**NALSAR PROXIMATE EDUCATION**
**NALSAR UNIVERSITY OF LAW, HYDERABAD**
**P.G.DIPLOMA IN PATENTS LAW**

**2018-19**

**Paper II – Practical**
**(Exploitation of Patents – Drafting, Specification & Patent Writing)**

**Time: 2 ½ hours.** **TOTAL MARKS: 100**

**INSTRUCTIONS TO CANDIDATES**

1. **The question paper to be interpreted as given and no clarification can be sought from the invigilator.**
2. **Attempt only one choice – either A or B**
3. **Answers in illegible handwriting will not be taken into consideration.**

***You are required to draft a complete specification containing; a.) Title of the Patent b.) Background of the Invention c.) Summary of the Invention d.) Claims e.) Abstract of the invention. (Do not write a detailed description or draw figures.)***

***The Claims in the patent draft carries 50 marks and remaining specification carries 50 marks.***

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**Note:**
*The answer guidelines contain some points (non-exhaustive) that could be covered in the answer to the Paper.*

# Option - A

US009775384B2

(12) **United States Patent**
**Harding**

(10) **Patent No.: US 9,775,384 B2**
(45) **Date of Patent: Oct. 3, 2017**

(54) **PAIN RELIEVING VEST OR JACKET**

(71) Applicant: **Marvin Harding**, Middle River, MD (US)

(72) Inventor: **Marvin Harding**, Middle River, MD (US)

( * ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **13/999,262**

(22) Filed: **Feb. 5, 2014**

(65) **Prior Publication Data**

US 2014/0303532 A1 Oct. 9, 2014

**Related U.S. Application Data**

(60) Provisional application No. 61/849,940, filed on Feb. 6, 2013.

(51) **Int. Cl.**
***A41D 1/04*** (2006.01)
***A61F 5/02*** (2006.01)
***A41B 3/02*** (2006.01)

(52) **U.S. Cl.**
CPC .................. ***A41D 1/04*** (2013.01); ***A41B 3/02*** (2013.01); ***A61F 5/026*** (2013.01); *A41D 2400/32* (2013.01); *A41D 2400/38* (2013.01)

(58) **Field of Classification Search**
CPC .. A41D 1/04; A41D 2400/32; A41D 2400/38; A61H 1/008; A41B 3/02; A61F 5/026
See application file for complete search history.

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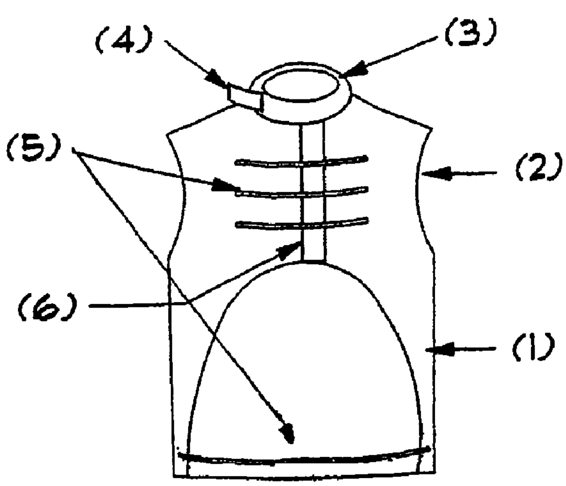
(Continued)

