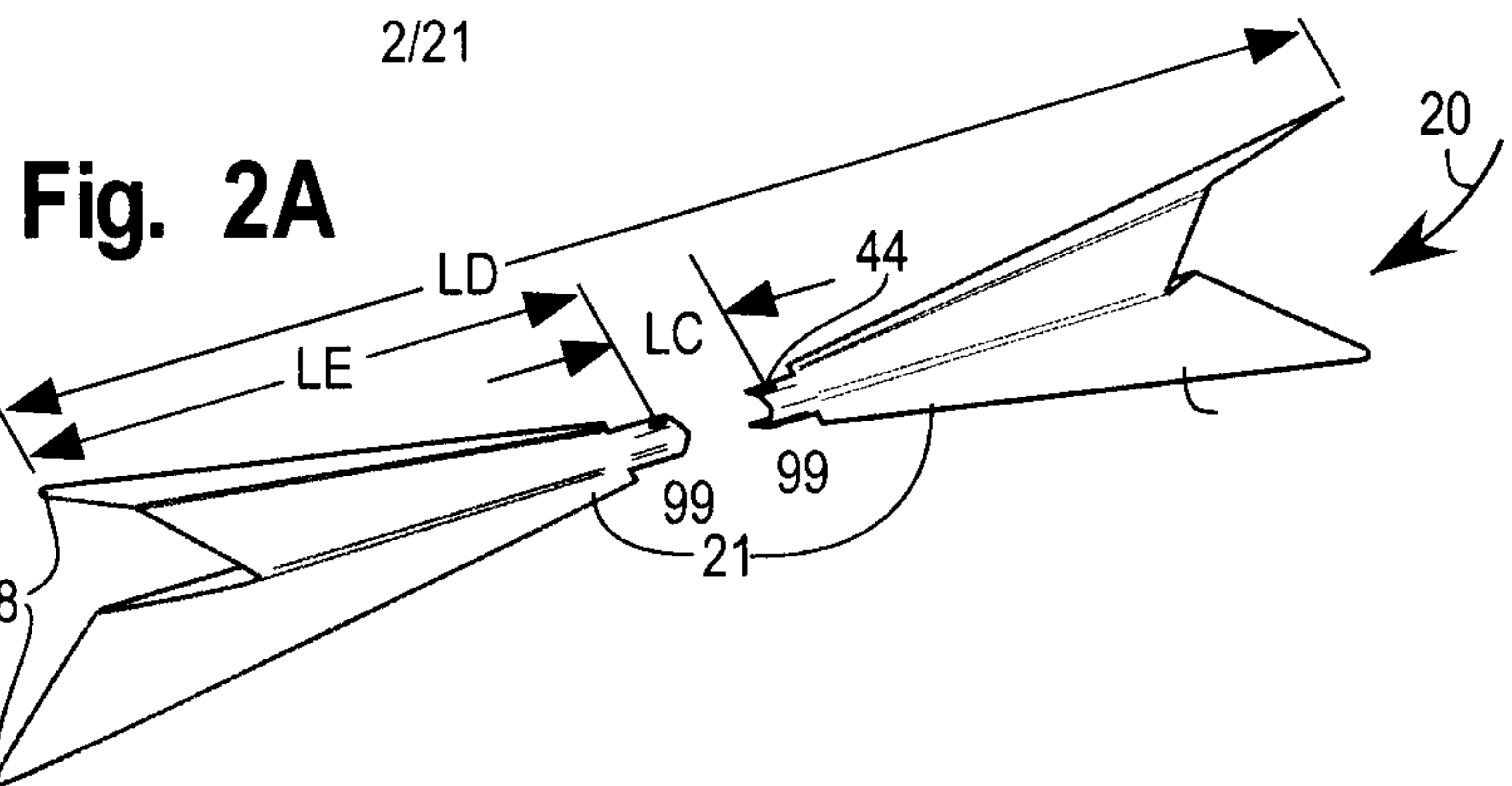


Fig. 2C

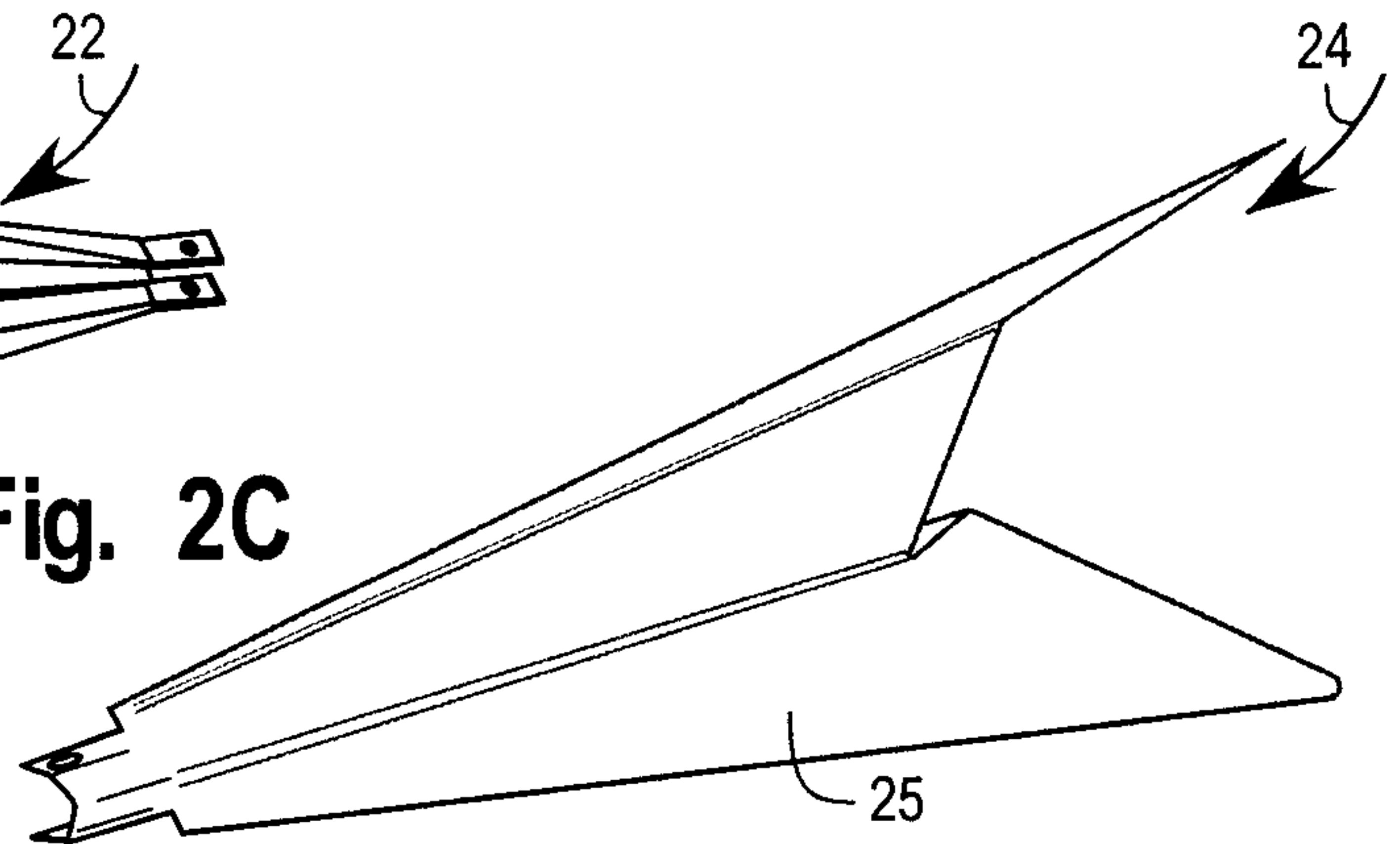


Fig. 2D

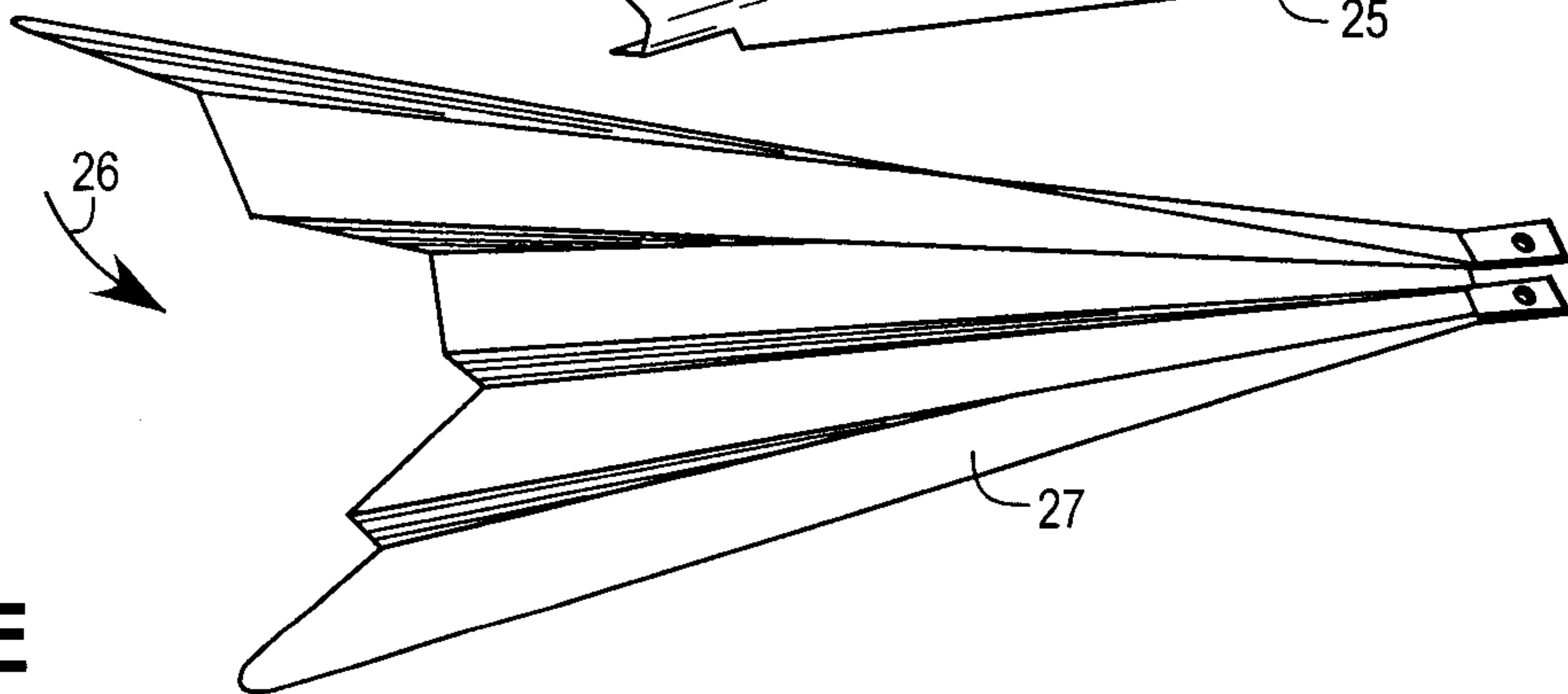


Fig. 2E

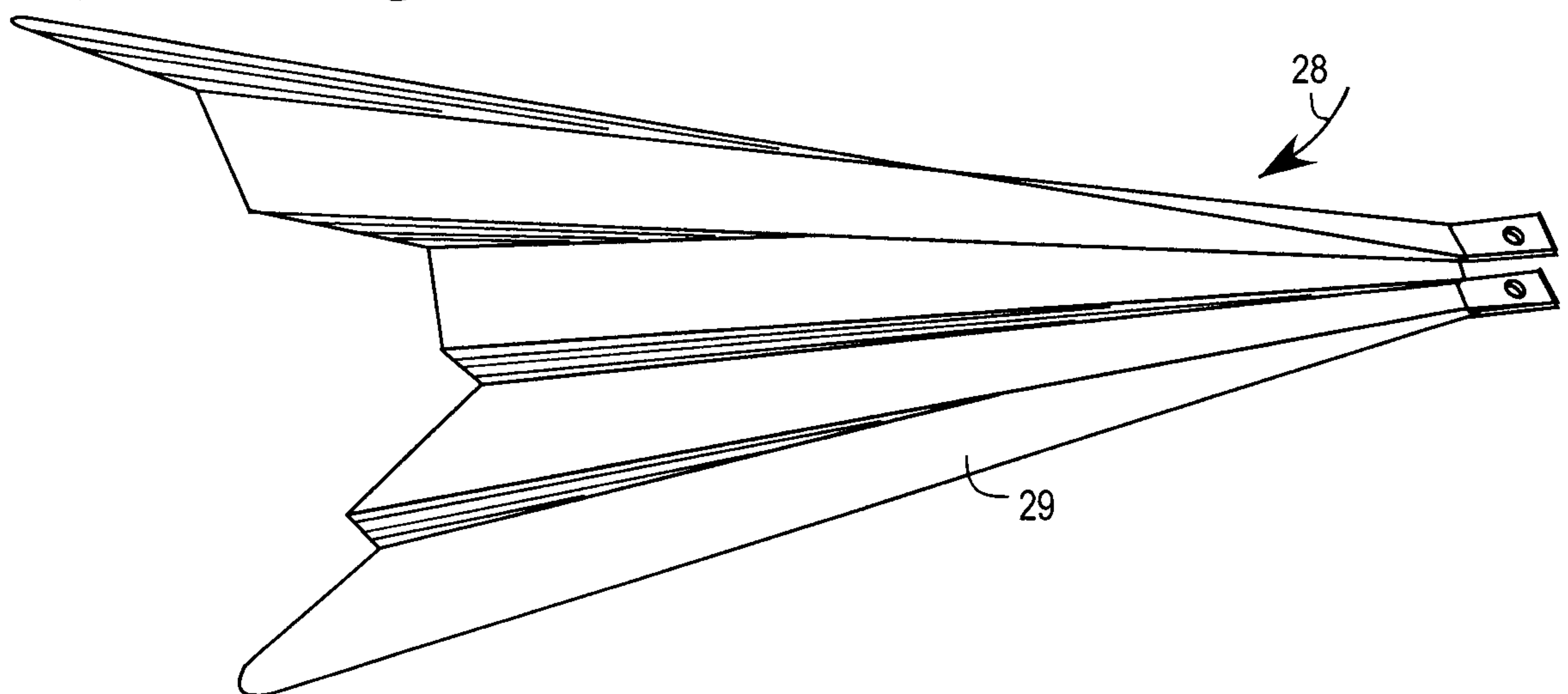
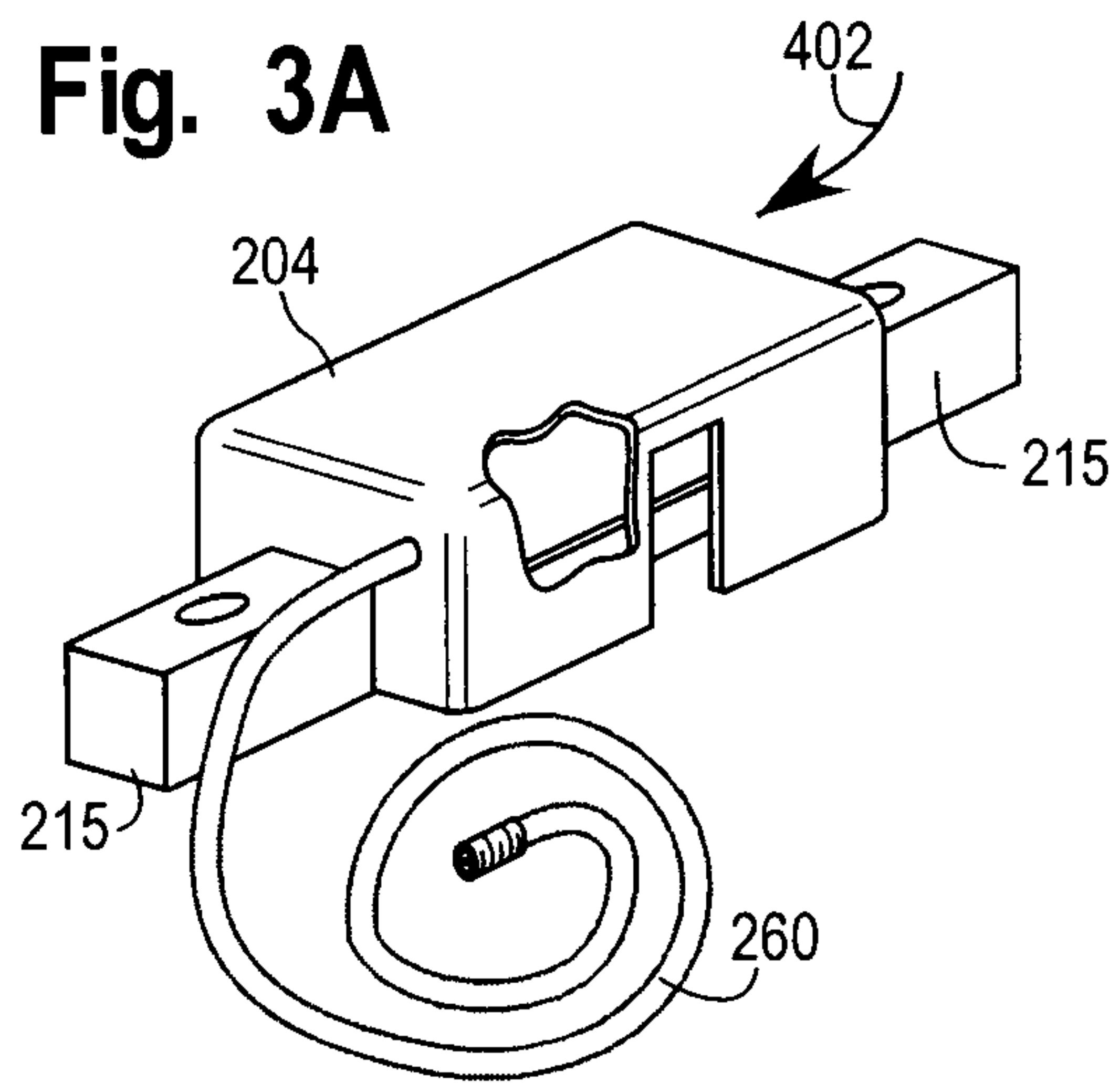
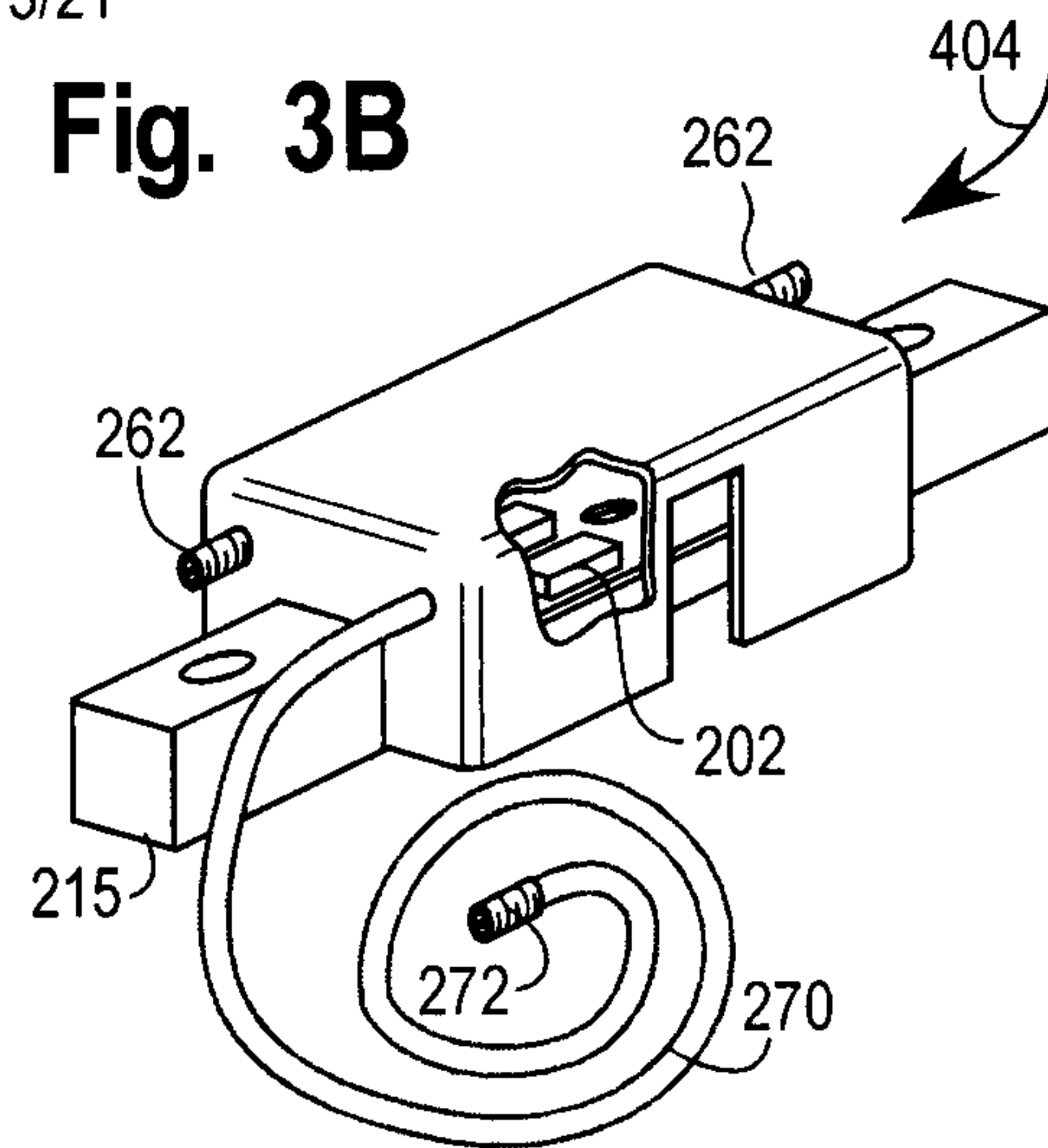
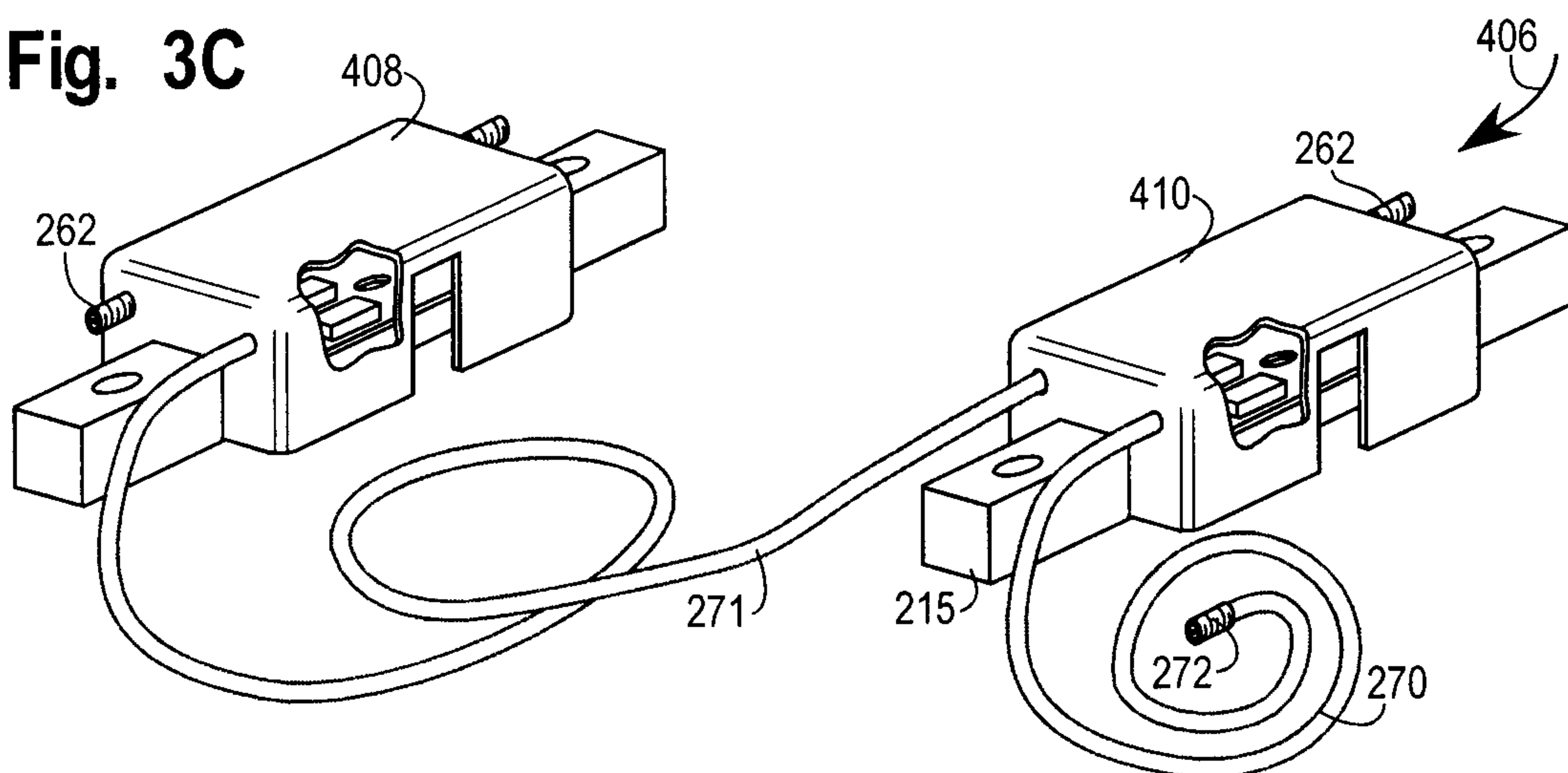
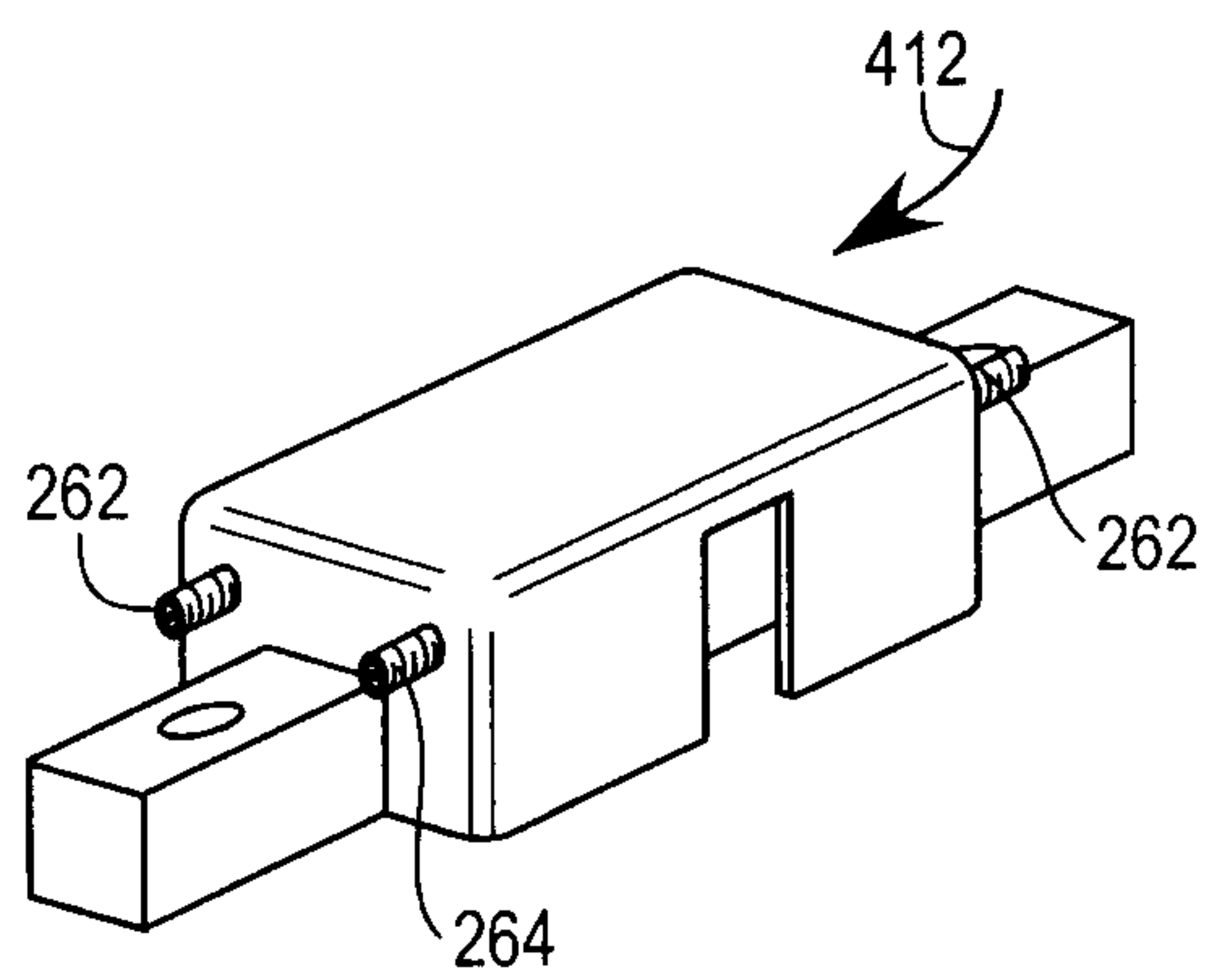
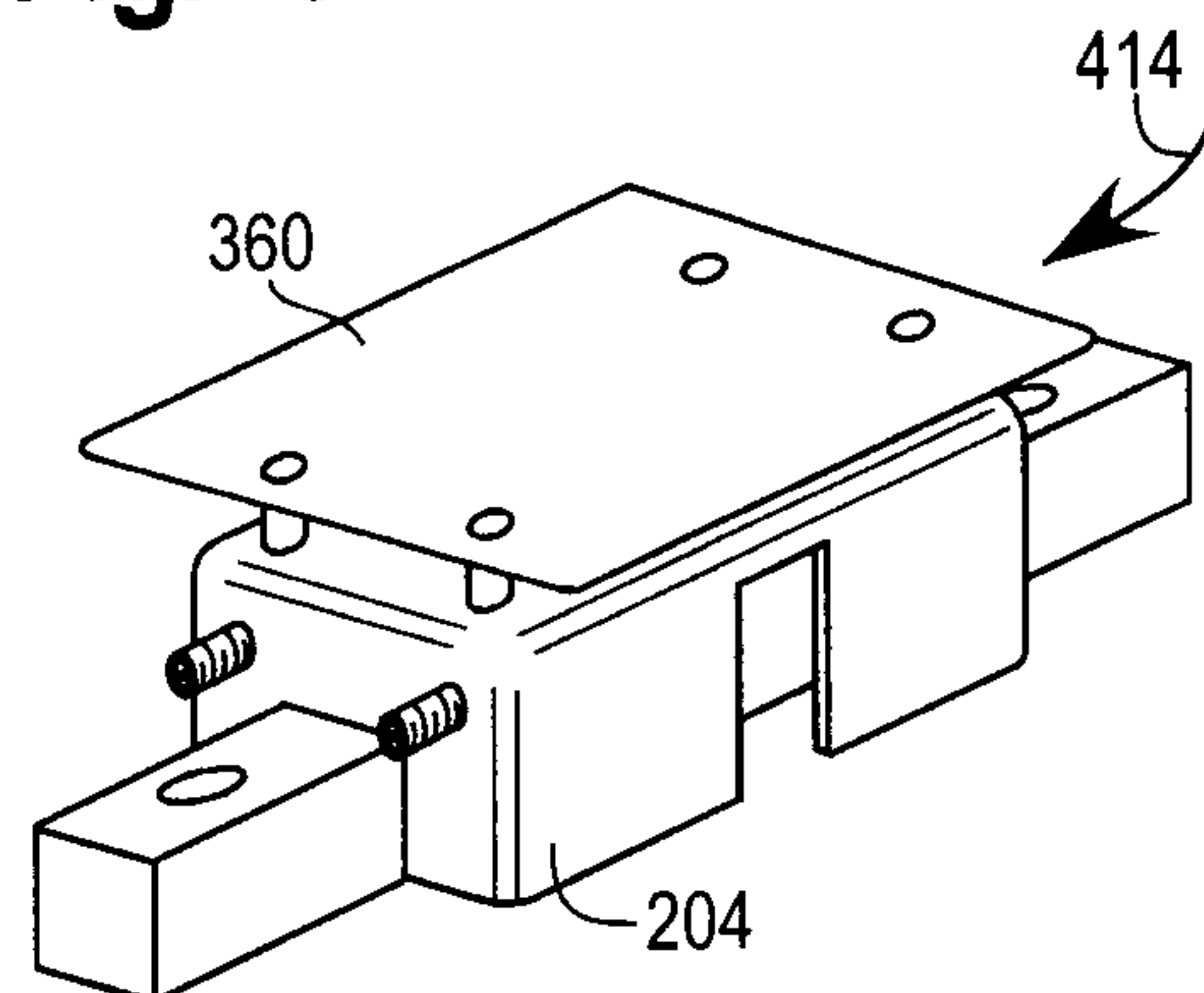