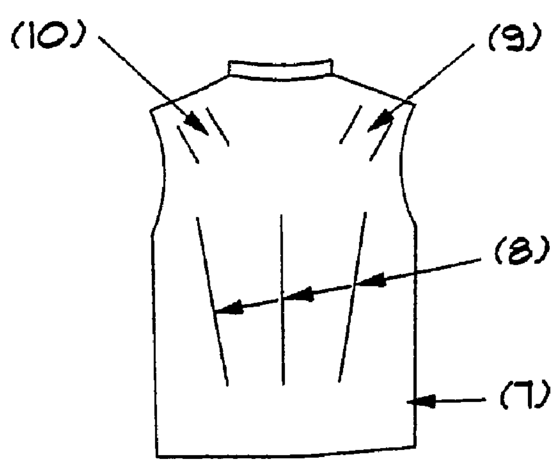
*Primary Examiner* — Sally Haden

(57) **ABSTRACT**

A pain relieving vest or jacket is an apparatus made of fabric segments having differing material properties comprising of a plurality of longitudinal waves forming a fabric design arranged to provide the vest or jacket with regions of differential compression that applies pressure or support to the neck, shoulder area, chest, sides of the body and back, area to alleviate or prevent pain. With the jacket the arm region is also included. It helps to reduce, alleviate, and the prevention of pain in the neck, shoulder area, chest, sides of the body and back area. The garment has 2 linear strips with hook and loop fastener attachments in the chest area to control and adjust compression. It can be made with or without string or strap attachments in the chest area for additional support to the shoulder area, chest, sides of the body and string or strap attachments for lower back compression. Also the vest does not cover the abdominal area for comfort and convenience to the individual user while wearing the vest.

**3 Claims, 1 Drawing Sheet**



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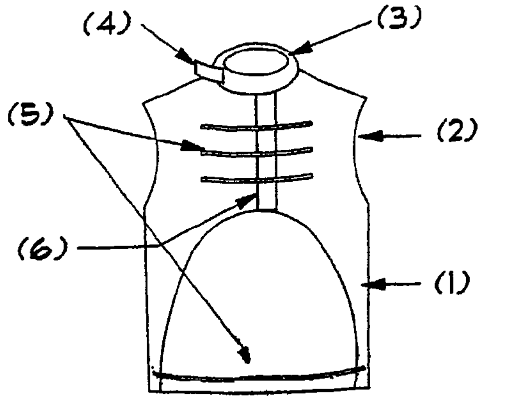



FIG. 1

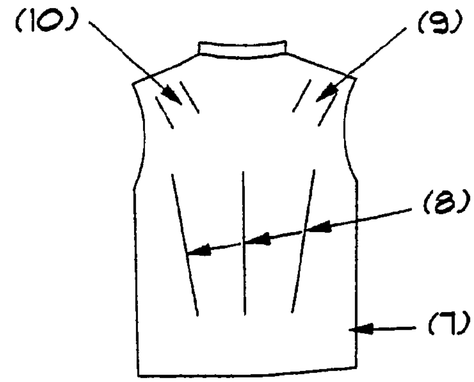



FIG. 2

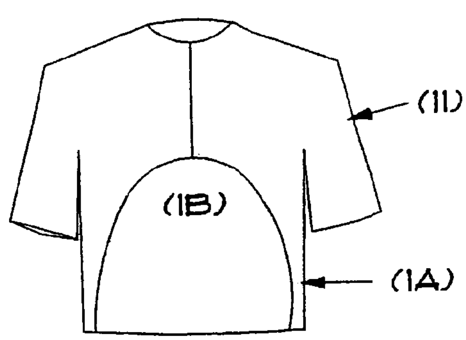



FIG. 3

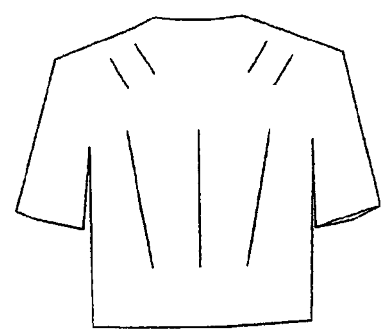


FIG. 4

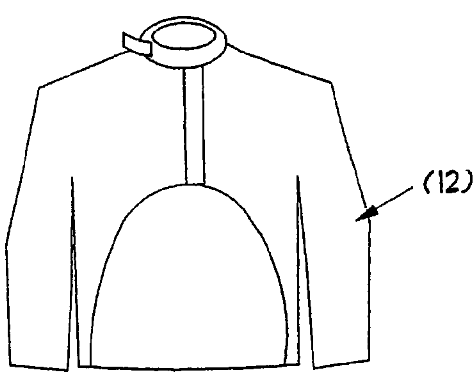



FIG. 5

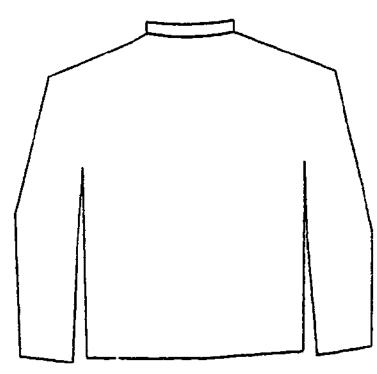


FIG. 6

# PAIN RELIEVING VEST OR JACKET

## CROSS-REFERENCE TO RELATED APPLICATION

This application claims the benefits of provisional patent Application No. 61/849,940, filed Feb. 6, 2013

## BACKGROUND OF INVENTION

### Description of Related Art

There are many devices for the back, shoulder area, chest, and neck pains. Most of these devices are for treatment to specific areas. Examples are back braces, neck braces, and support braces for the shoulder and chest areas. Also there are compression garments.

A neck or back brace is worn for problems that occurred from staying on a computer an extended period of time, sports injuries, car accidents, and other ways that's cause neck problems. And support braces for the shoulder and chest areas are worn for the same type of injuries listed above.

Compression garments which are pieces of clothing are available for specific areas also. FOR EXAMPLE these garments are used to alleviate pain in the neck, chest, back, shoulders, elbow, wrist, and finger pain that have occurred while using a computer possibly, sports injury, car accidents, and other ways that cause pain in those areas.

U.S. Pat. No. 7,901,371 is a posture correcting back brace device for promoting proper posture in the user wearing the device. The device properly corrects the user's posture when he or she is slouching shoulder's forward, and is discrete and comfortable to wear. Two sides of the back plate of the invention are mutually rotatable along a vertical edge which includes a pivot means comprised of a hinge or other device. The back plate further includes a spring means for biasing each side of the back plate away from the user. A pair of shoulder pads each contacts the front side of one of the user's shoulders. The spring means urges each shoulder pad rearward while urging the pivot means of the back plate forward. When the user wearing the invention slouches, the shoulder pads in the invention urge the user's shoulders backwards, thereby correcting the user's posture.

U.S. Pat. No. 4,215,687 relates to body or limb encircling therapeutic devices, and more particularly to a combination of cooperating elements which may be made available preassembled or in kits and utilized to construct such body or limb encircling therapeutic devices on persons suffering from disorders such as lymphedema, phlebitis, varicose veins, post-fracture and injury edema, stasis ulcers, obesity, and circulatory disorders requiring treatment by wearing such therapeutic devices which apply a compressive force on or support of the body or limbs.

U.S. Pat. No. 5,653,244 relates to a therapeutic garment for which is the same principal or type of treatment as present invention. However it is used for leg, ankle, and feet. The garment is made from a flexible, foldable, light weight hook and look type fabric which, due to its inherent characteristics, can be prefabricated in different sizes and need not be custom-made for the wearer. U.S. Pat. No. 6,409,694 is a ventilated neck brace that provides support to the wearer's neck while providing improved ventilation and breathability. Most embodiments of the neck brace are comprised of an elongate member that defines a neck support, a transition section and an elongate shoulder rest. Most configurations of the neck brace allow the wearer to adjust the width and length of the neck brace.

The advantages of my invention is that it will be able to treat the pain or discomfort areas without having to wear two or more different devices. It will treat the back (upper to mid extremities), shoulder area, chest, sides of the body and neck, plus upper and lower arm areas (optional). It can be a vest or a jacket, long or short sleeve, and not only be adjustable by 2 linear fabric strips with hook and loop fastener lining attachment but with polyester string cord or straps that loops or hooks to lock garment in place to make it more efficient for the individual user. Also just as important, it will not bring discomfort to the abdominal area while wearing it, unlike some or maybe most back support devices/compression garments on the market today because the abdominal area is not covered when wearing my garment design.

## SUMMARY OF INVENTION

The Pain Relieving Vest or Jacket is a unique invention.

The vest can be worn which will be able to alleviate pain in the neck, shoulder areas, chest, sides of the body, and back area.

The jacket can be worn which will be able to alleviate pain in the neck, shoulder areas, chest, sides of the body, and back area, along with the arm region.