Fig. 3A

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Fig. 3B**Fig. 3C****Fig. 3D****Fig. 3E**

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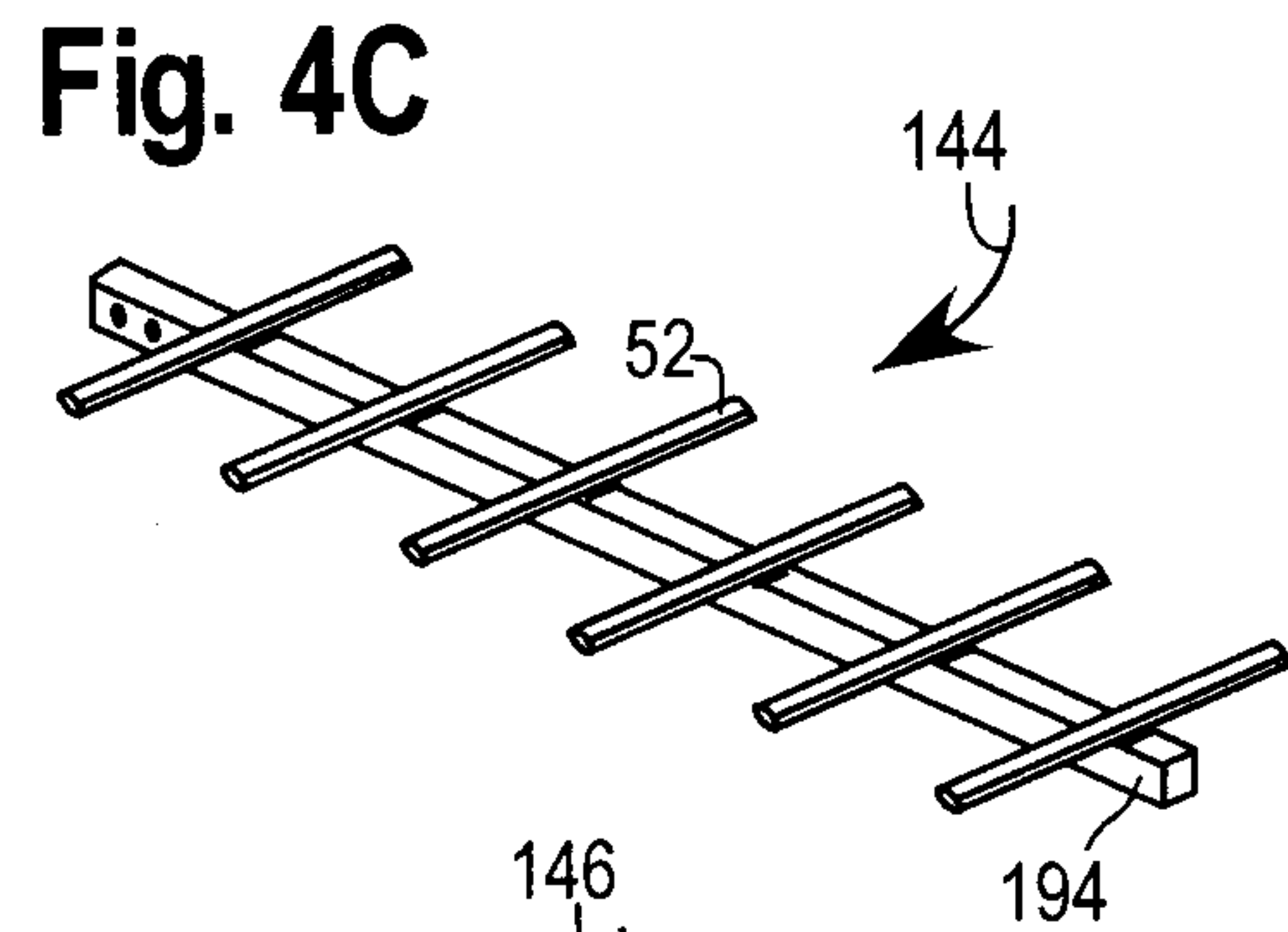
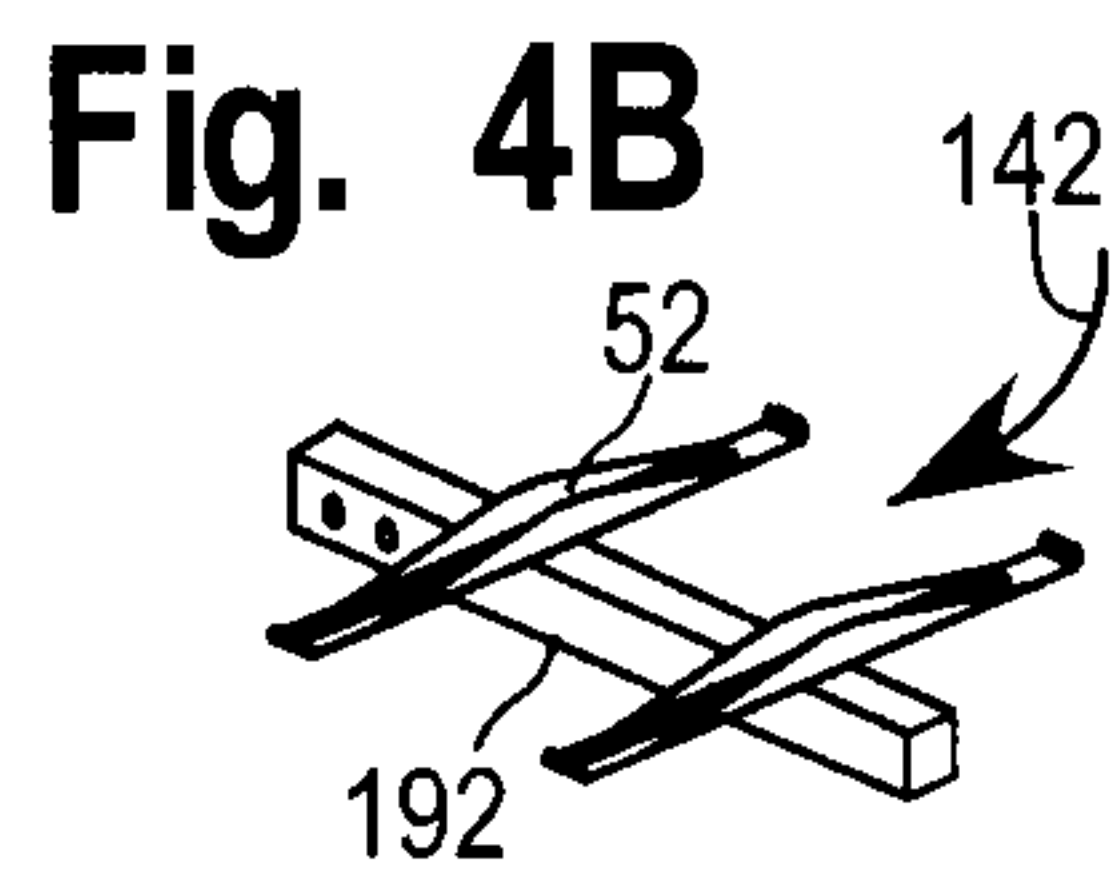
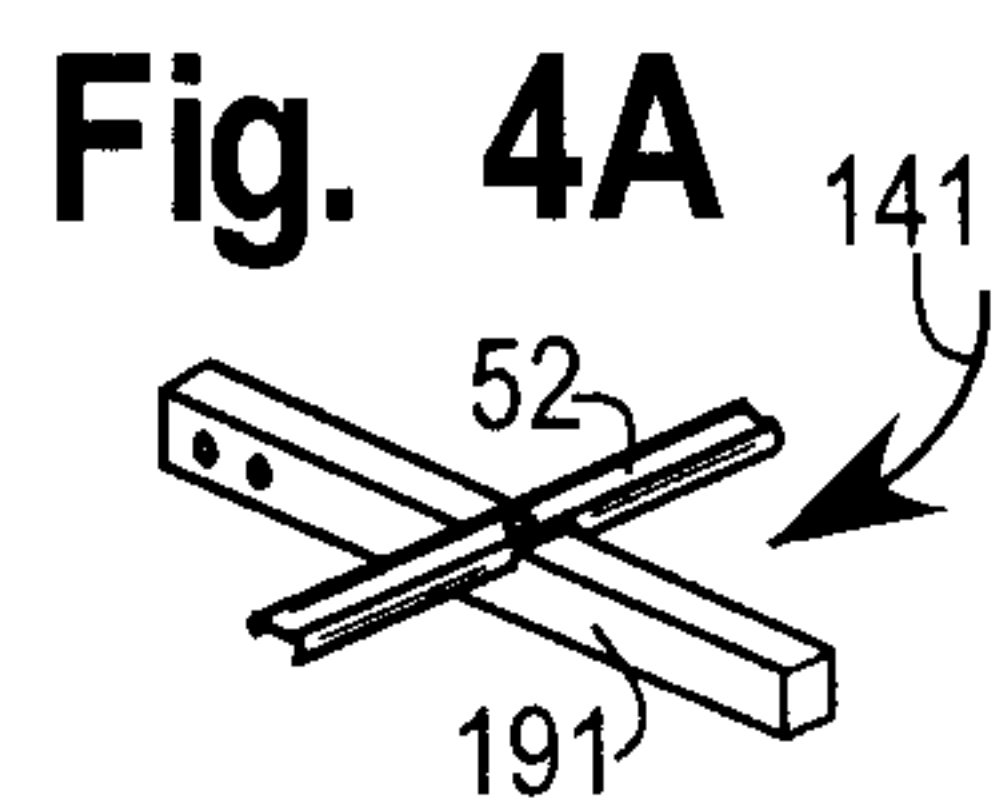


Fig. 4D

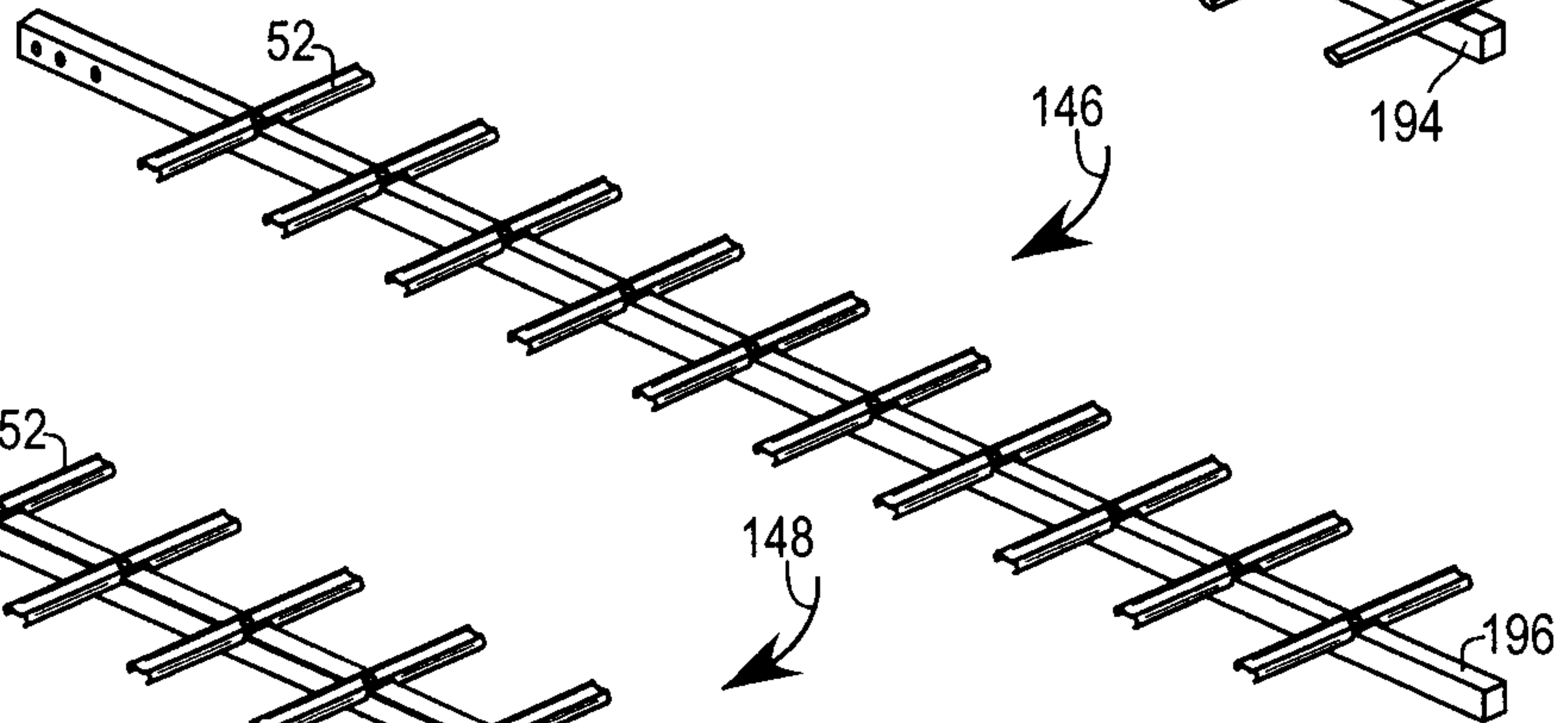


Fig. 4E

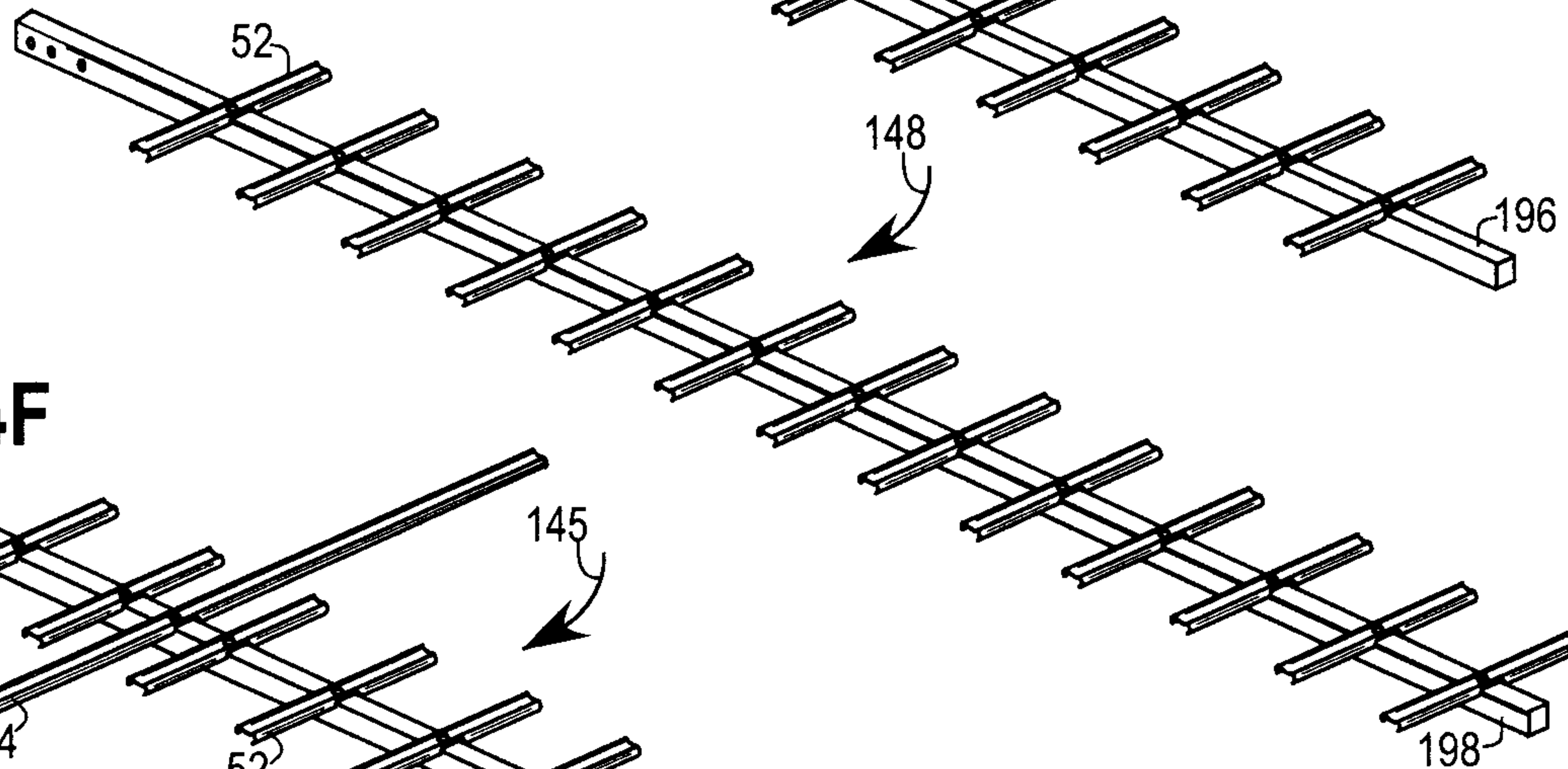


Fig. 4F

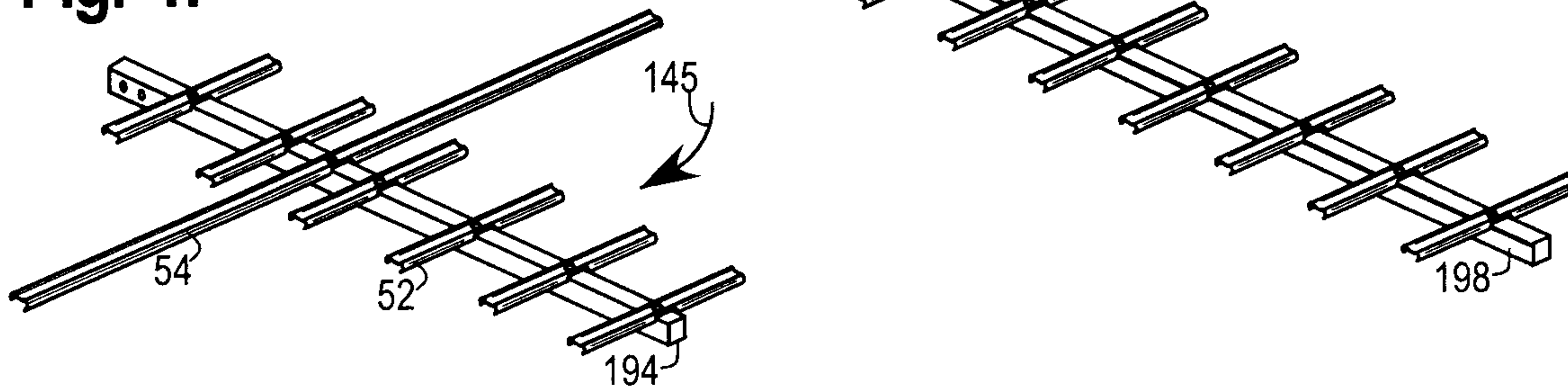


Fig. 4G

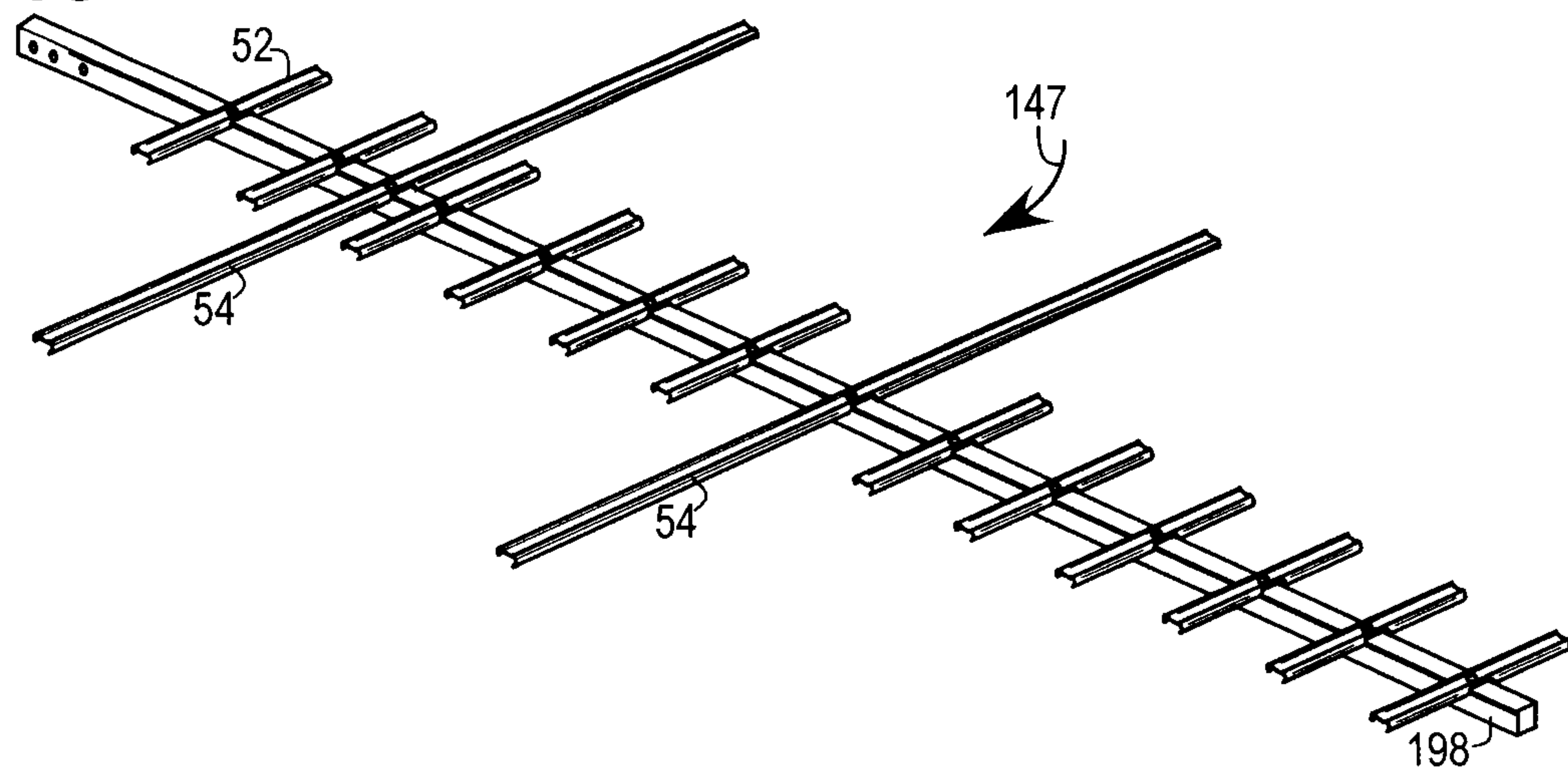
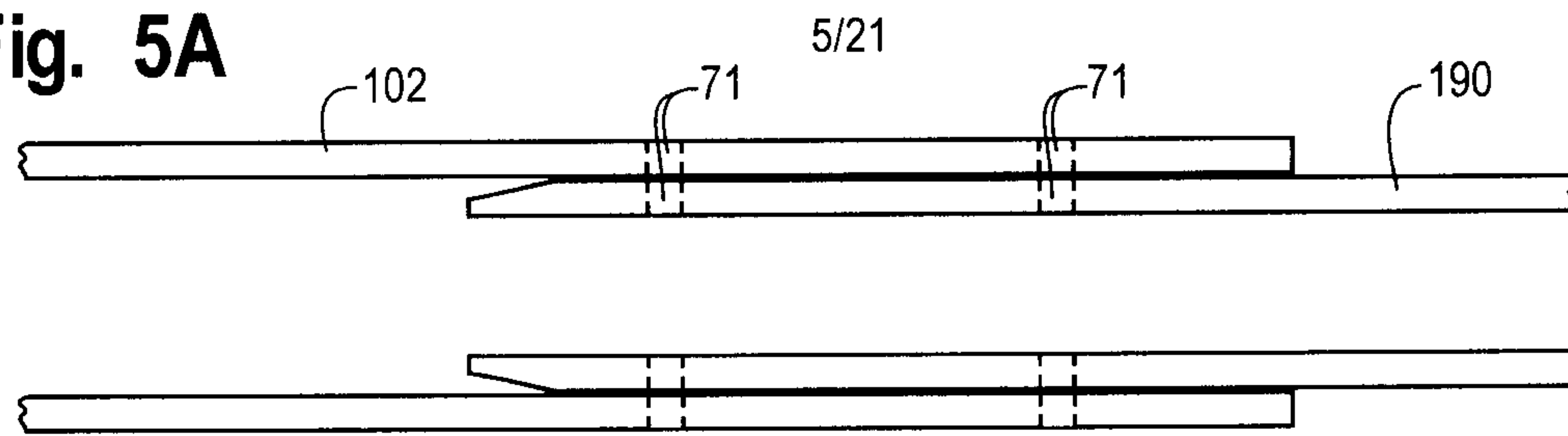
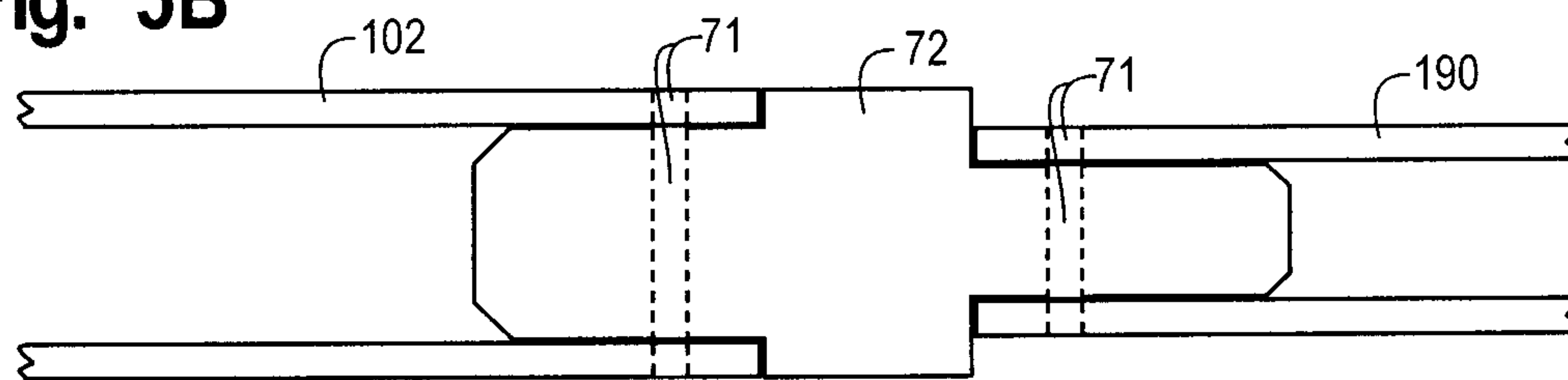
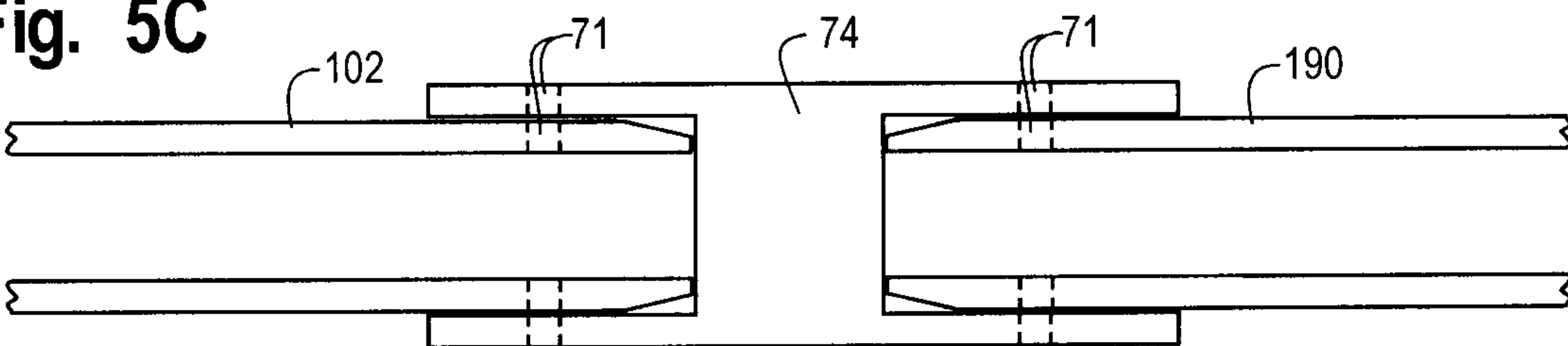
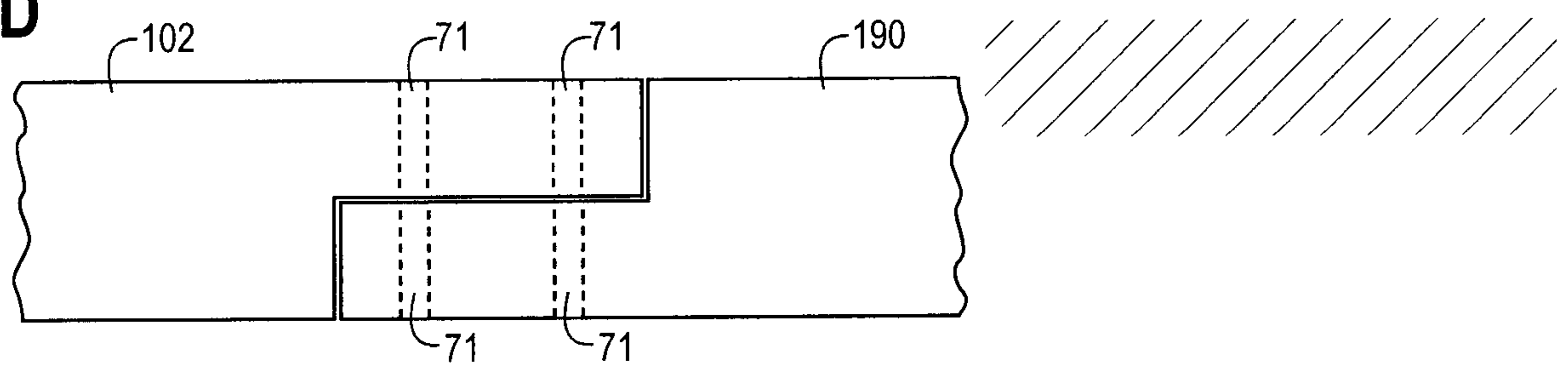
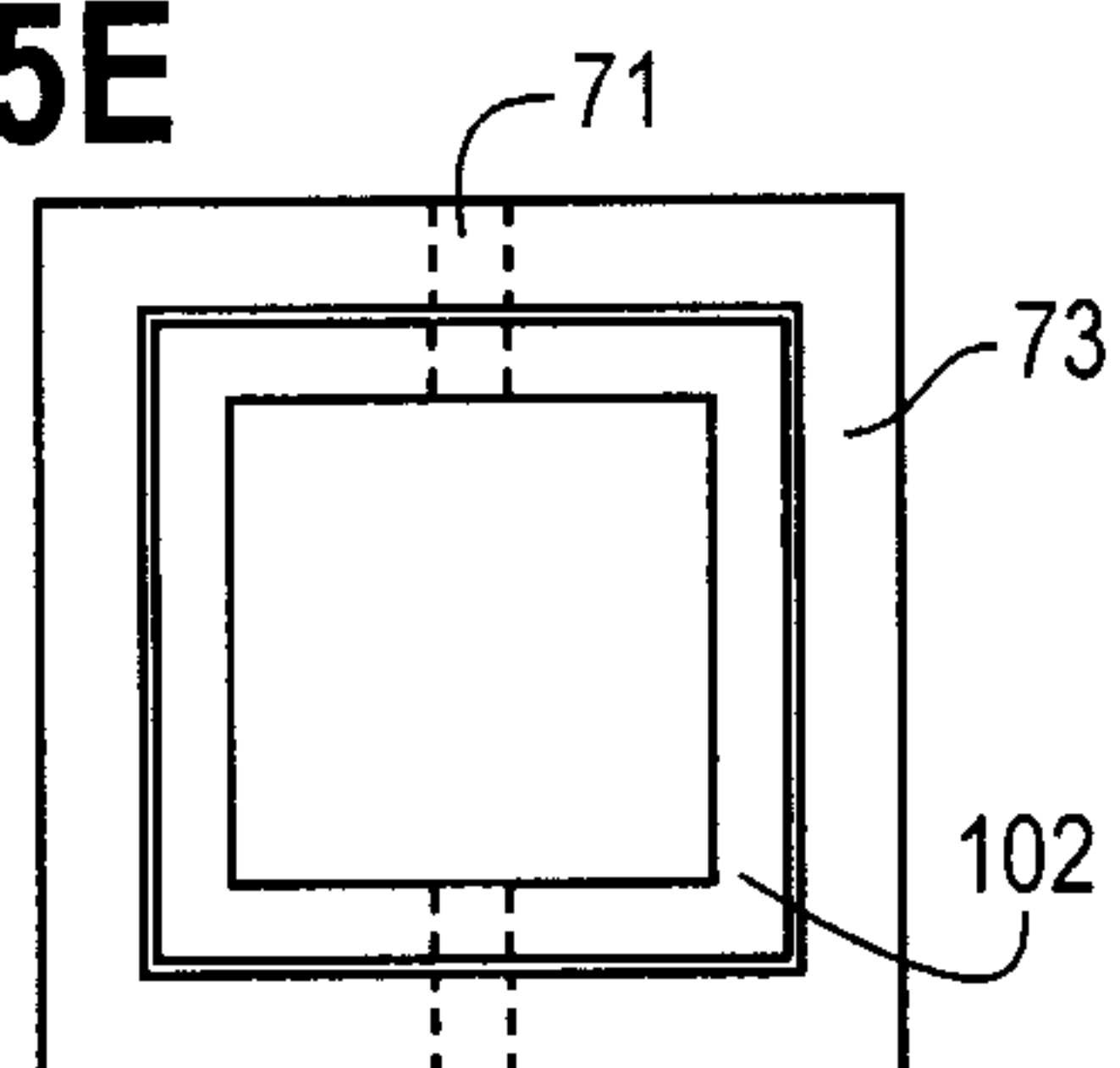
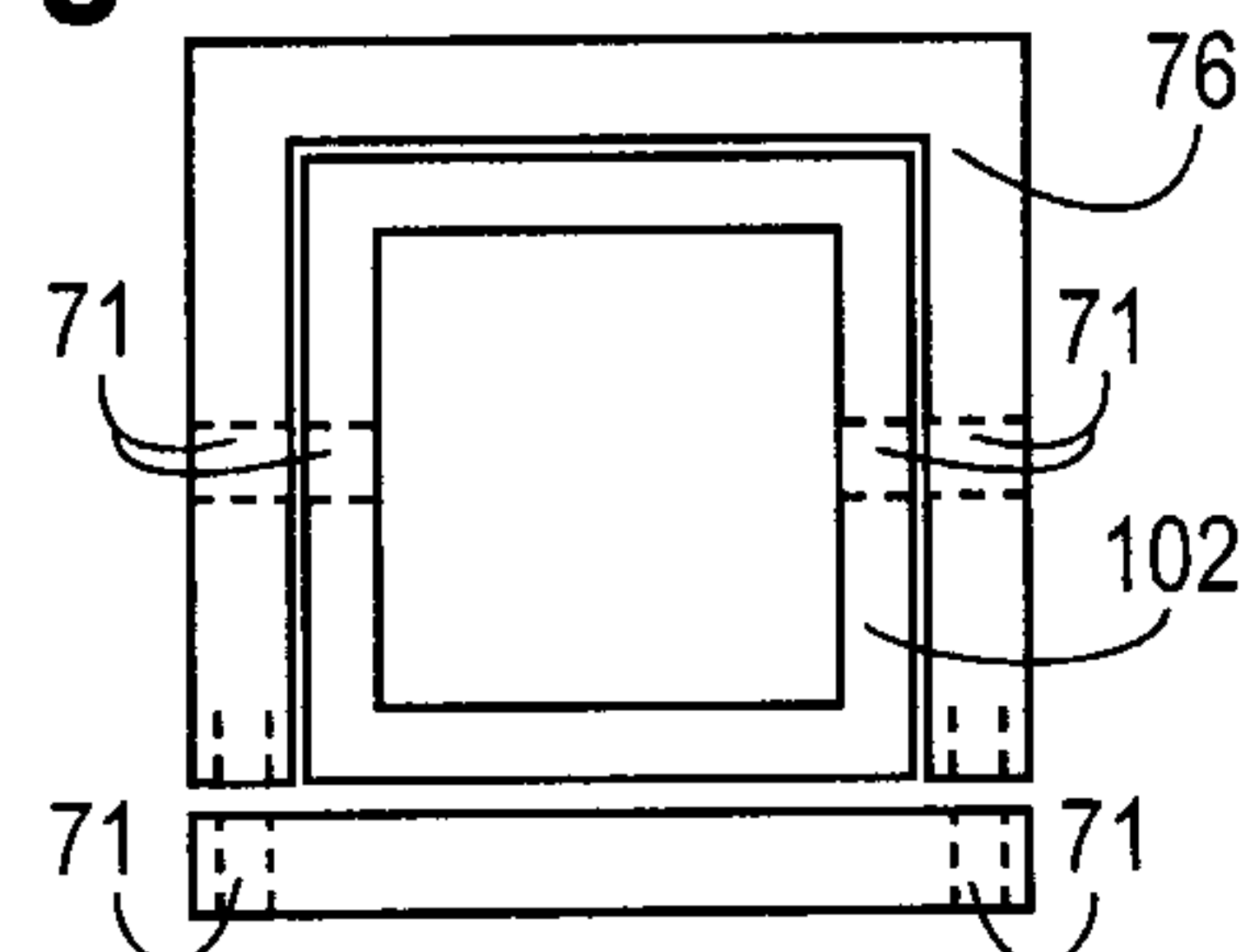
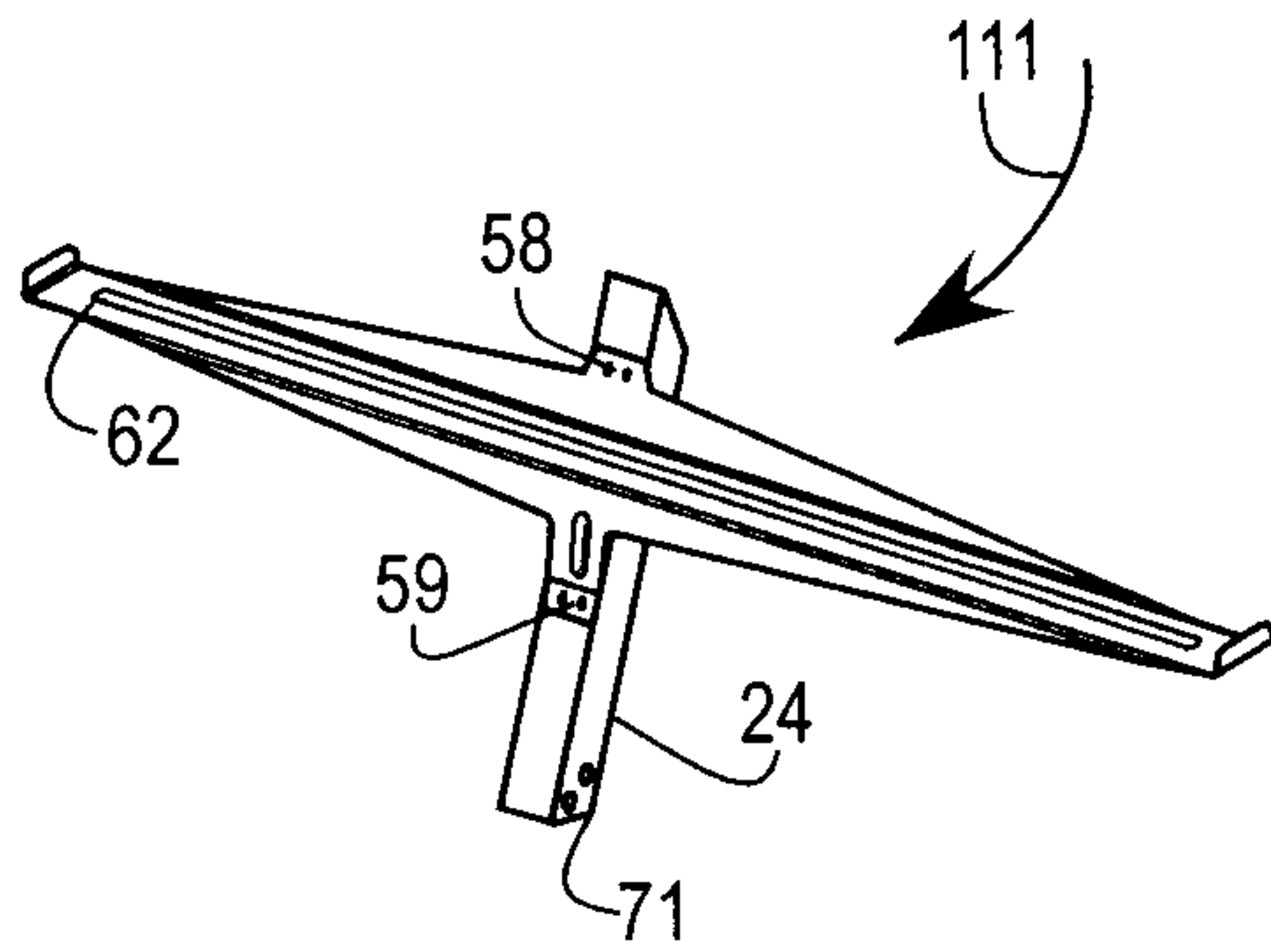
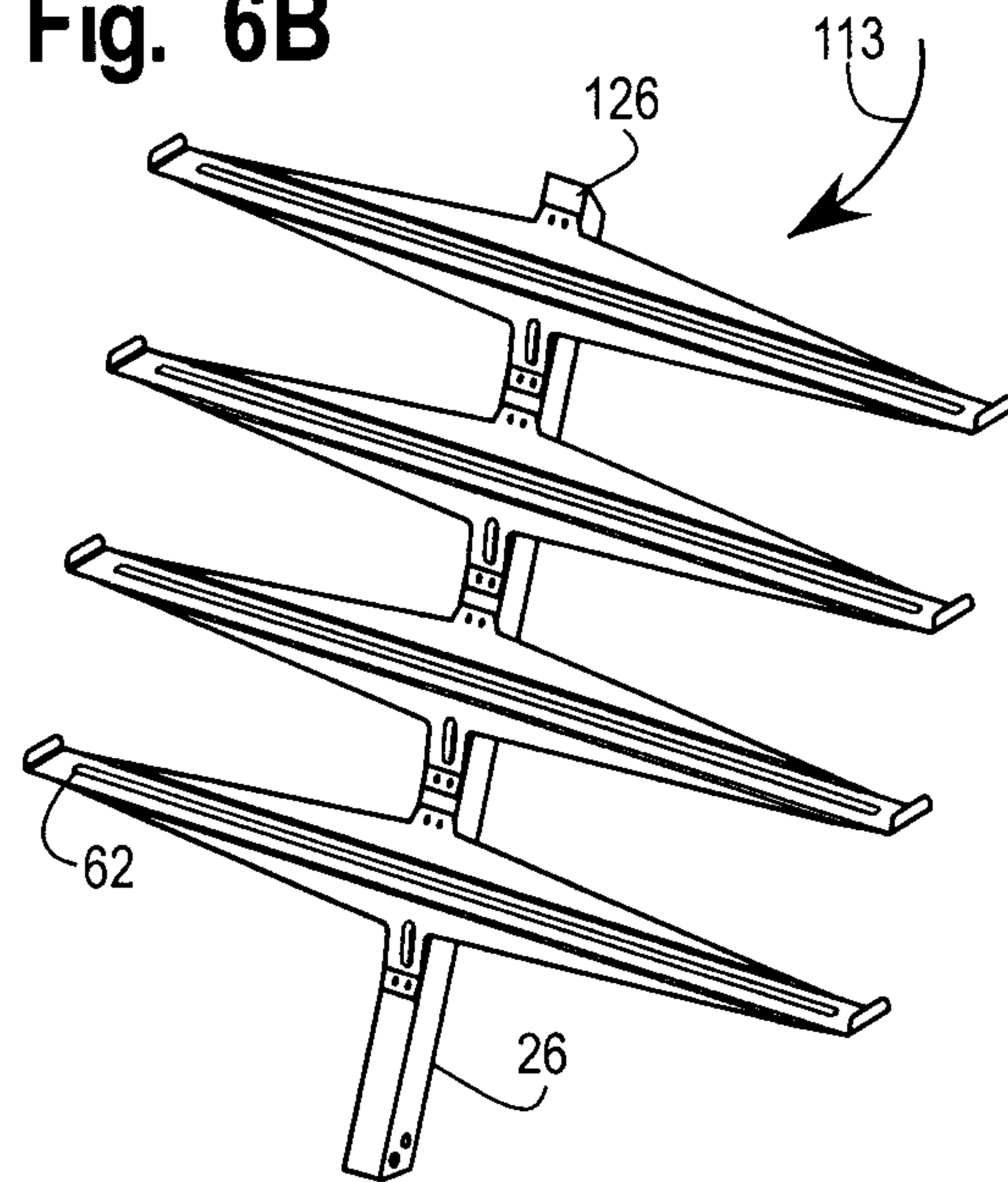
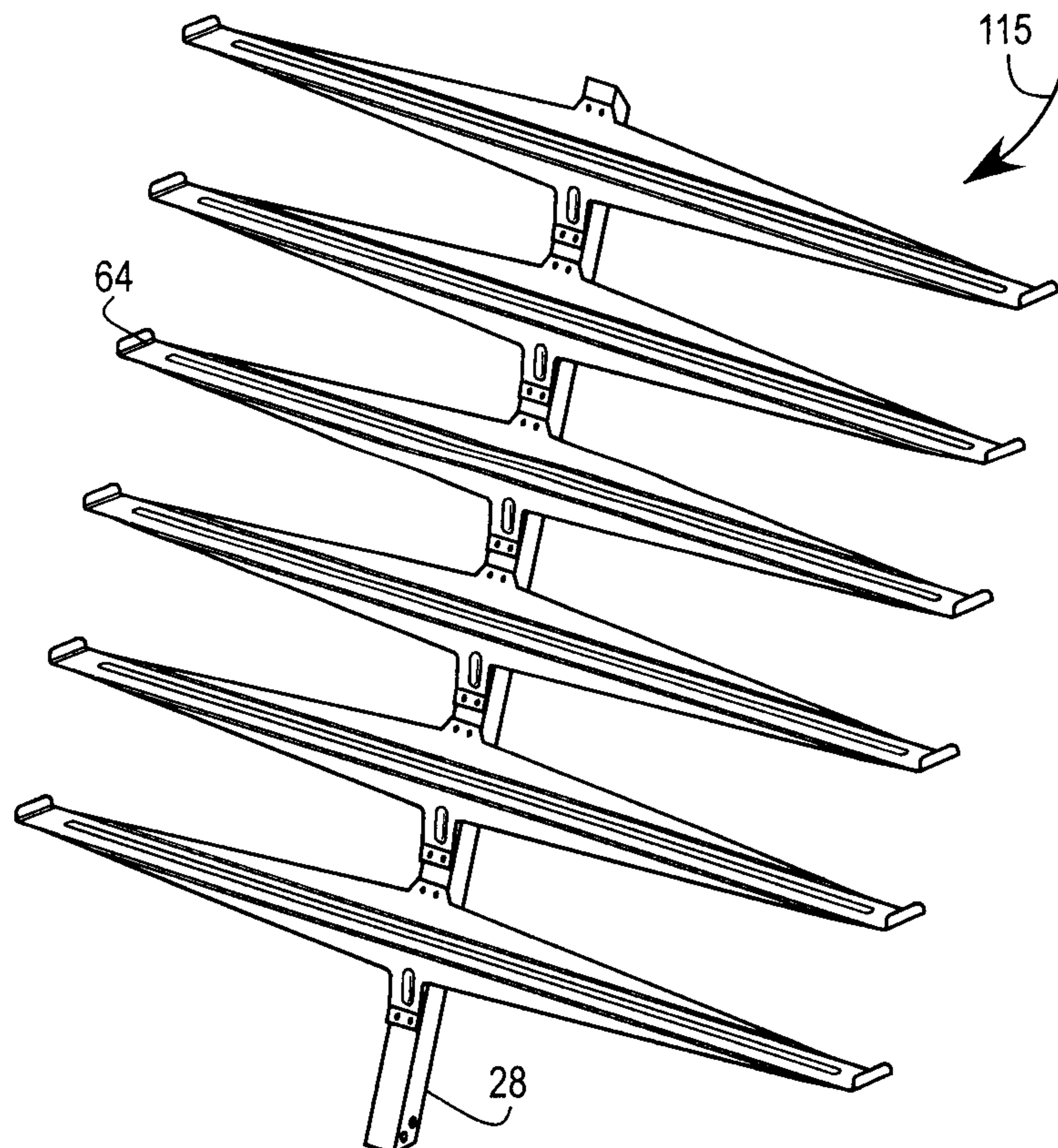


Fig. 5A**Fig. 5B****Fig. 5C****Fig. 5D****Fig. 5E****Fig. 5F**

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Fig. 6A**Fig. 6B****Fig. 6C**

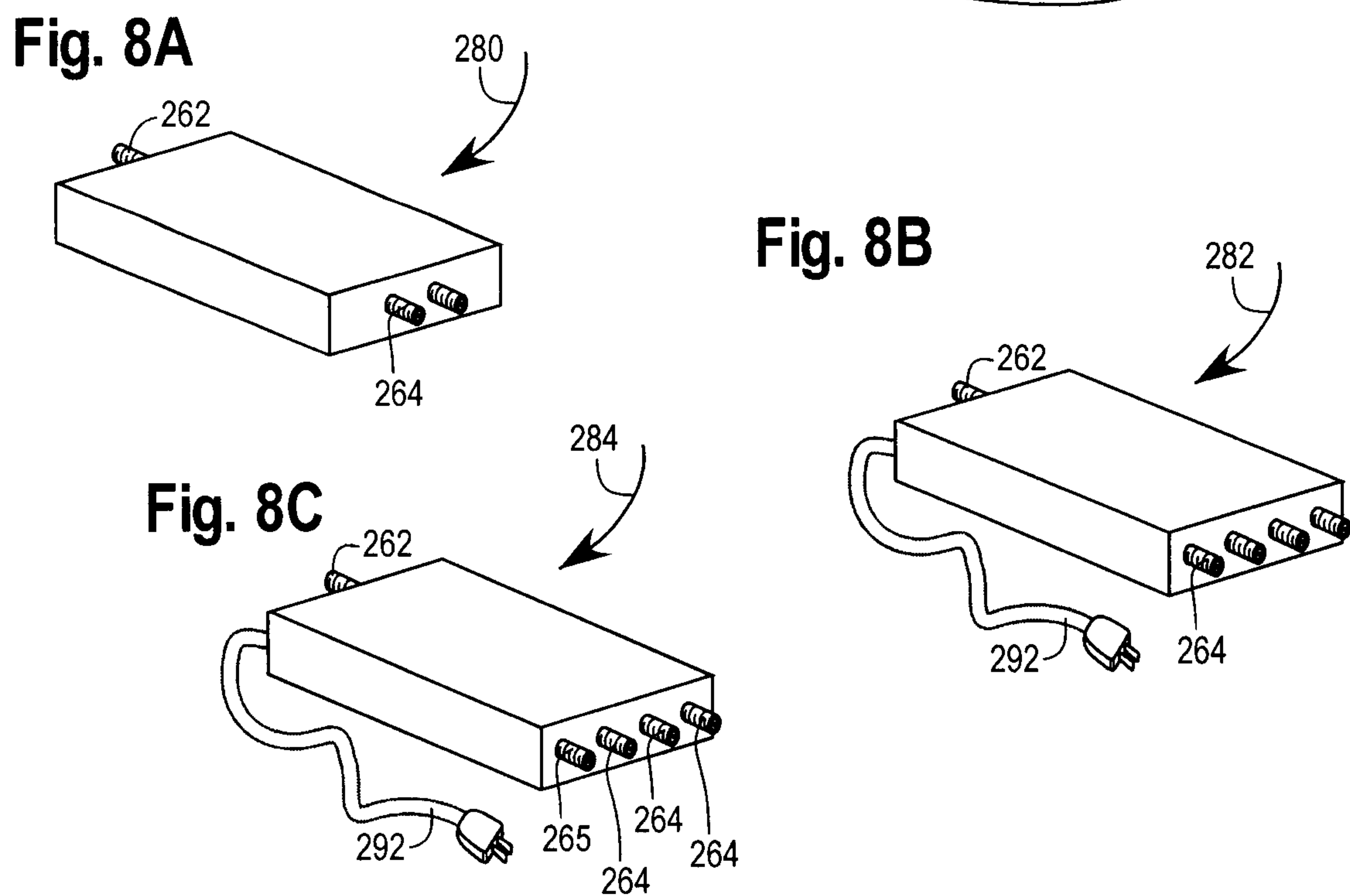
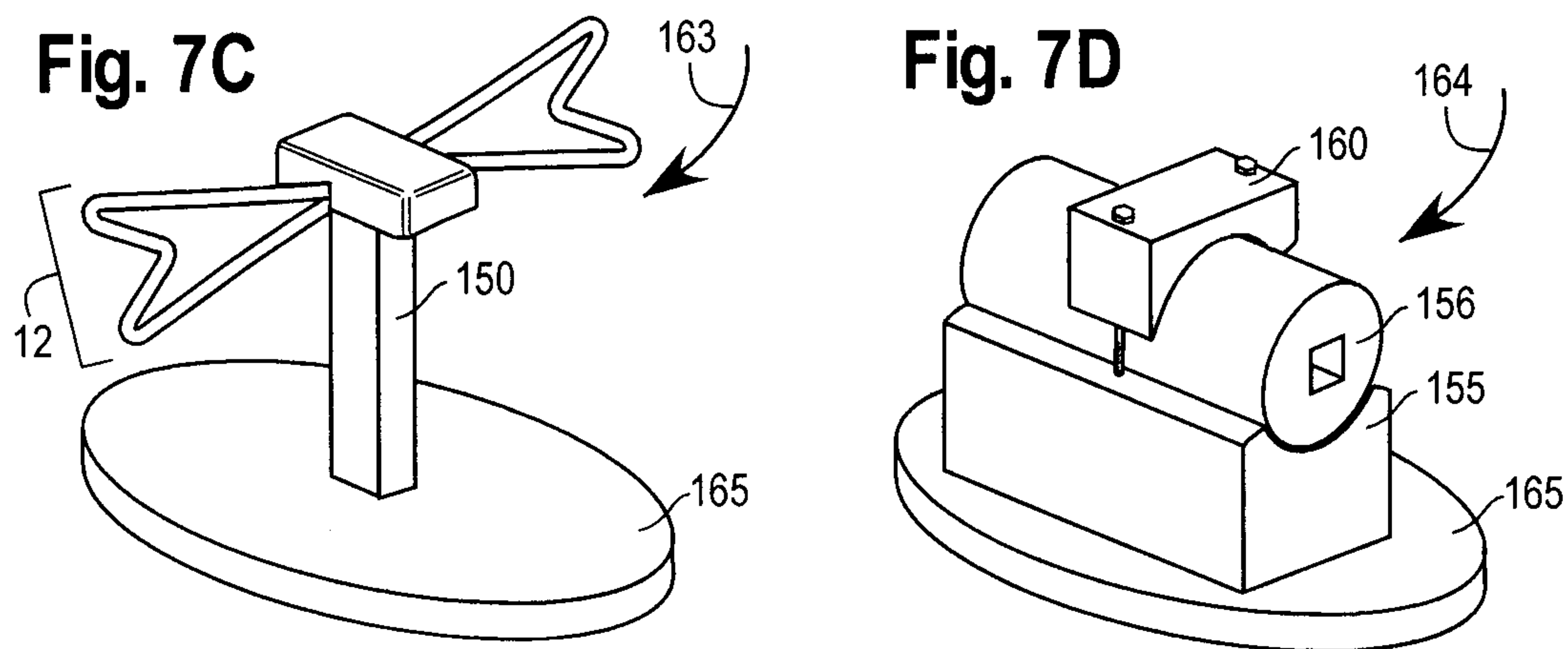
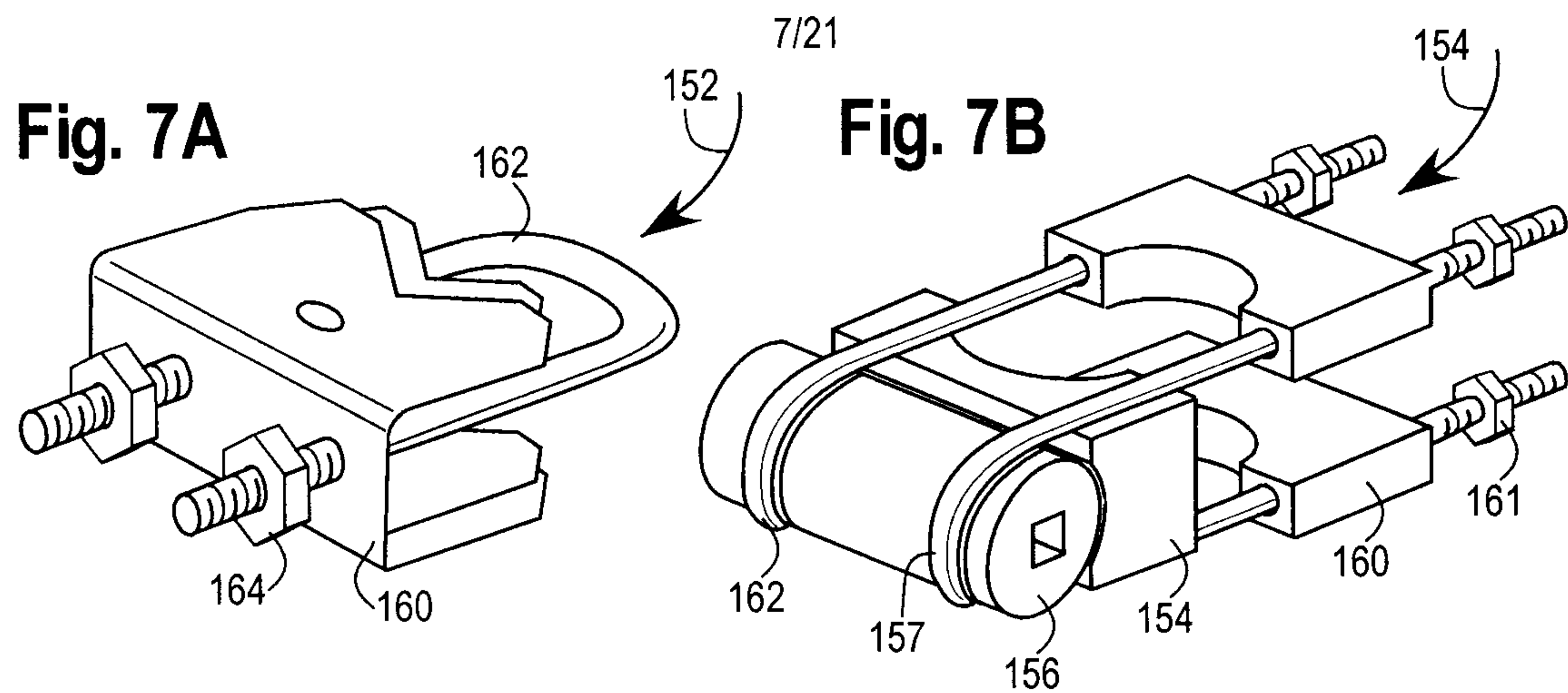


Fig. 9A

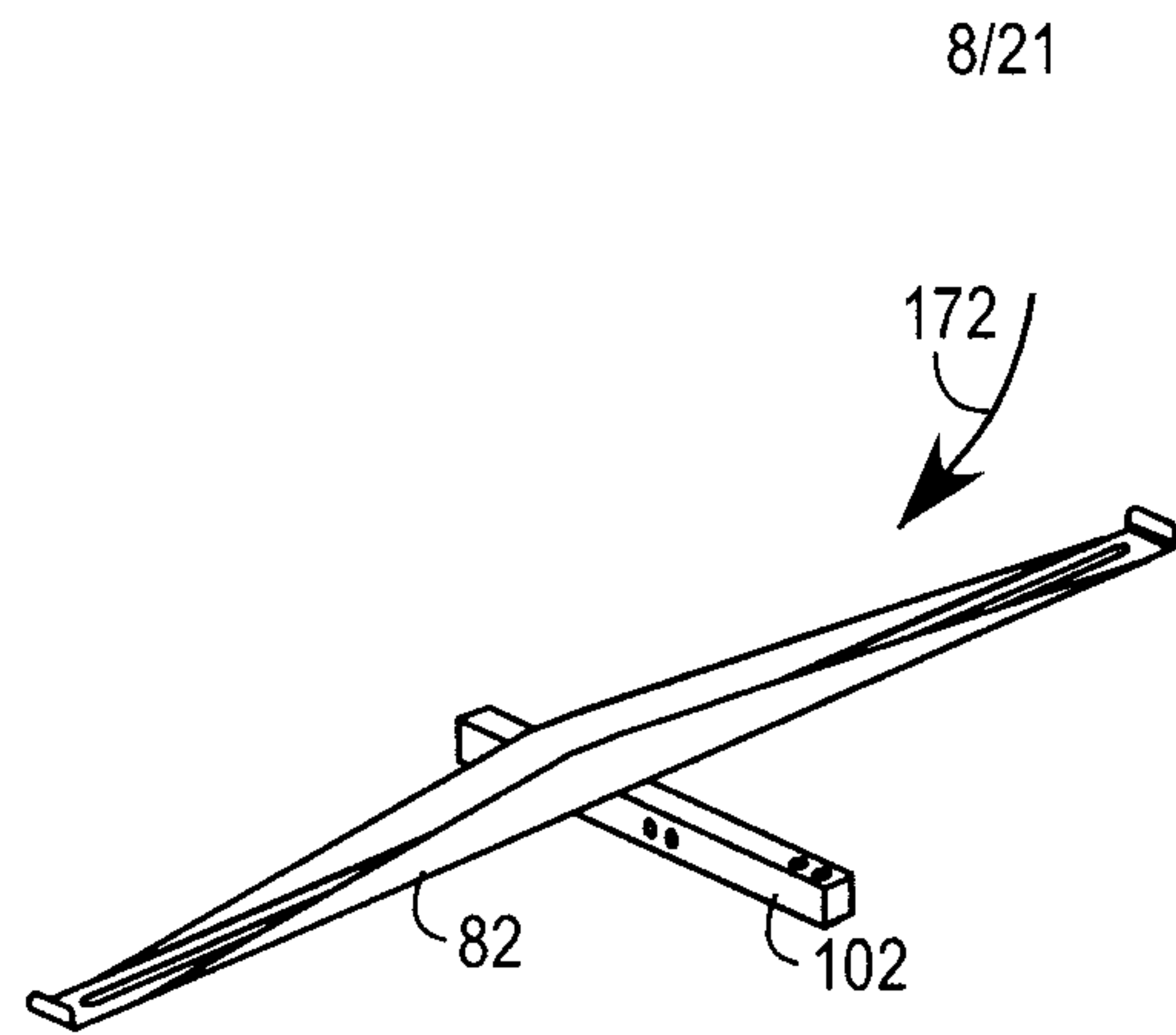


Fig. 9B

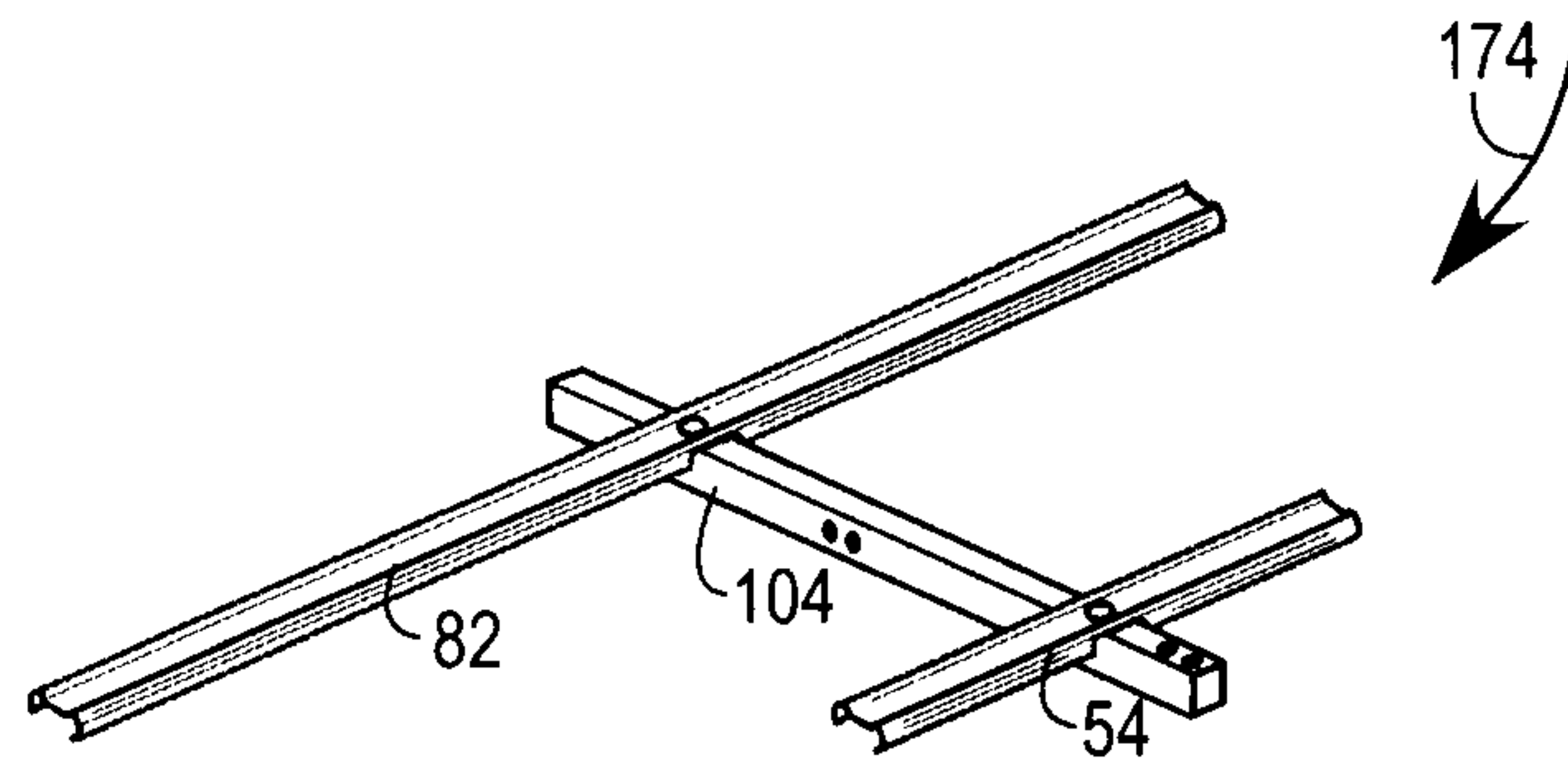
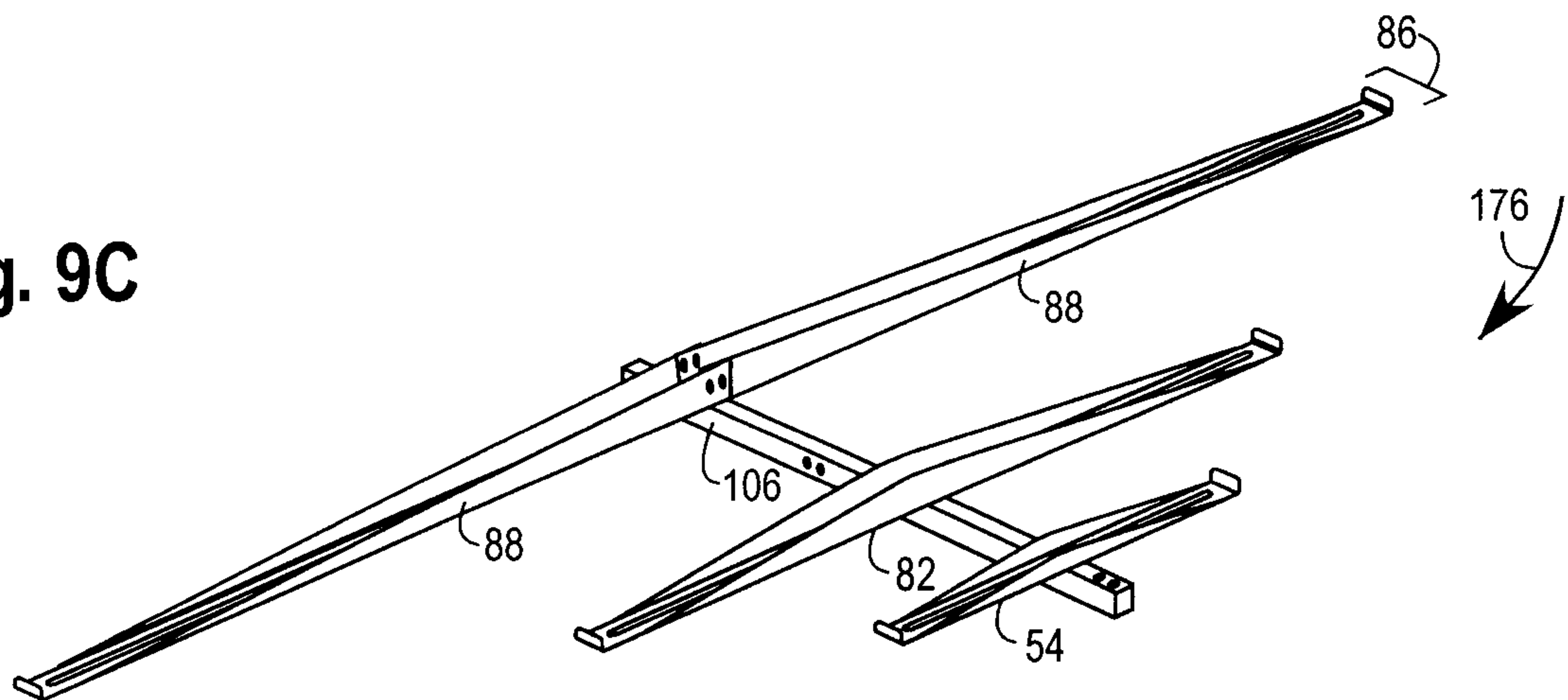
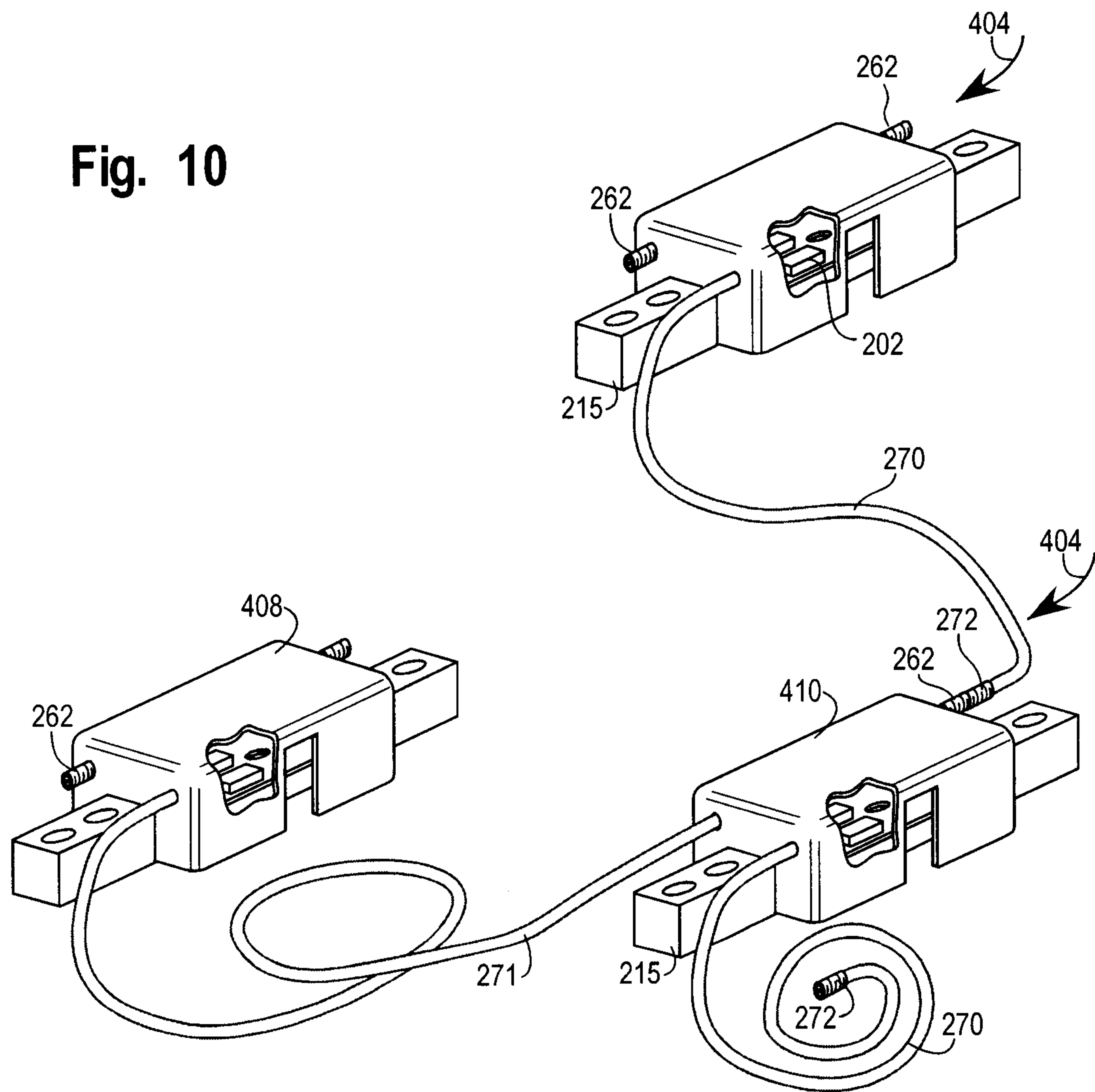


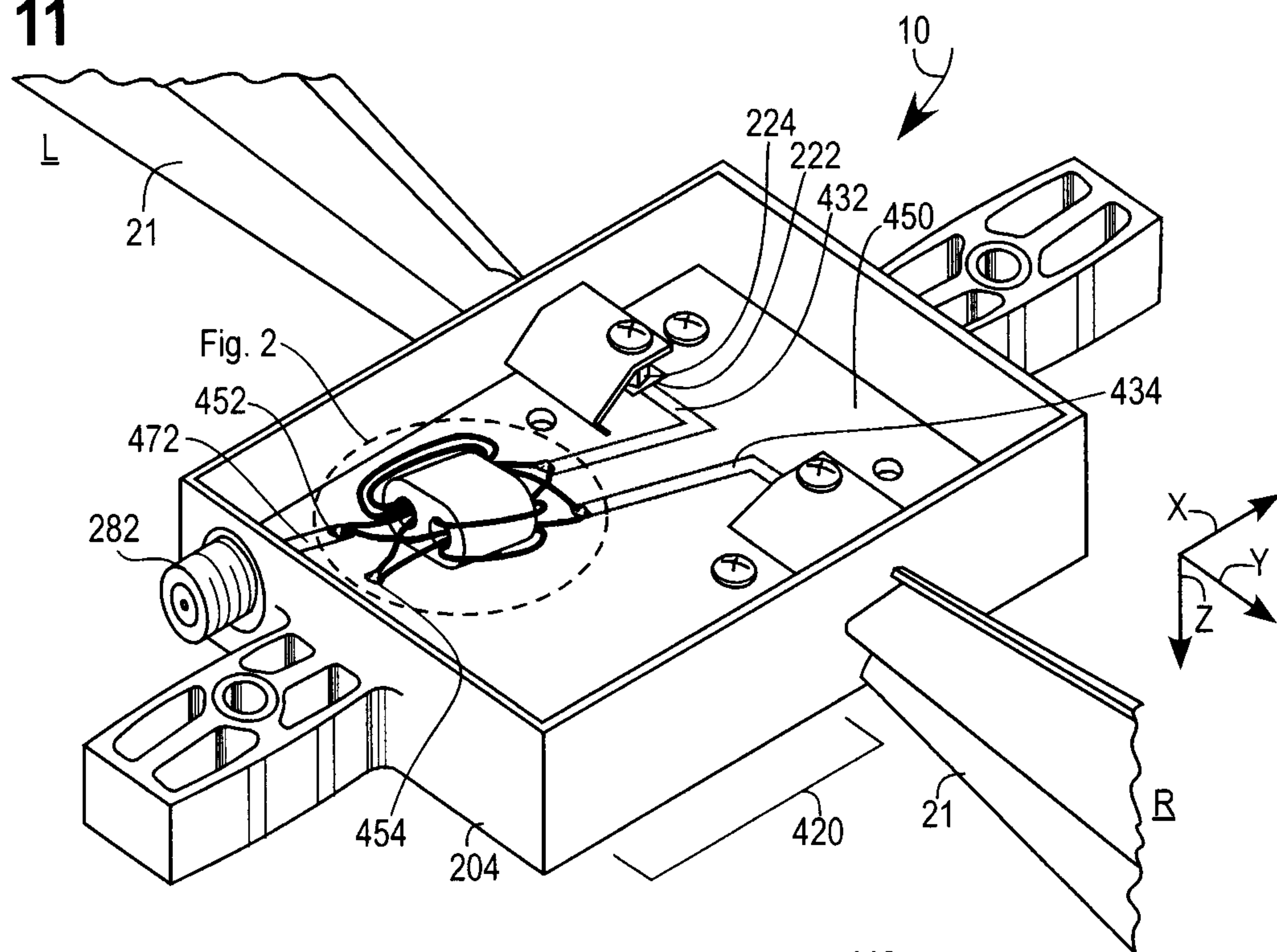
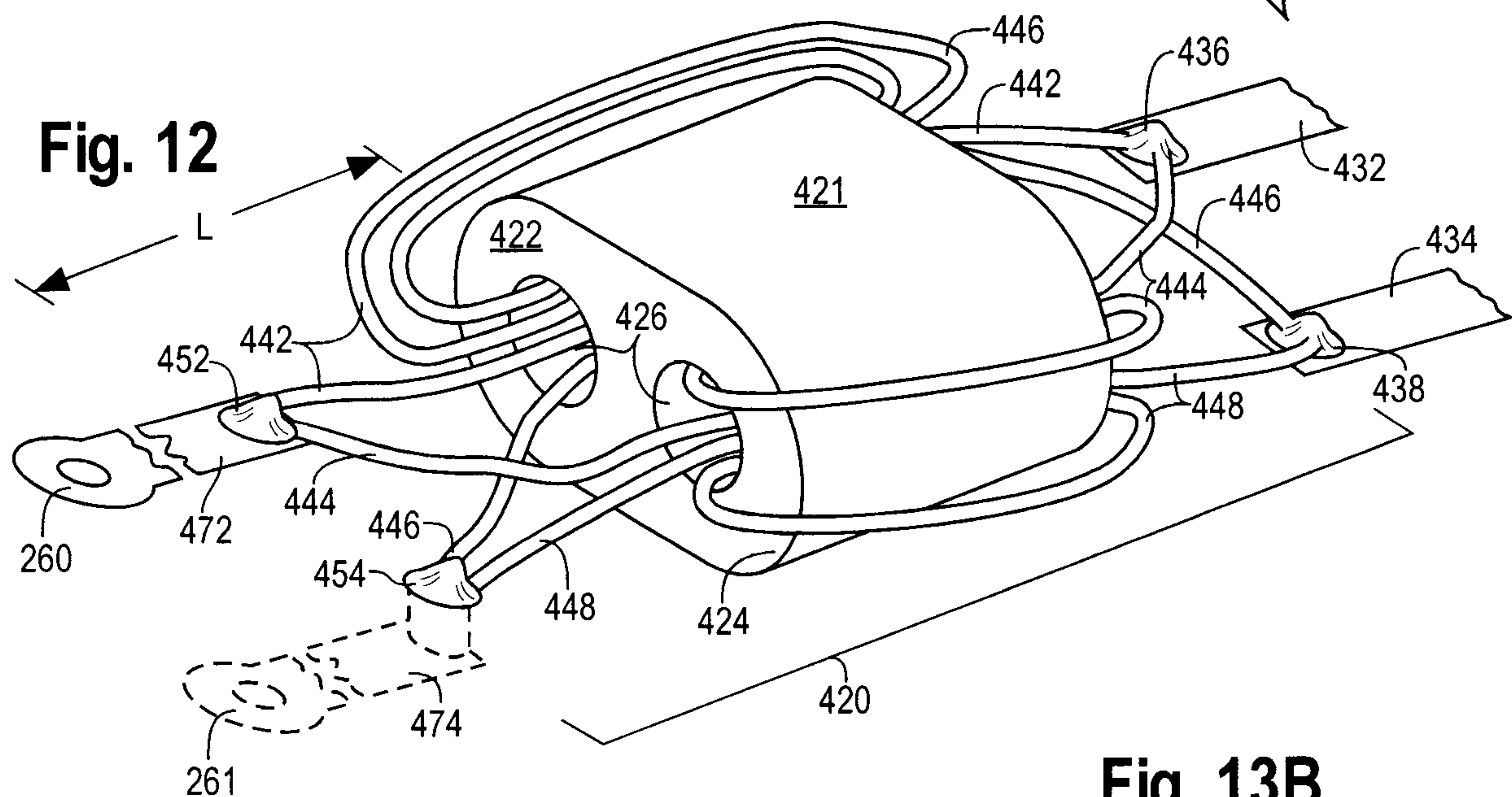
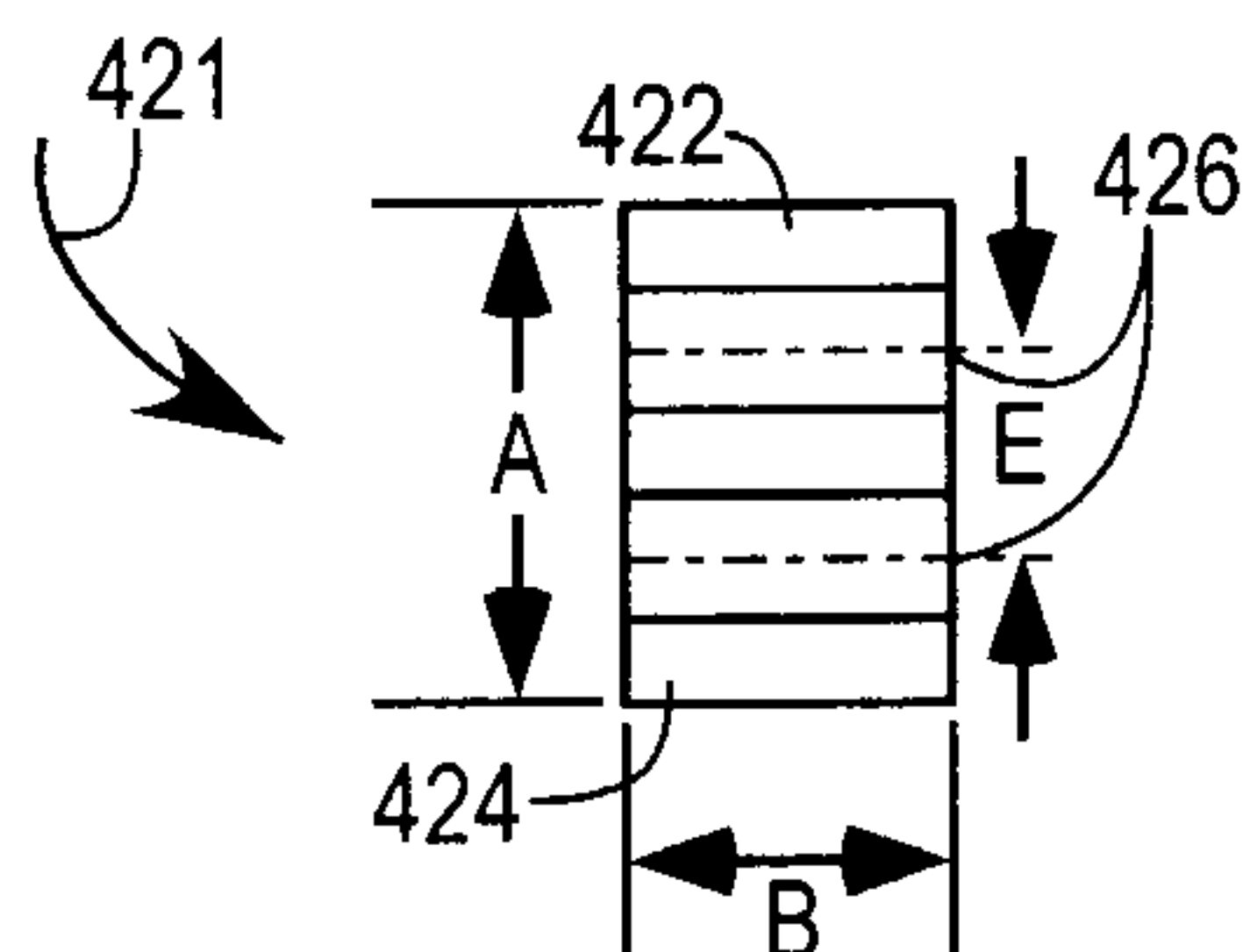
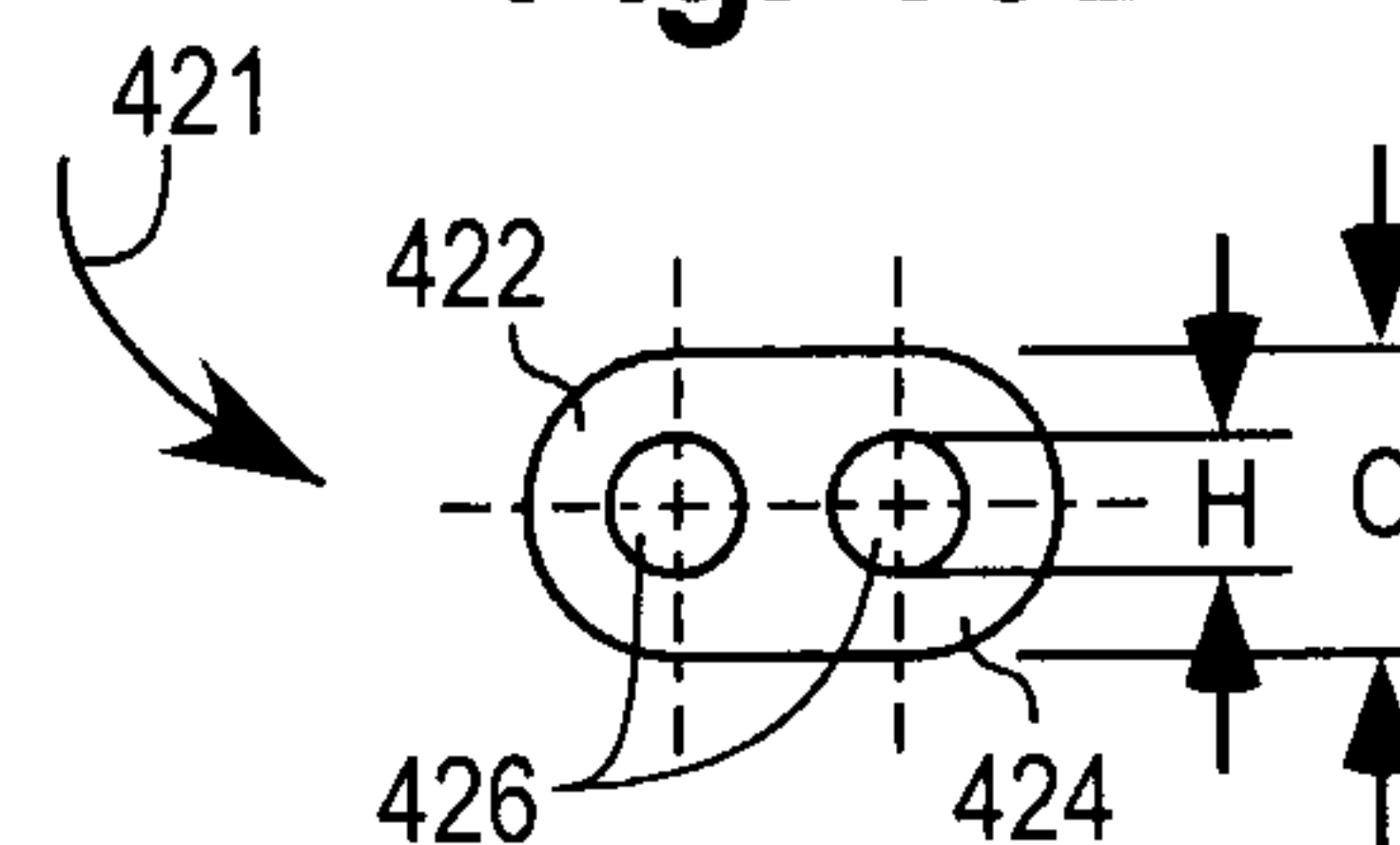
Fig. 9C



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Fig. 10

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Fig. 11**Fig. 12****Fig. 13A****Fig. 13B**

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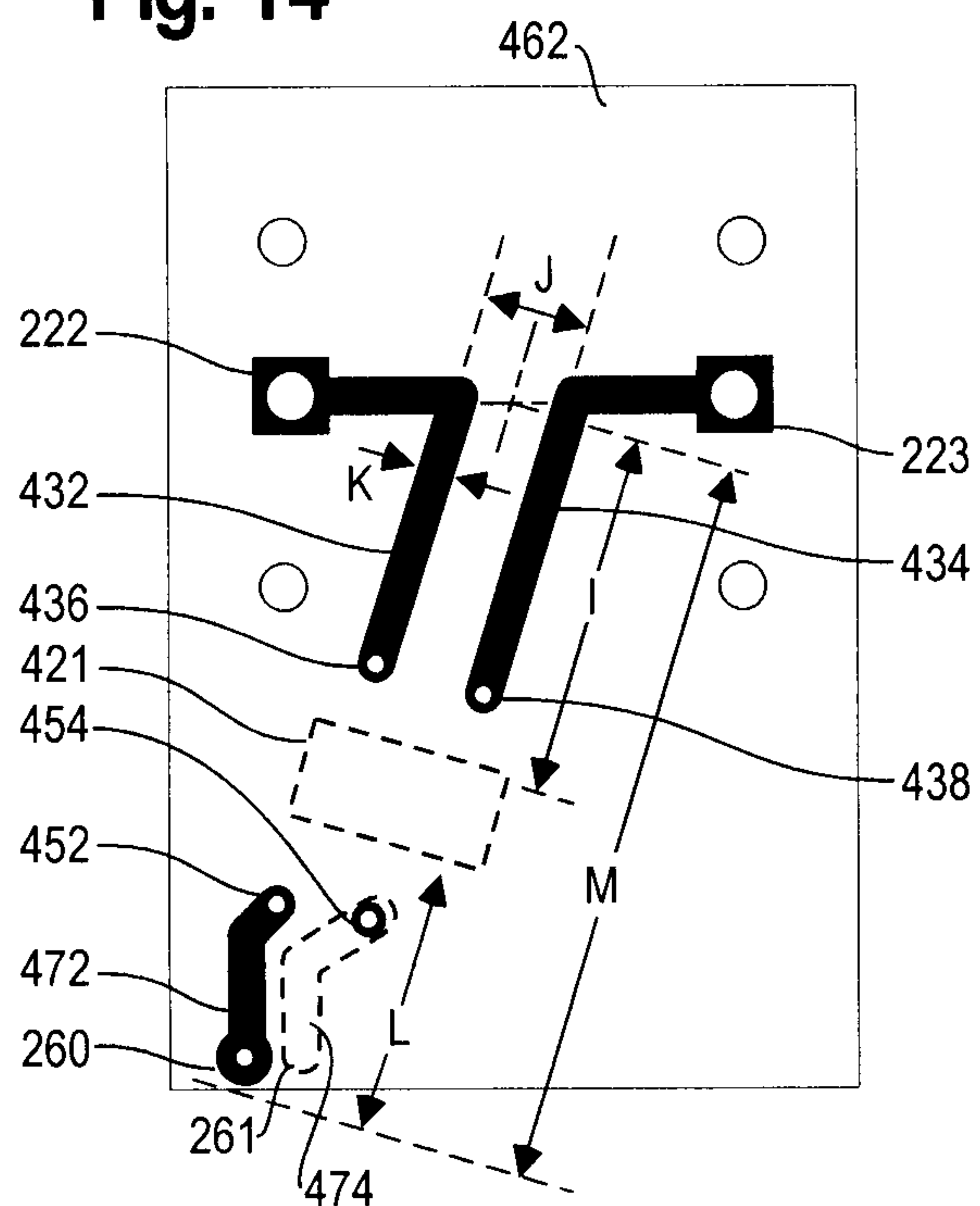
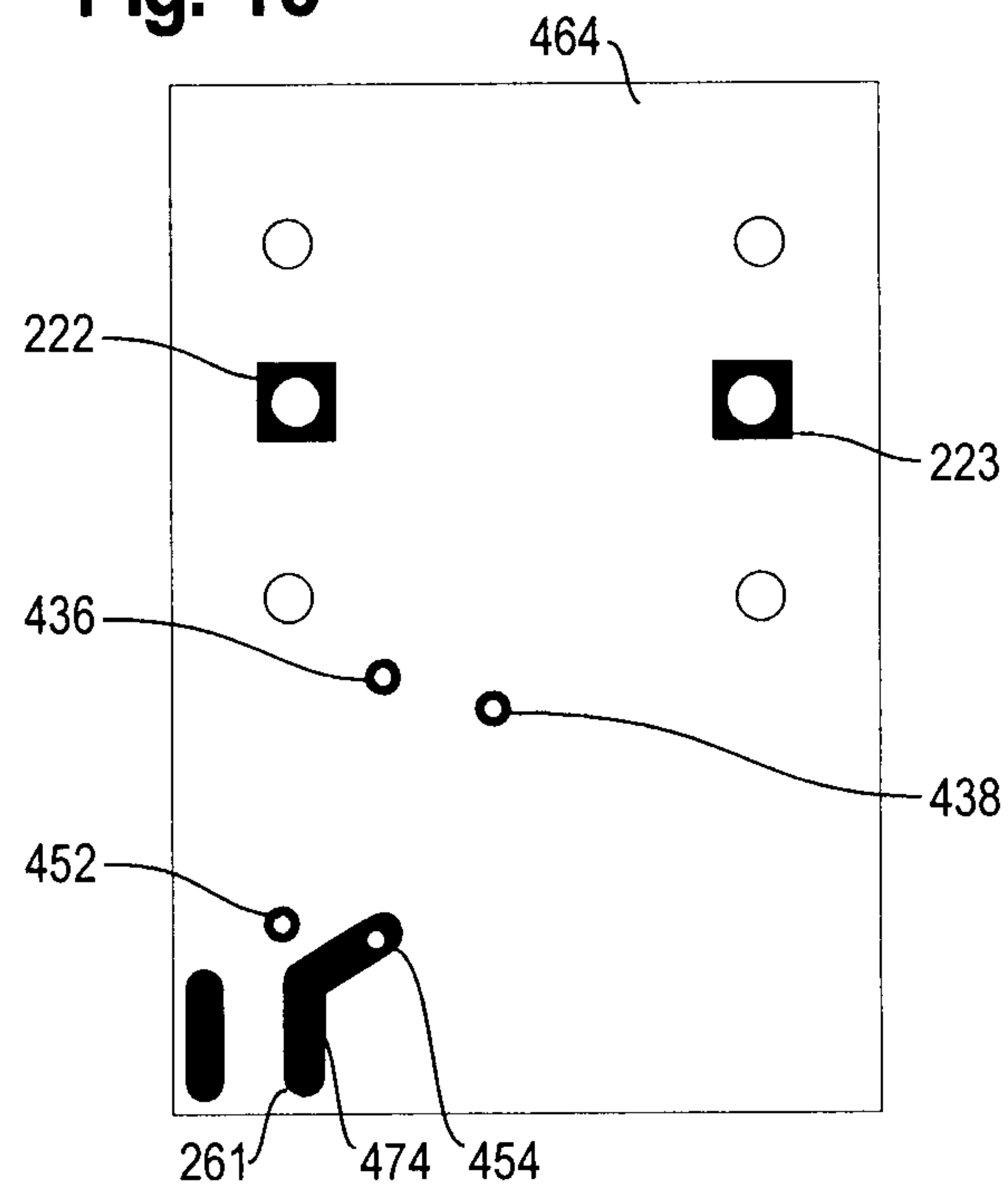
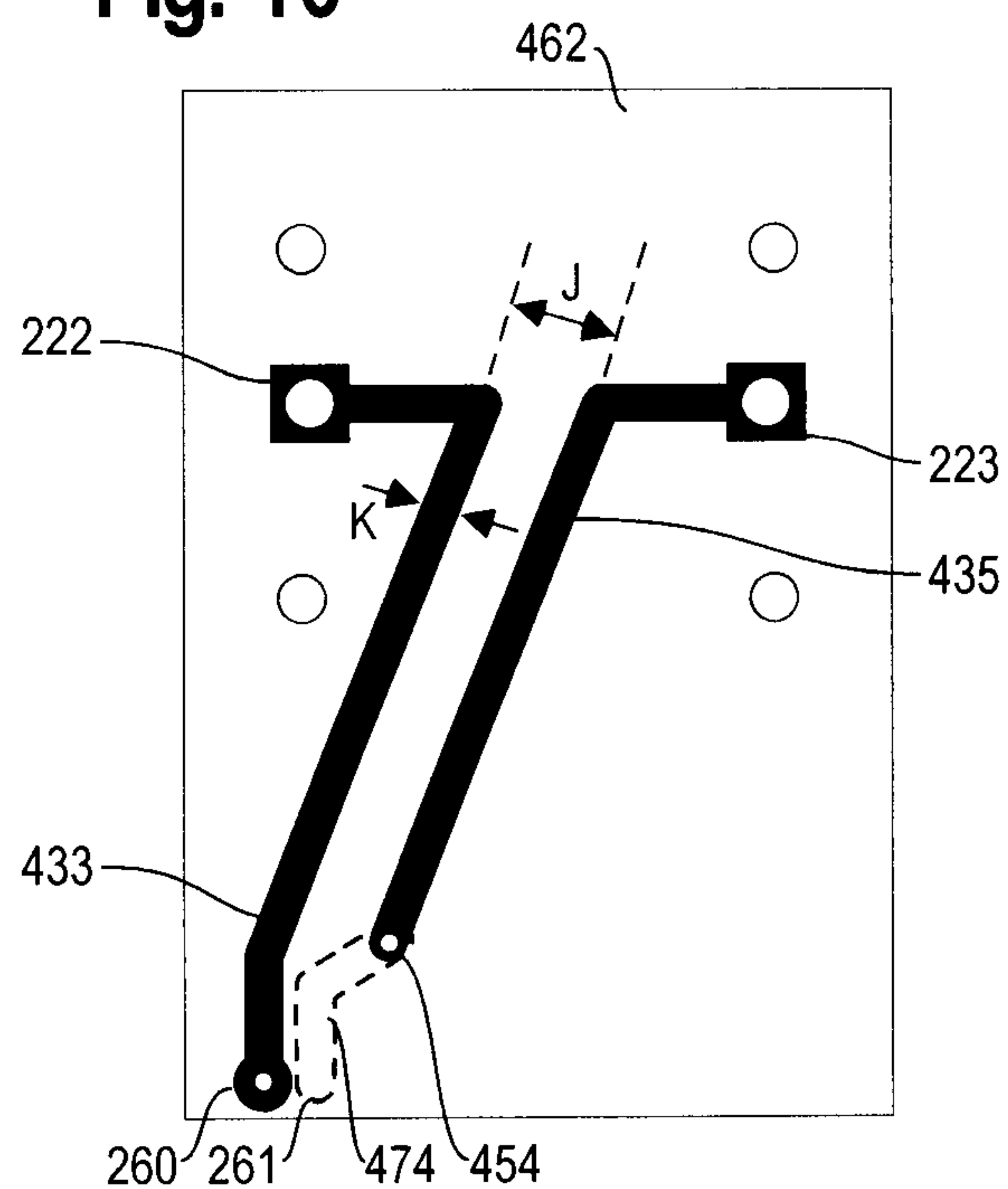
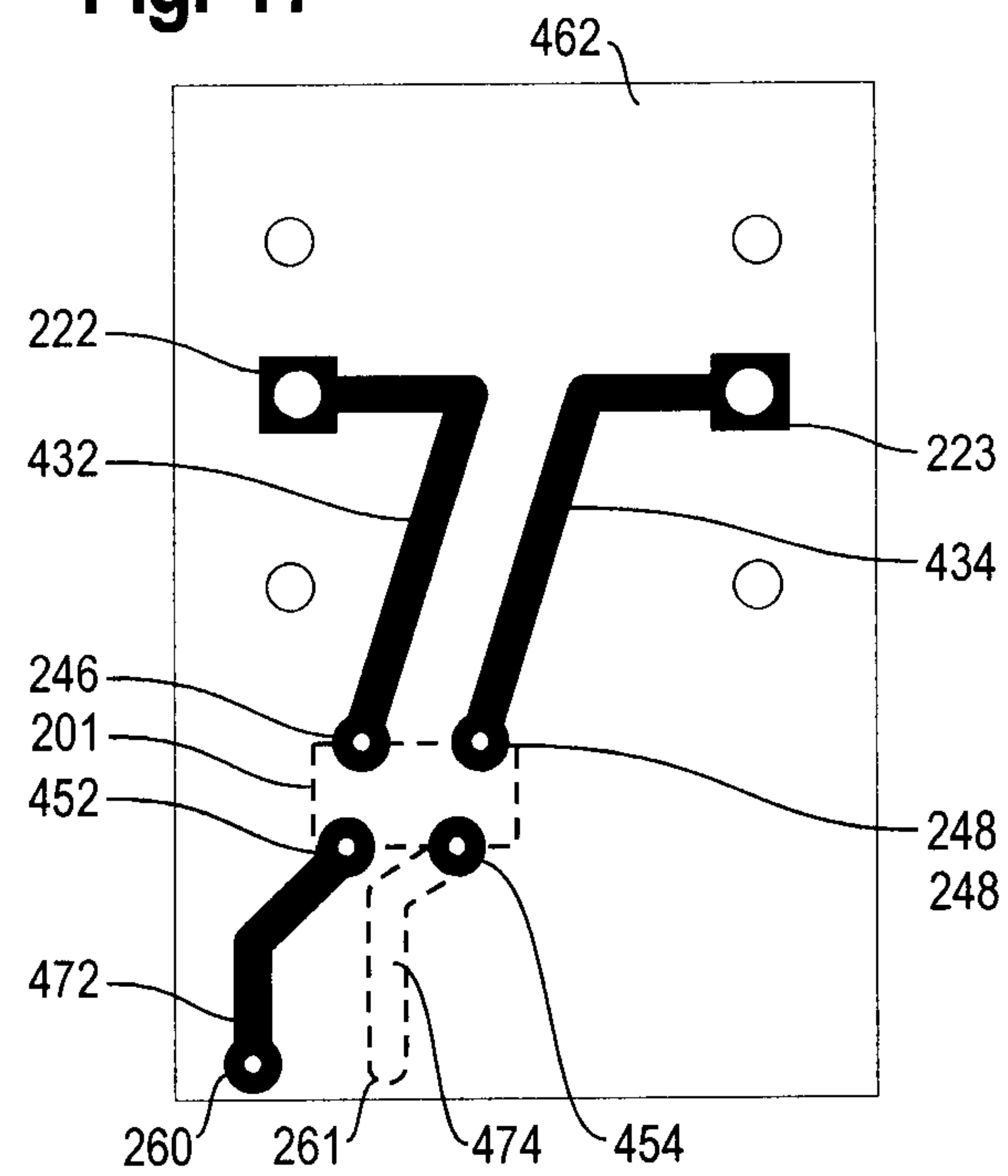
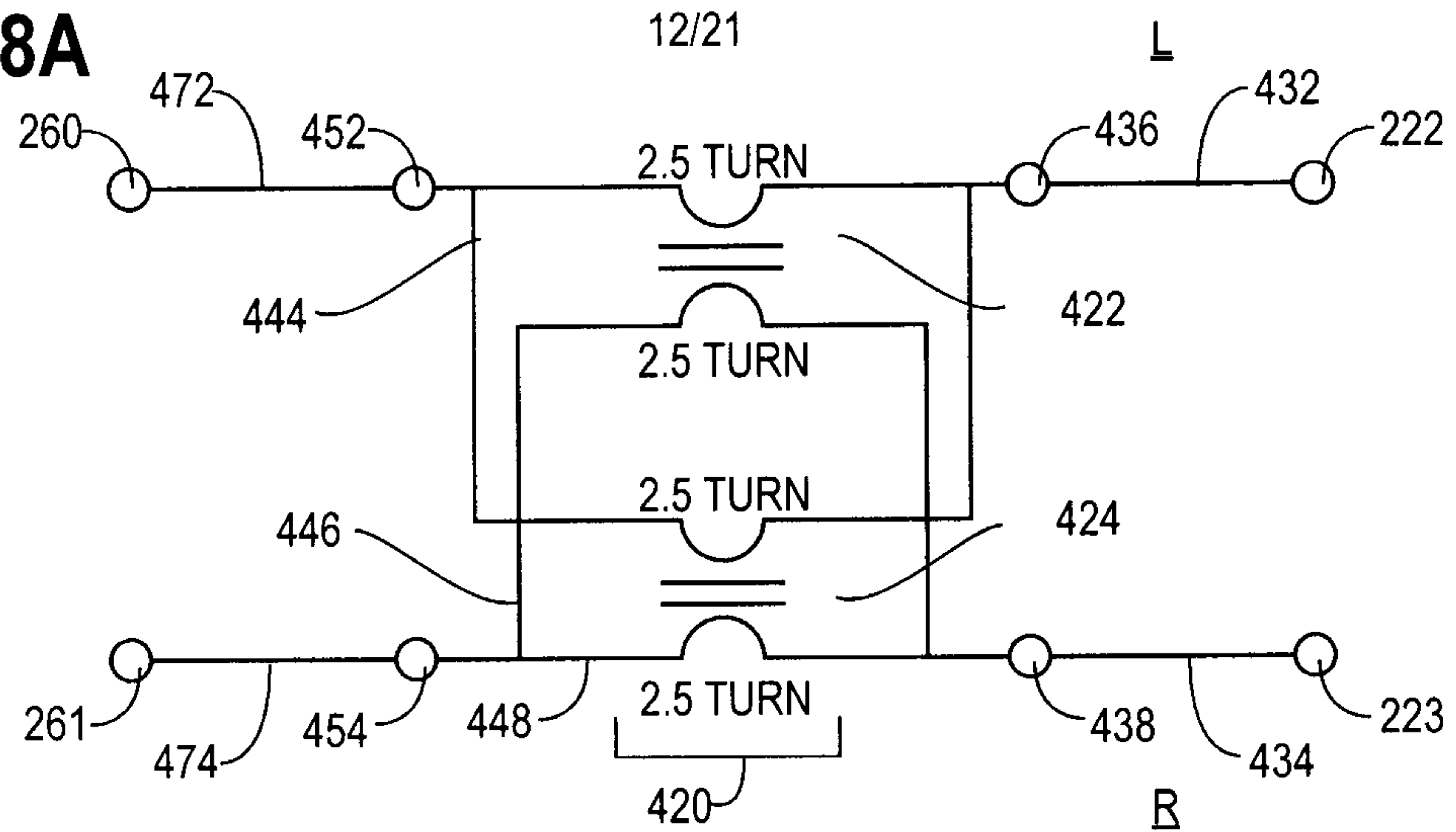
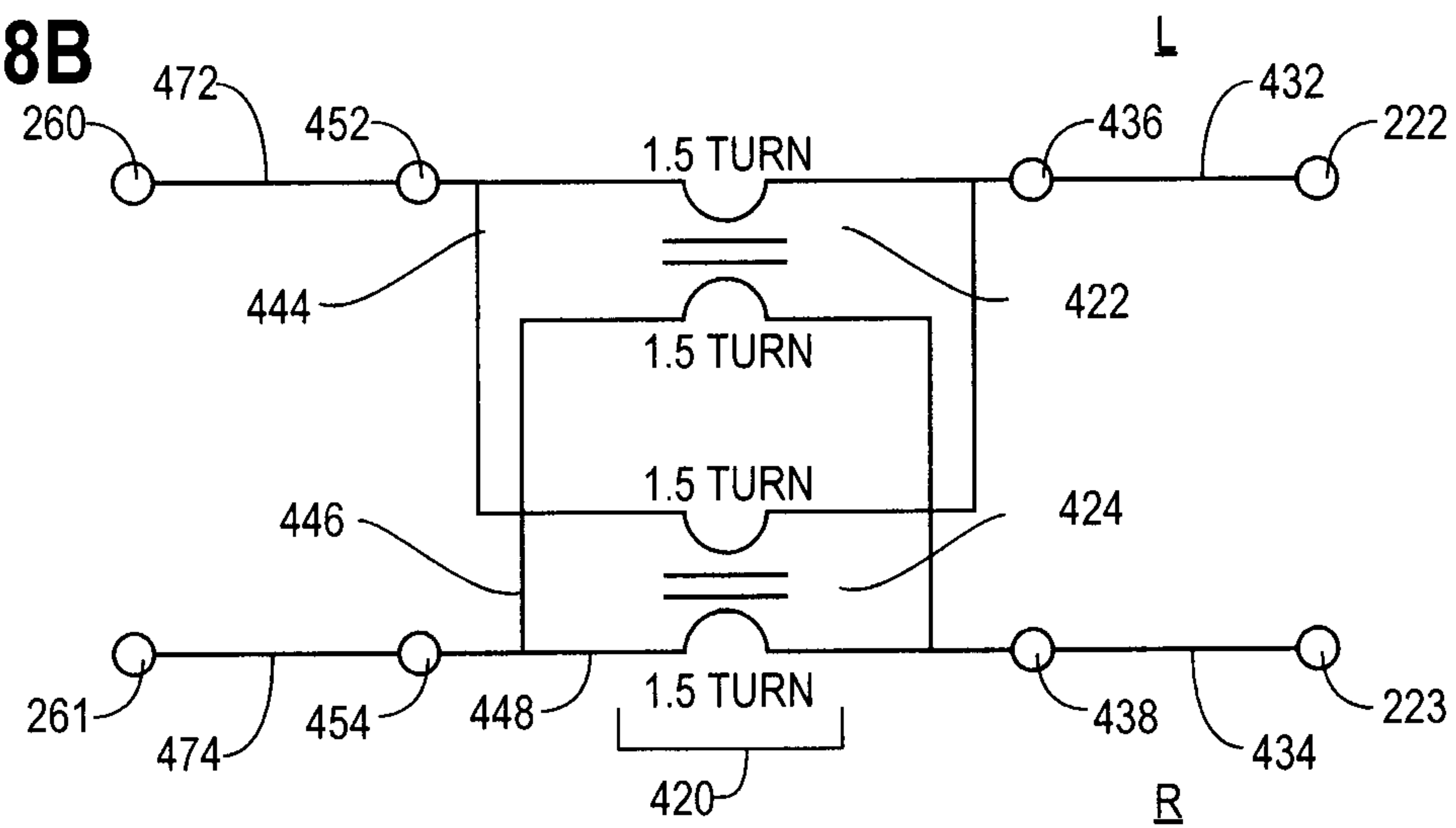
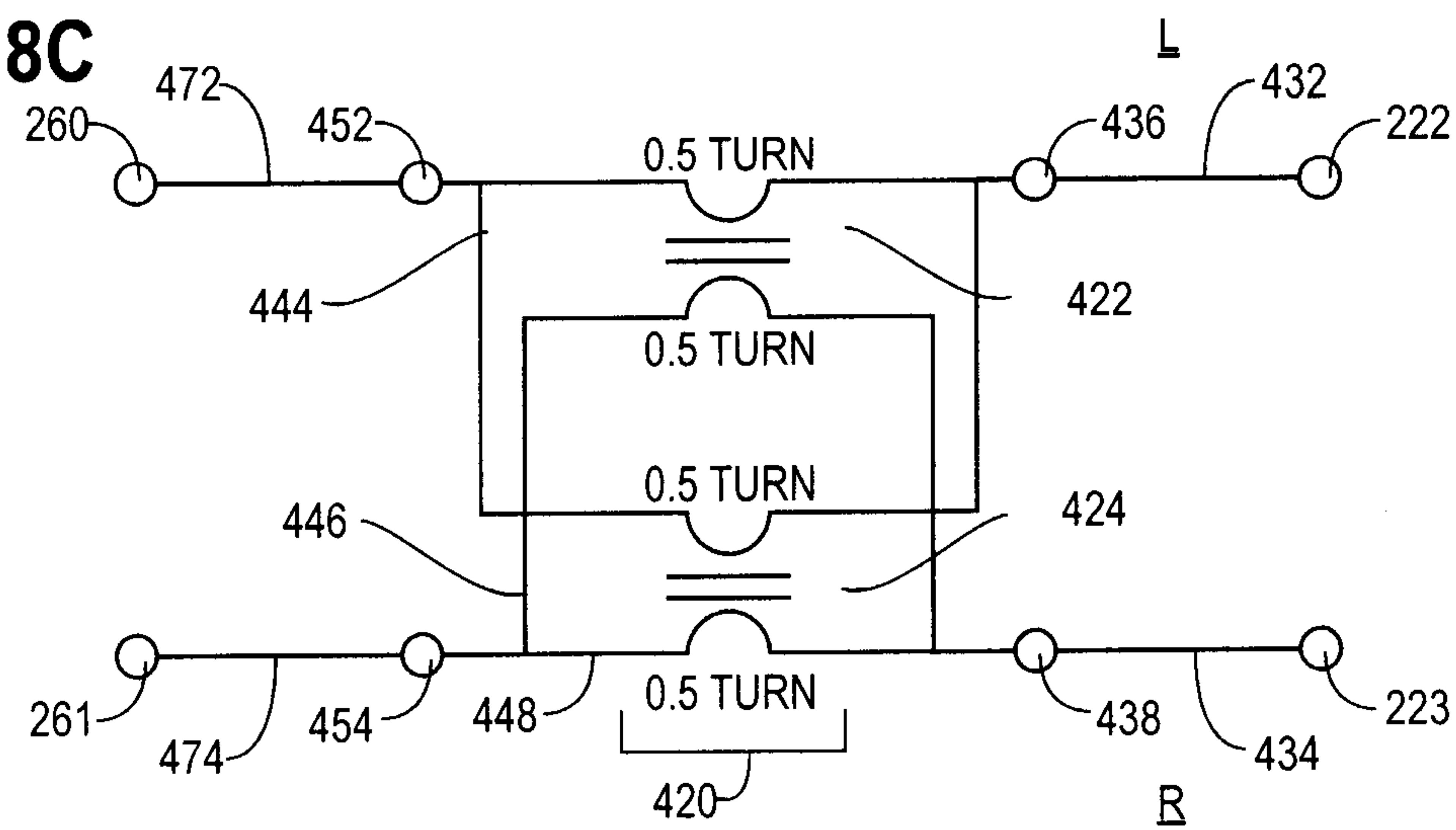
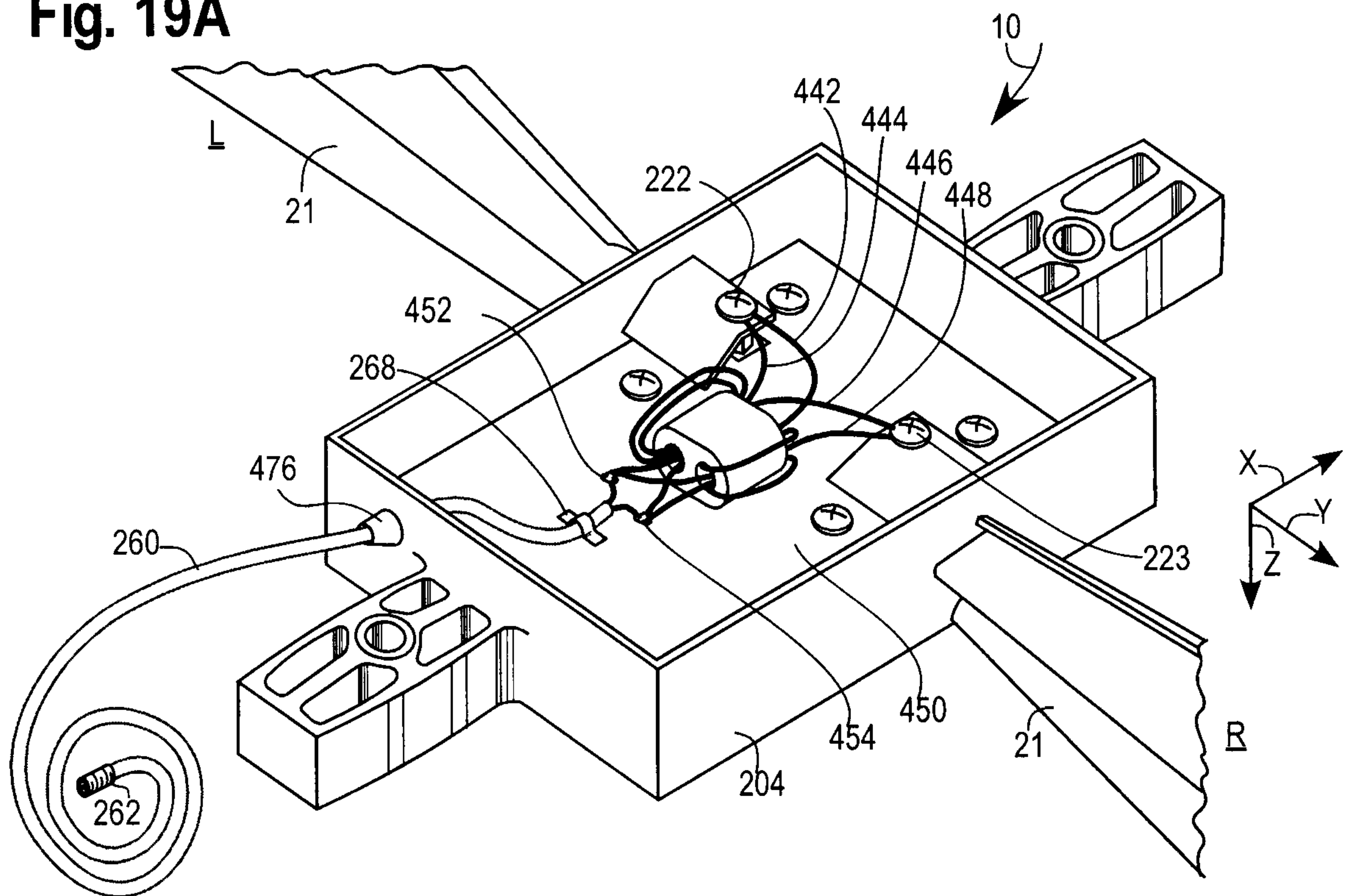
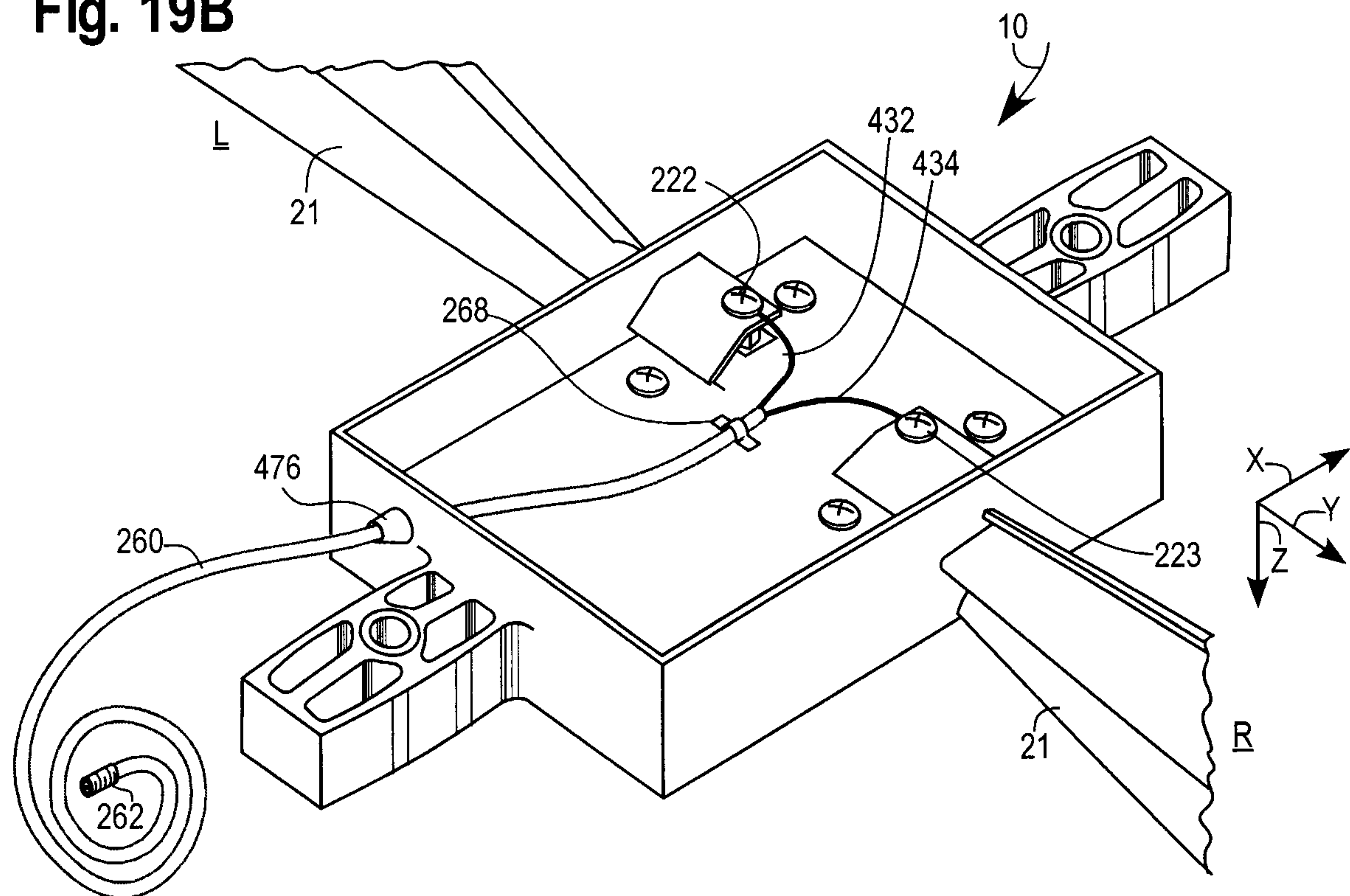
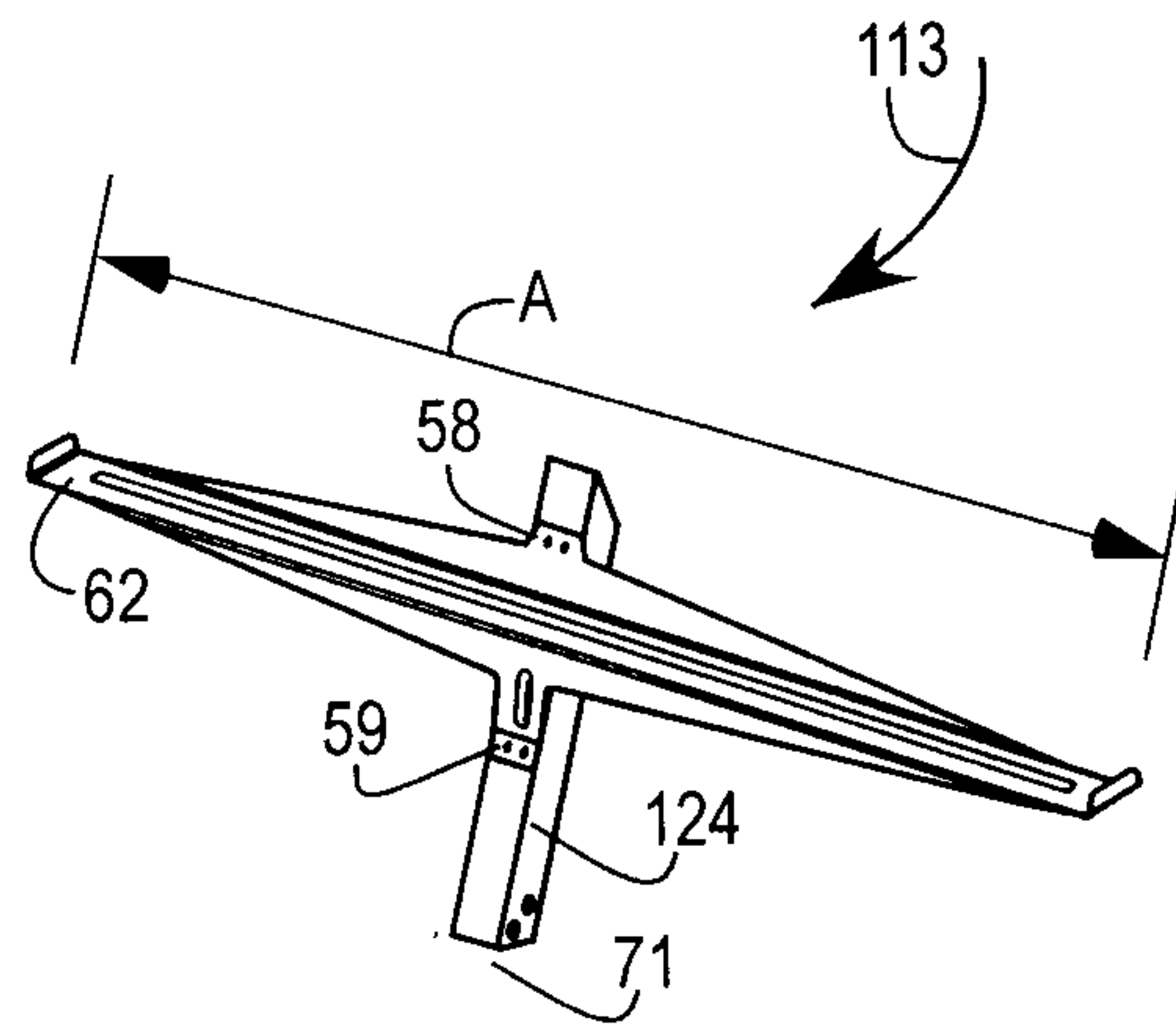
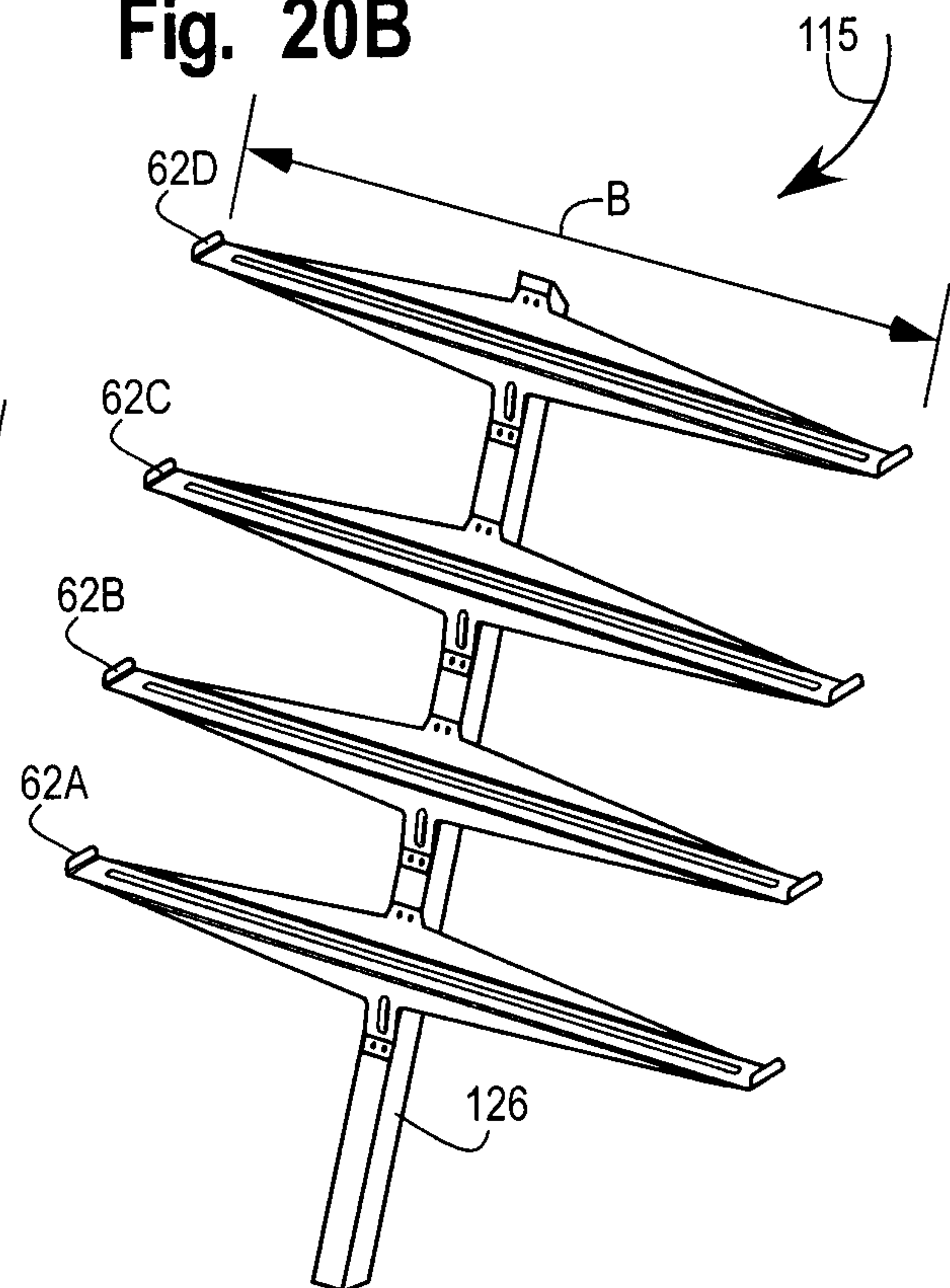
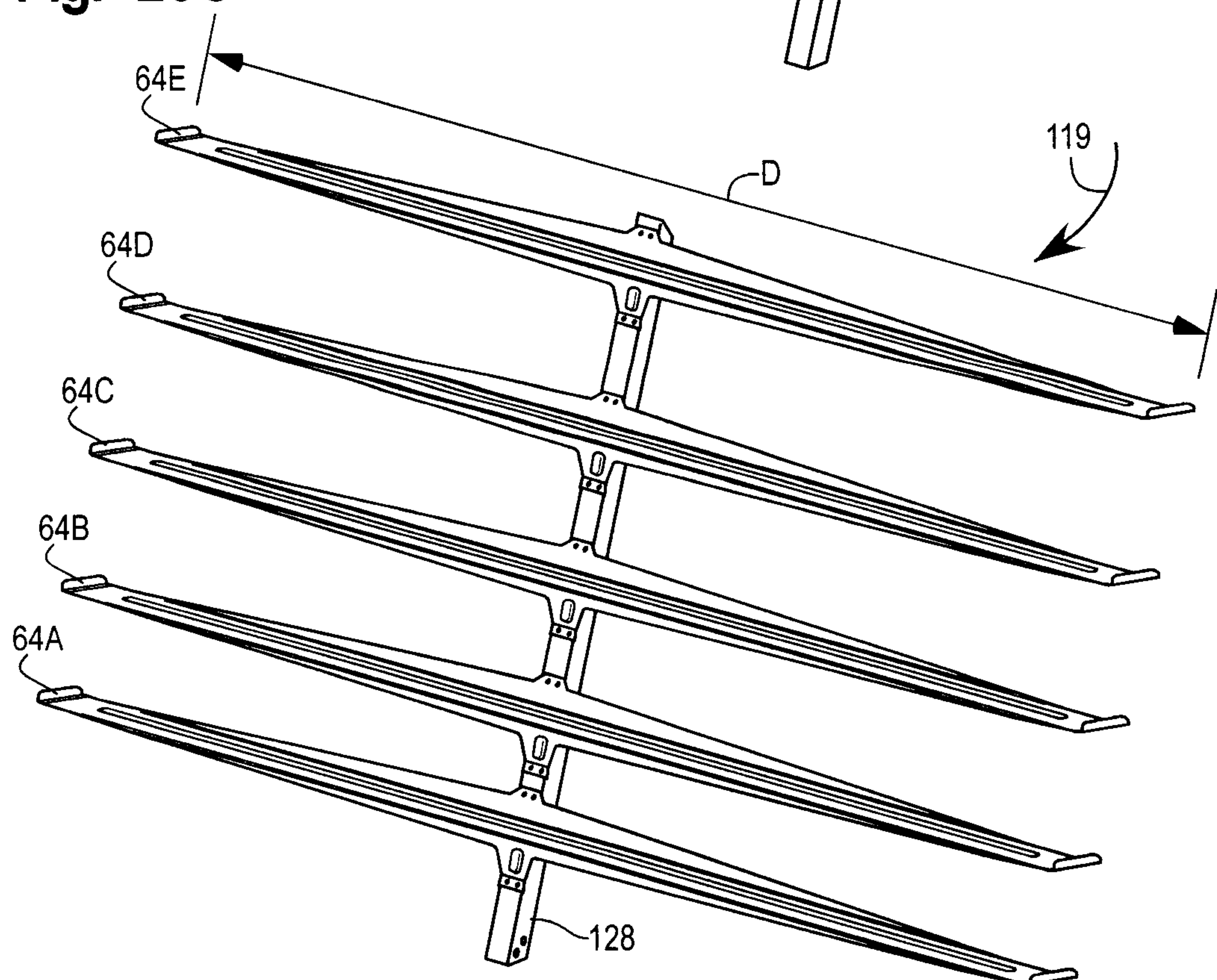
Fig. 14**Fig. 15****Fig. 16****Fig. 17**

Fig. 18A**Fig. 18B****Fig. 18C**

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Fig. 19A**Fig. 19B**

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Fig. 20A**Fig. 20B****Fig. 20C**

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Fig. 21

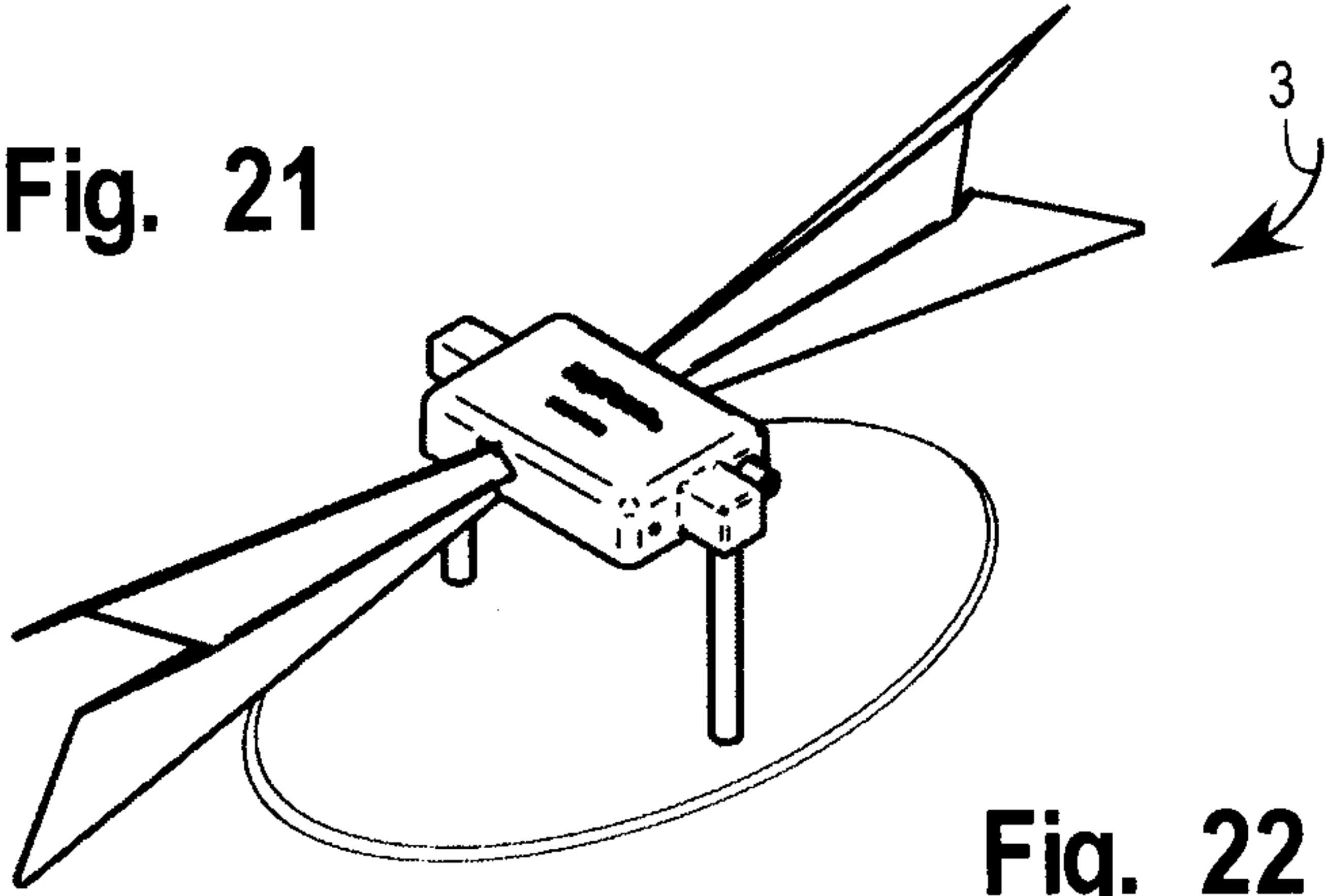


Fig. 22

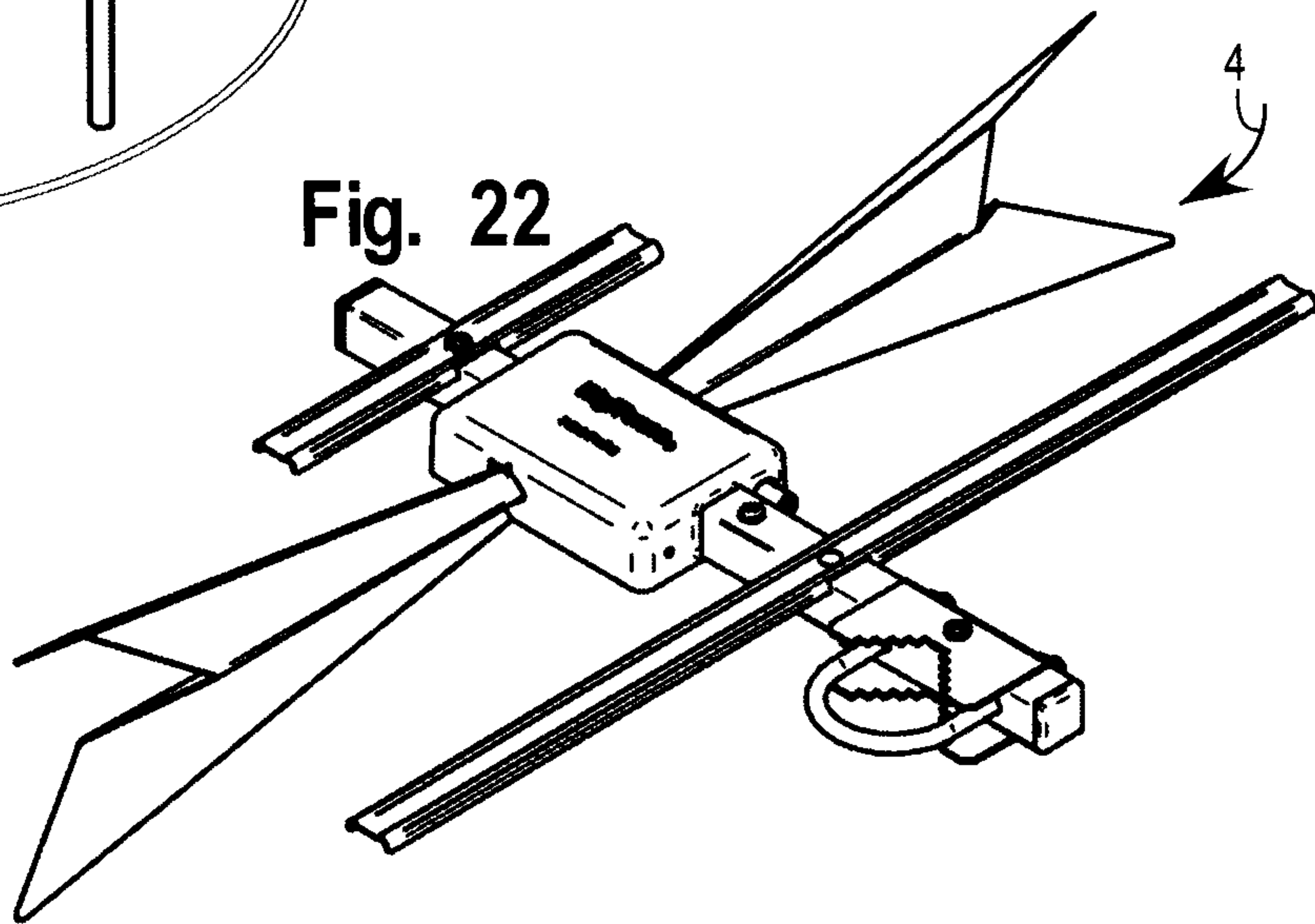


Fig. 23

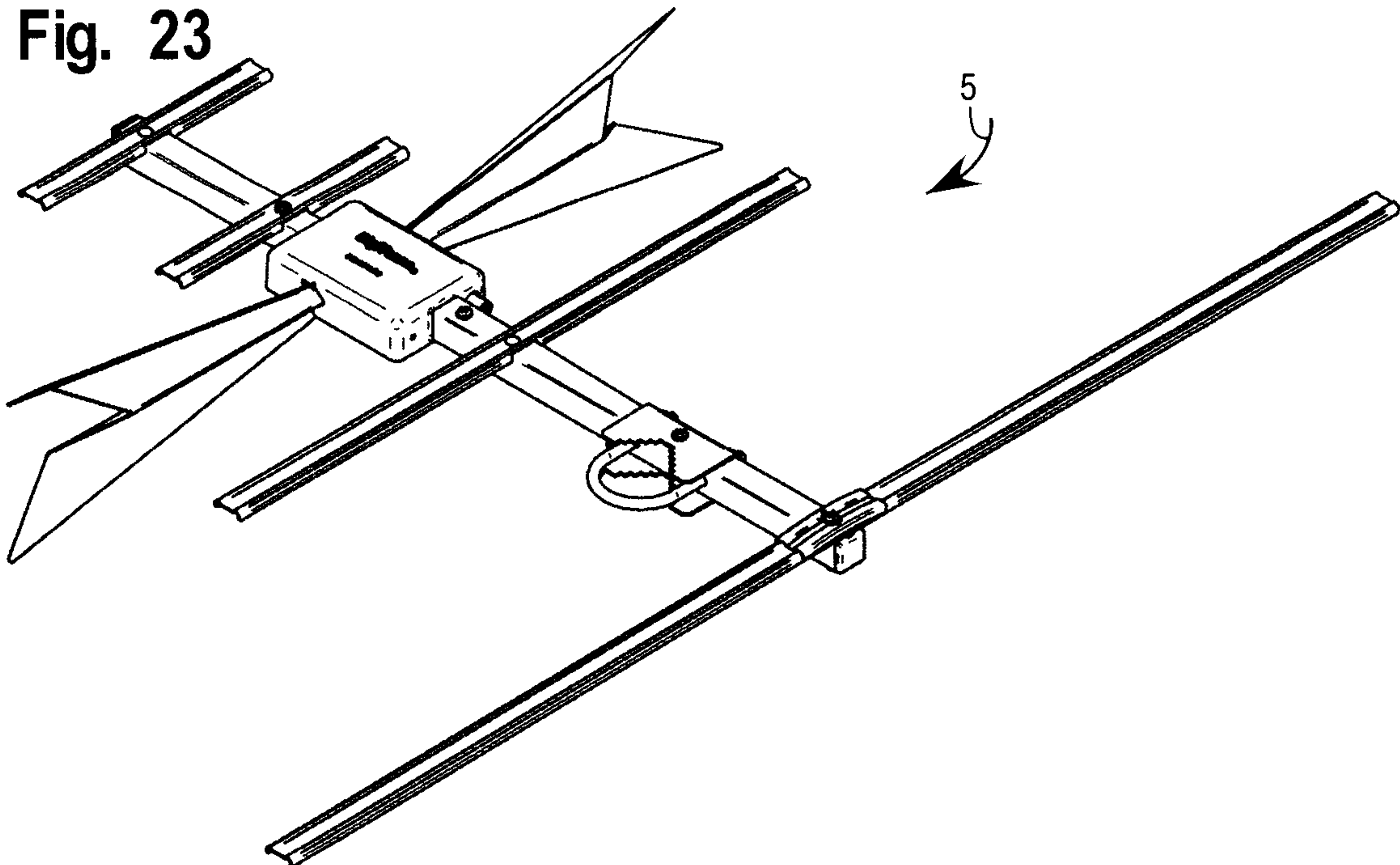


Fig. 24

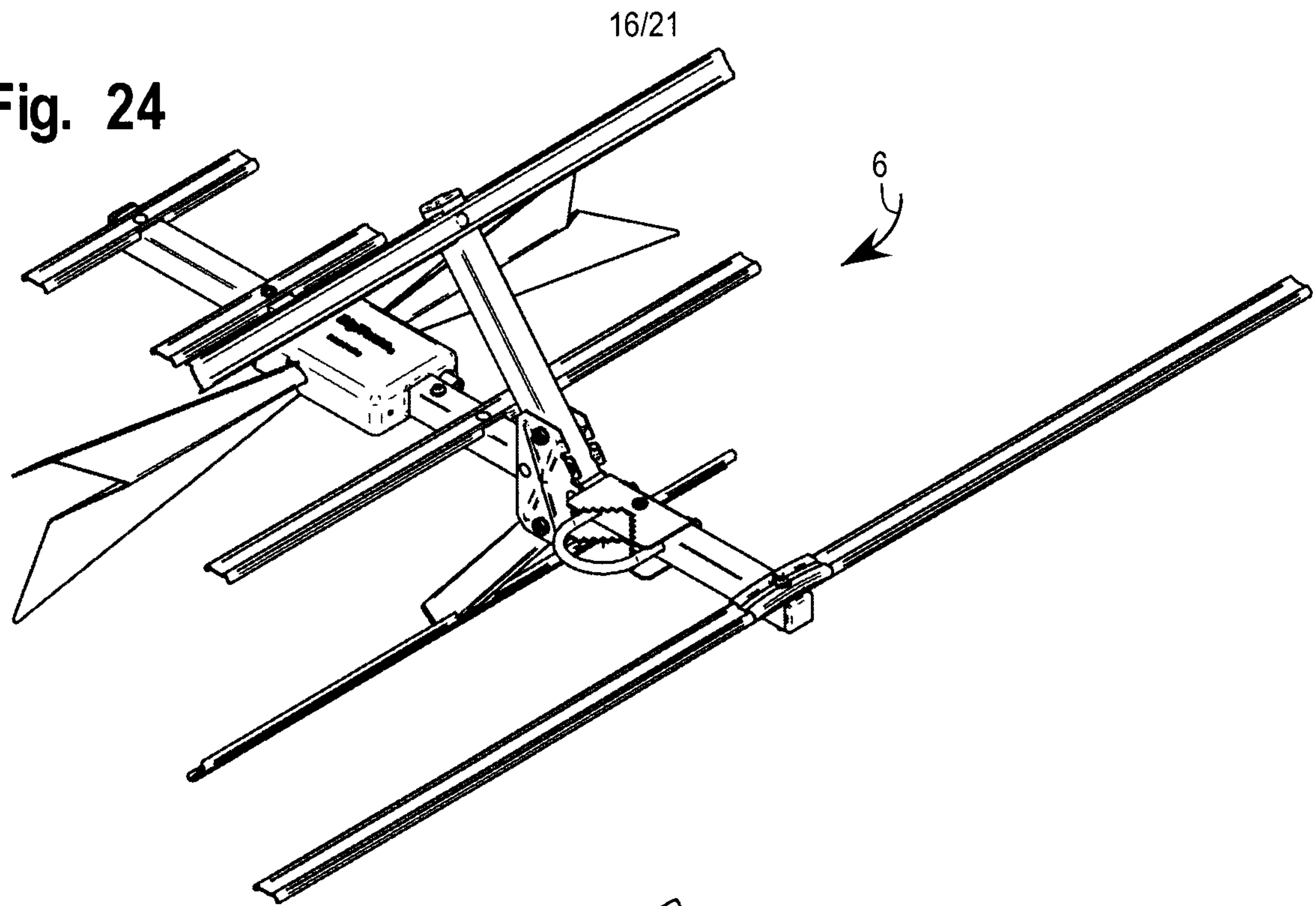
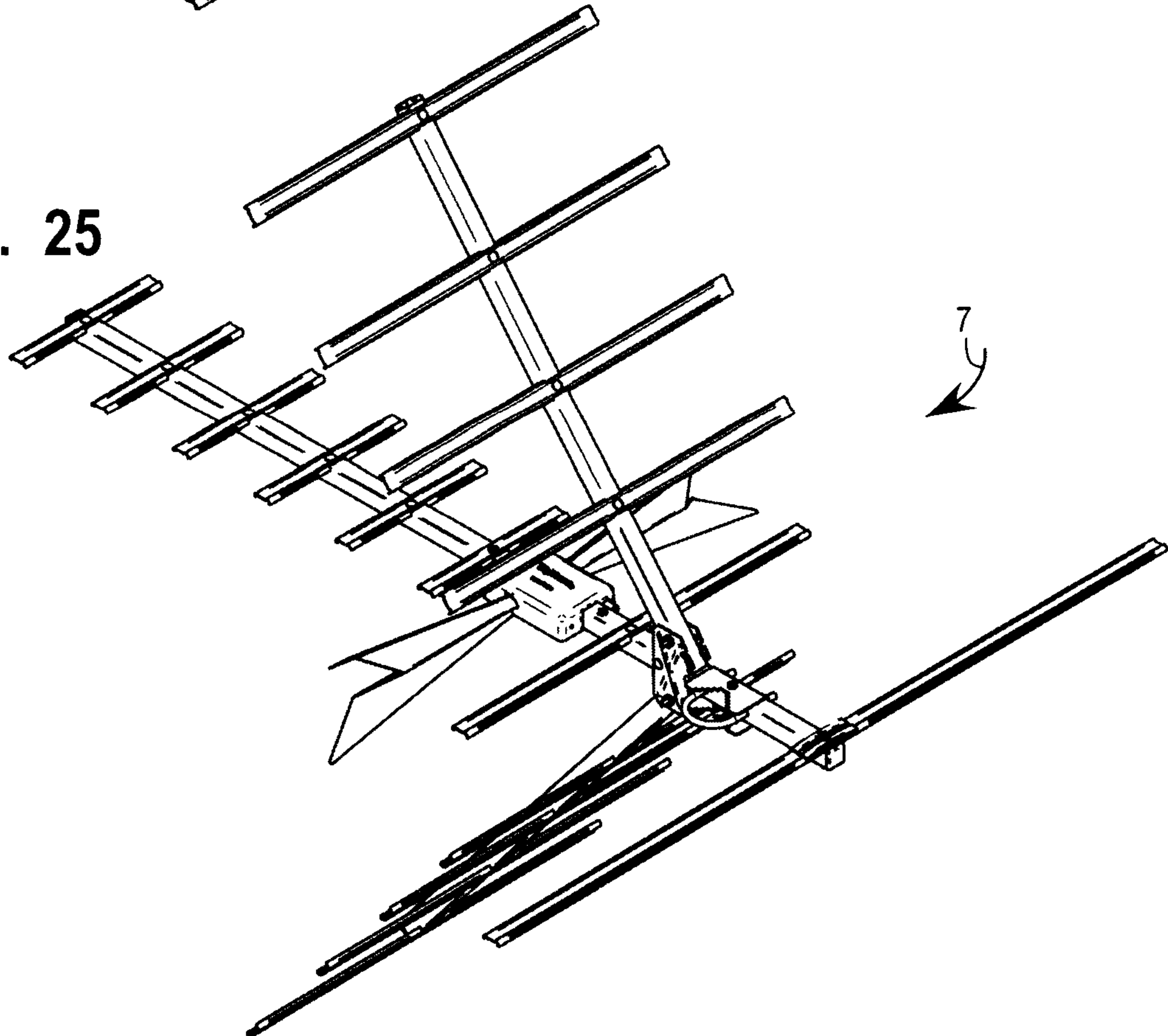


Fig. 25



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Fig. 26

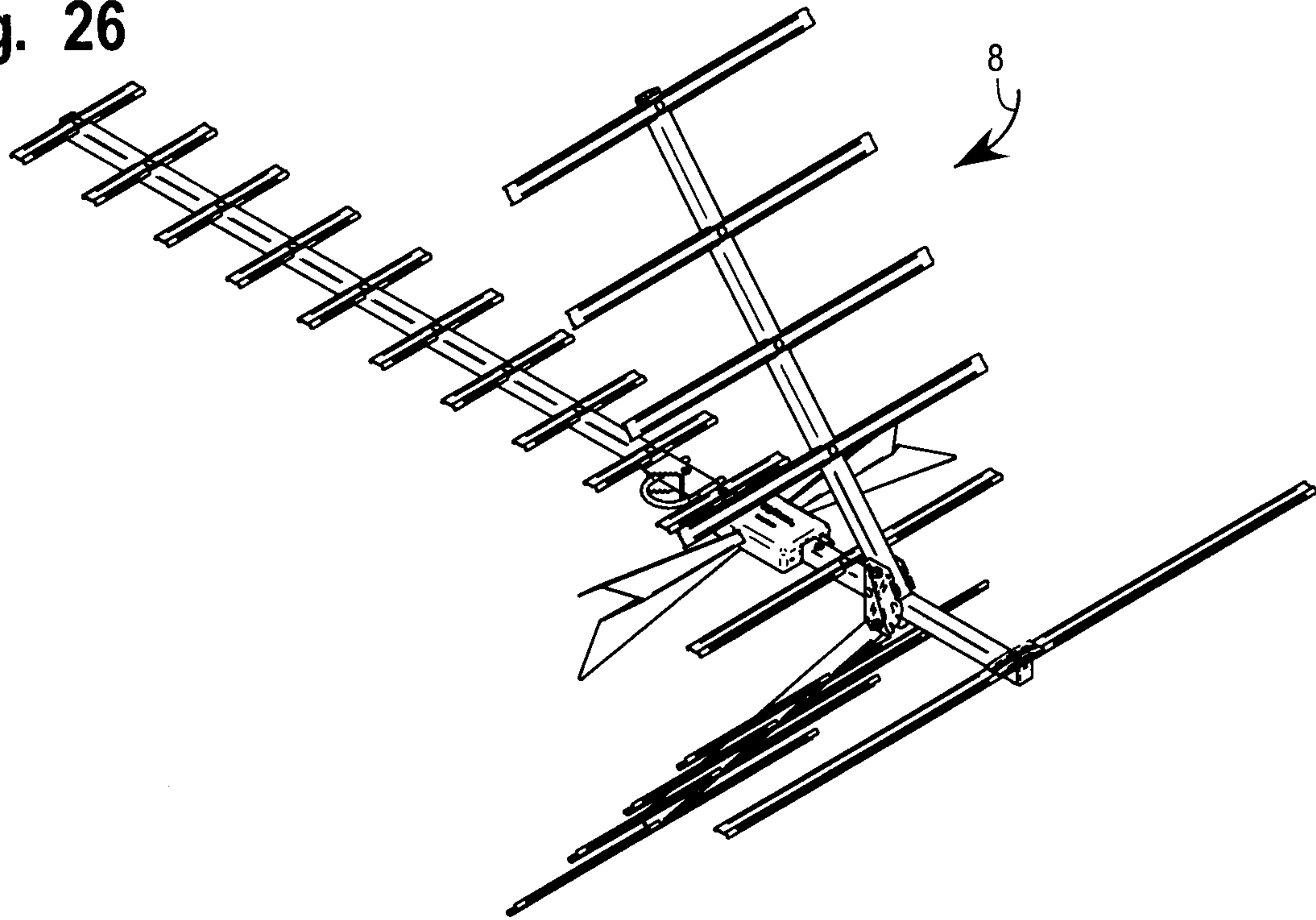


Fig. 27

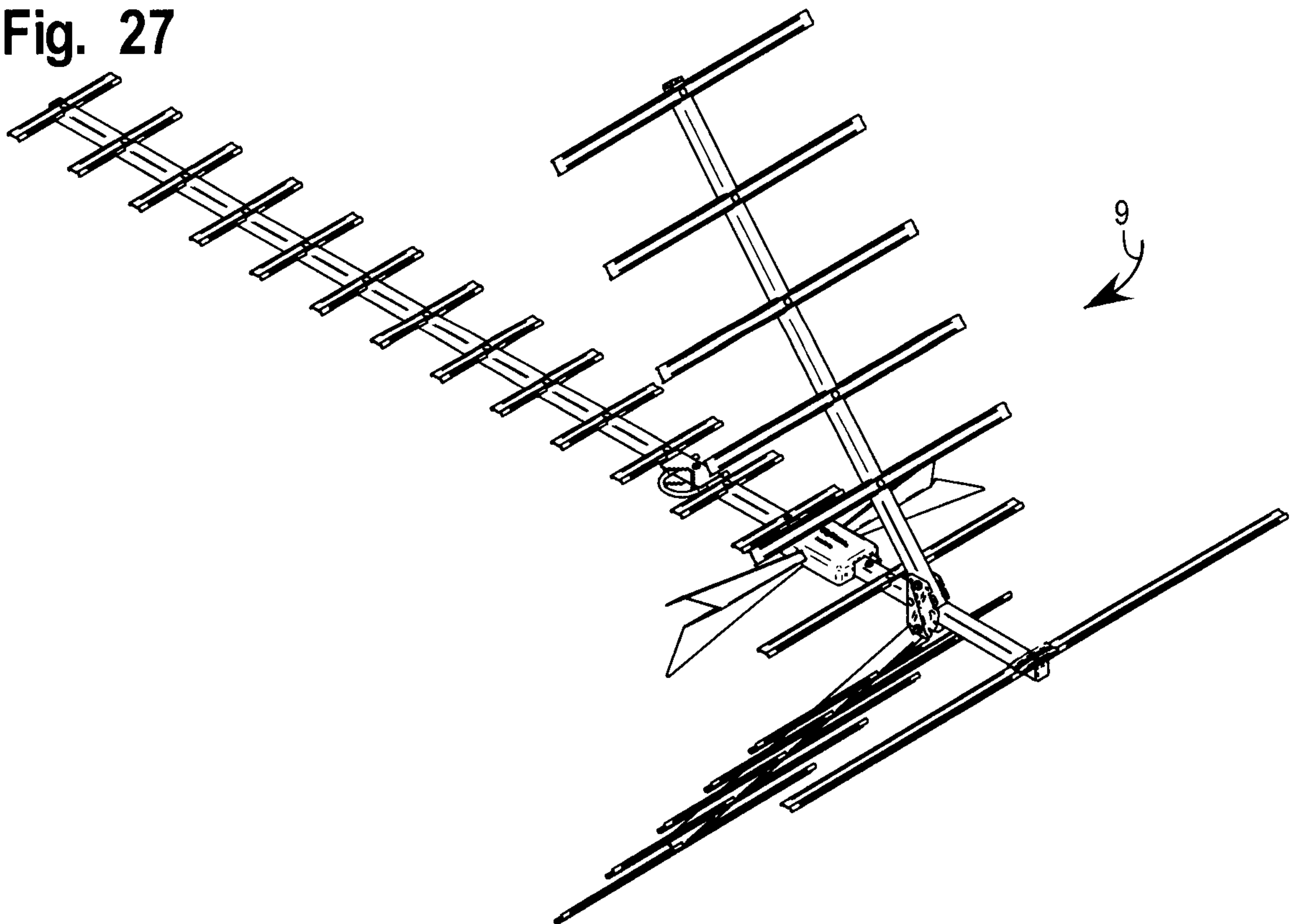
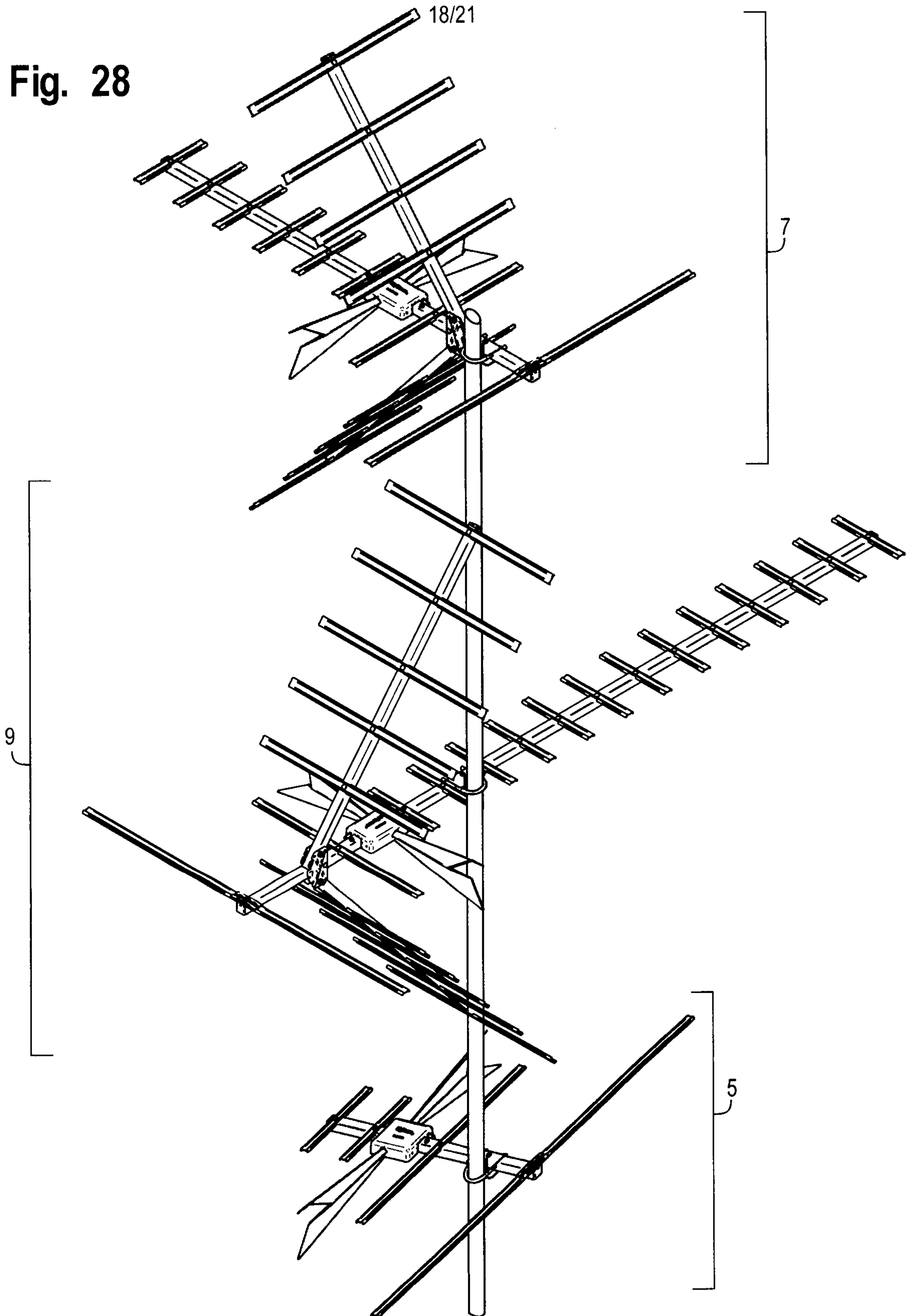


Fig. 28



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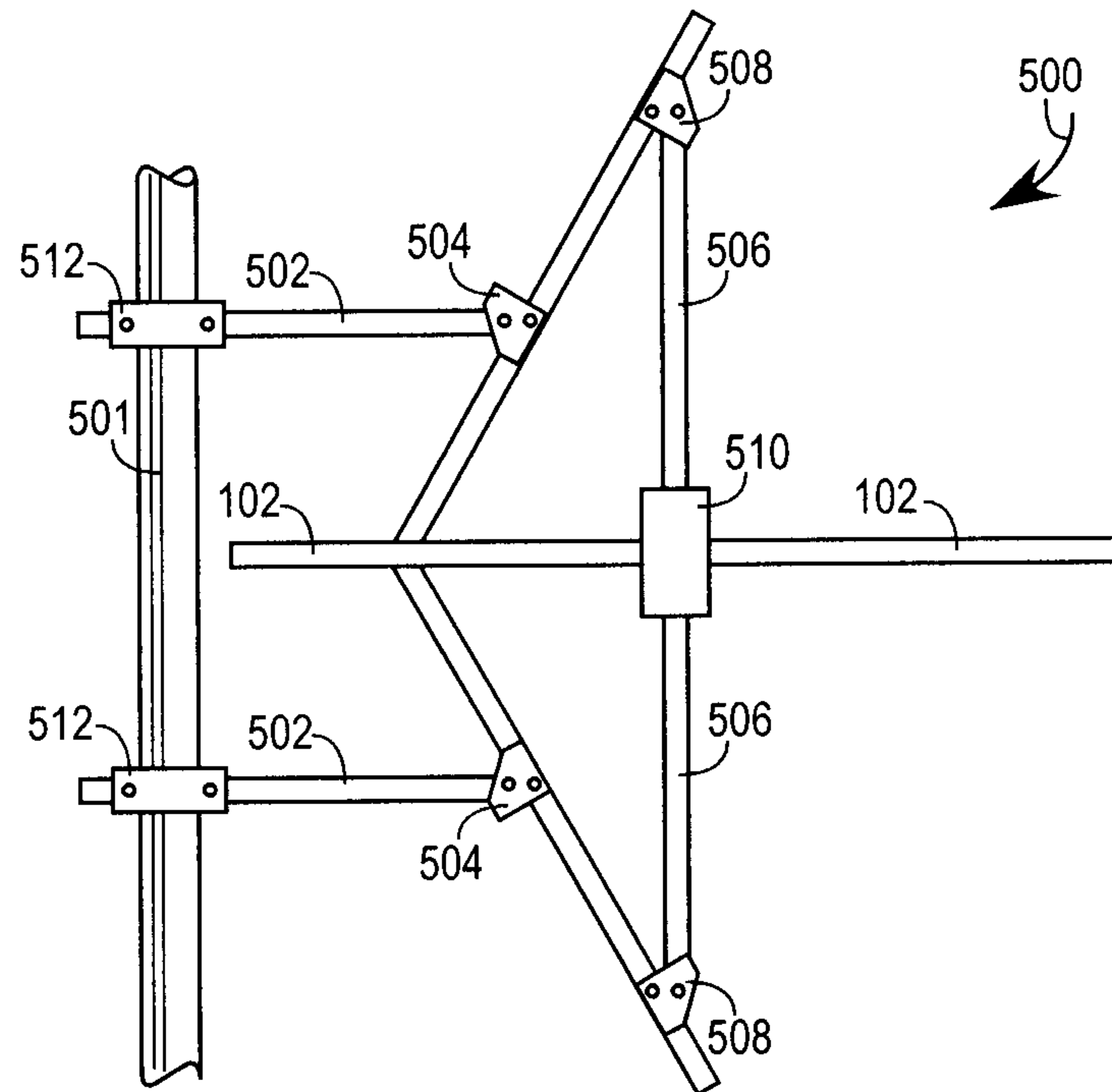
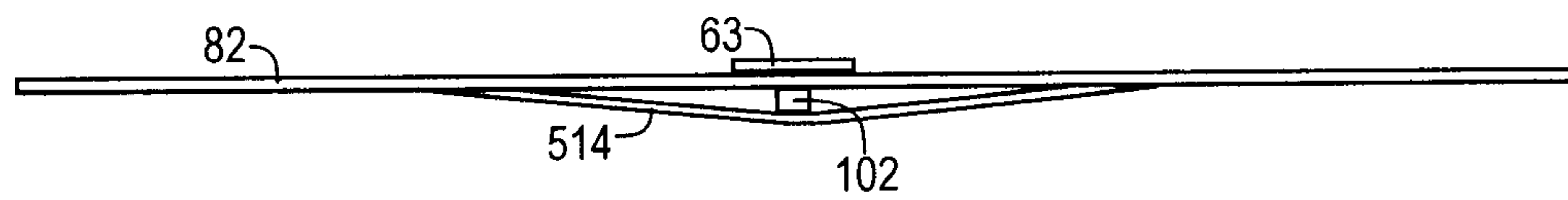
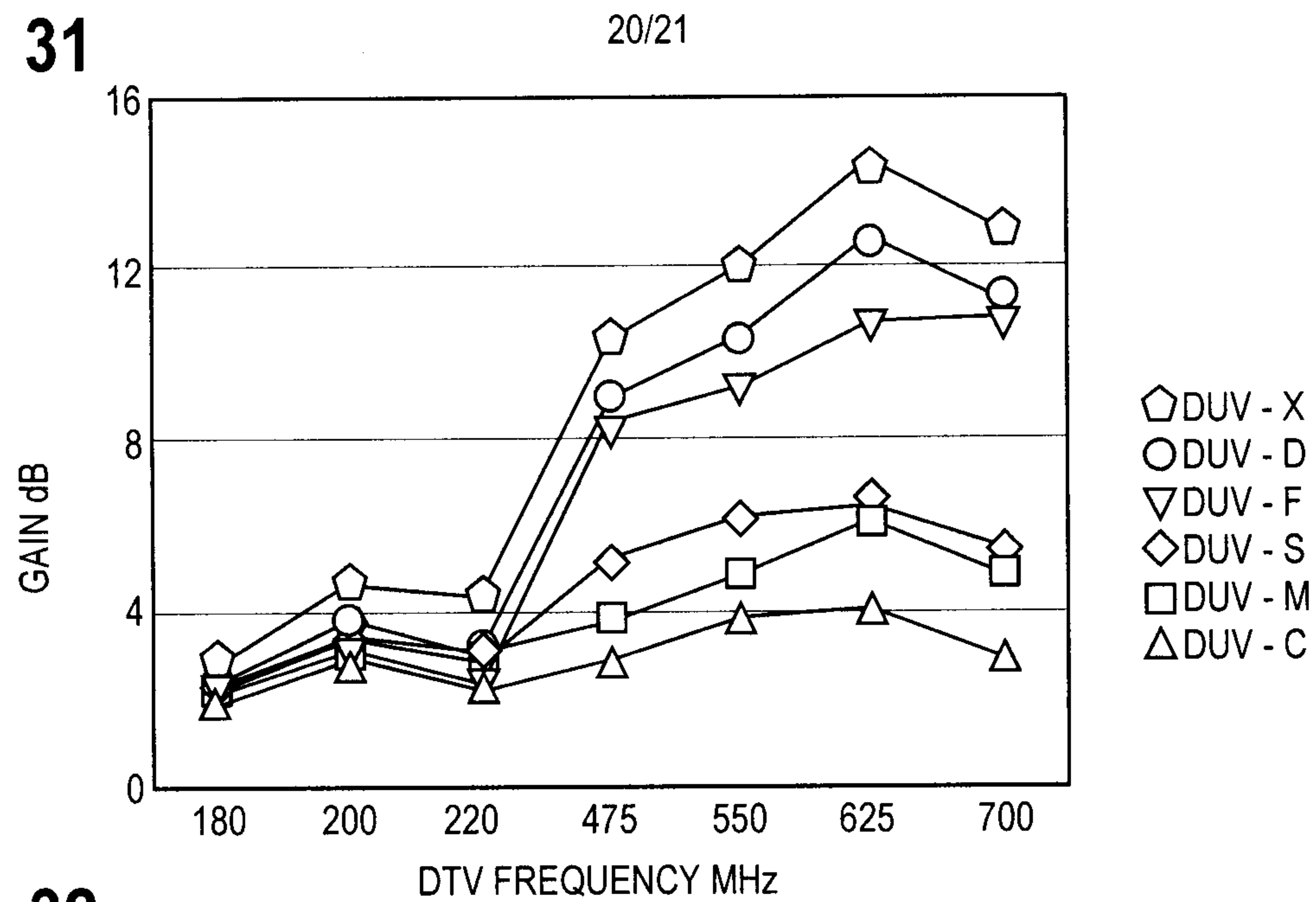
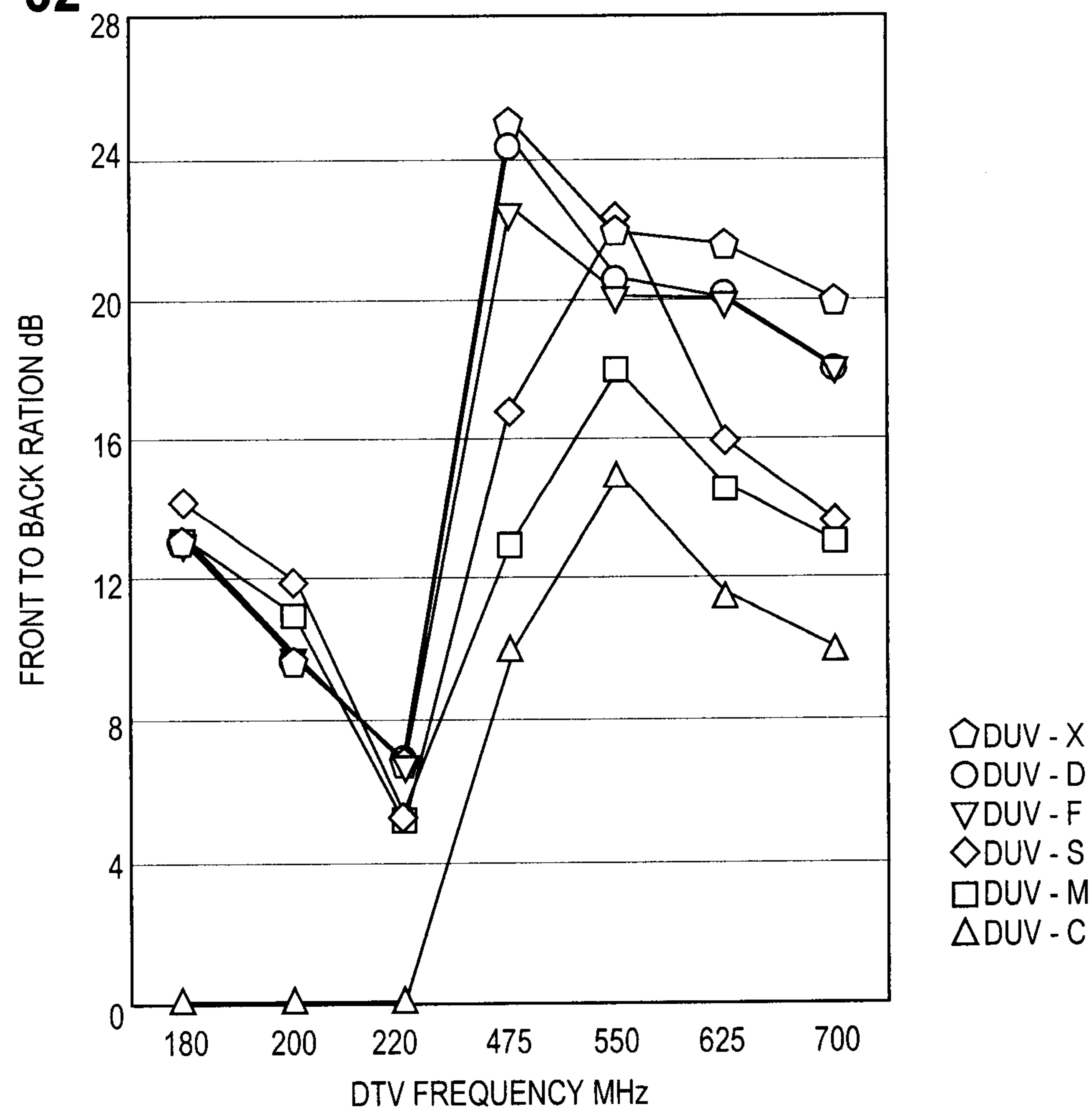
Fig. 29**Fig. 30**

Fig. 31**Fig. 32**

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Fig. 33