For the pain relieving vest or jacket there is 2 linear strips with hook and loop fastener attachments in the chest area to control and adjust compression in the areas being treated by the garment to the comfort of the individual user. (Neck or collar attachment with hook and loop fastener is optional). Areas of treatment are the shoulders, chest, sides of the body and back (including the trapezius, levator scapulae, infraspinatus, serratus anterior muscle, serratus posterior superior muscle, rhomboid major muscle, teres minor and major muscles, thoracolumbar fascia, and latissimus dorsi muscles). Also the arm region when wearing the jacket. The vest or jacket can be made with or without foam padding, with or without pliable metal stay or sheets in the lower back of the vest. THE GARMENT CAN BE MADE WITH A POLYESTER STRING CORDS OR STRAPS THAT LOOPS OR HOOKS to hold garment in place so garment can apply compression along with OR without the linear strips with hook and loop fastener lining attachment in chest area.

Compression garments are often made of spandex type of material. For example, spandex/polyester, spandex/nylon. Also compression garments can be made of polyester/cotton, nylon/cotton, cotton/bamboo fiber, a therapeutic copper technology, there are many types of material to make the invention. A method of making a compression garment includes combining yarn and/or fibers to form a continuous web that includes plurality of circumferential band regions of differential compression arranged in a predetermined pattern or longitudinal waves corresponding to regions of a user's body. The method also includes forming one or more regions of pile or raised fibers in one or more of the band regions, but not limited to this type of material.

Another method of making a compression garment features combining a plurality of fabrics segments having differing elastic properties to form a compression garment having regions of differential compression, and forming one or more regions of pile or raised fibers in one or more of the fabric segments, but not limited to just this material.

Garments can be also made from a material called Breath-O-Prene™ used for back braces, knee braces, etc. This material helps deliver oxygen back to the skin surface.

AGAIN COMPRESSION GARMENTS CAN BE MADE FROM THE METHODS LISTED ABOVE, BUT NOT LIMITED TO THOSE METHODS DUE TO DIFFERENT AND NEW INNOVATIVE TECHNOLOGIES BEING DEVELOPED AND USED.

Also pliable metal stay or sheets MAY be used just like in back support devices on the market. Also optional, pliable metal stay/sheets or with/without foam padding at the bottom of vest or jacket.

The Garment should be made from a comfortable and flexible material.

The garments should be latex-free if possible for machine washing.

The invention can be made in different colors for consumers to choose from.

Also different size options available for men and women. And the options for kids sizes.

## OTHER REFERENCES

http://en.wikipedia.org/wiki/Compression_garment
http://en.wikipedia.org/wiki/Back_brace
http://en.wikipedia.org/wiki/Neck_brace

## DRAWING FIGURES

FIG. **1**. Shows vest frontal view/RIGHT side of invention with 2 linear strips with hook and loop fastener lining starting from lower mid chest area up to collar area, with collar along with a 2 linear strip, hook and loop fastener attachment with foam insulation (optional). Included are 3 polyester string attachments or straps across the chest area. Also vest is shaped from bottom lower right and left sides of body frame, curved lining around the stomach up to beginning of chest area above abdominal area.

FIG. **2**. Shows vest back view of invention

FIG. **3**. Shows jacket with frontal view/LEFT side without collar and attachment. Also shows opposite side as it would be under attachment in FIG. **1** of invention with short sleeves made of a compression material.

FIG. **4**. Shows jacket with back view of invention with short sleeves without a collar, including pliable metal stay or sheets (optional).

FIG. **5**. Shows jacket frontal view of invention with long sleeves and collar with 2 linear strips with hook and loop fastener attachments lining starting from the lower chest area up to collar. Also collar with a 2 linear strip, hook and loop fastener attachment with foam insulation (optional).

FIG. **6**. Shows jacket back view of invention with long sleeves.

## DRAWING REFERENCES

**1**. VEST FRONTAL VIEW/RIGHT SIDE
**1** A. VEST FRONTAL VIEW/LEFT SIDE
**1**B. FRONTAL VIEW OF LINING GOING AROUND THE ABDOMINAL AREA FROM LOWER LEFT TO RIGHT SIDES.
**2**. No sleeves
**3**. Collar
**4**. Adjustable 2 linear strips with hook and loop fastener for collar attachment.
**5**. Locking polyester 3 string or strap attachments across the chest (Optional).
**6**. Adjustable 2 linear strips with hook and loop fastener attachment Lining in chest area.
**7**. VEST BACK VIEW
**8**. Pliable metal stay or sheets (optional), 8 inches long×½ or so inches wide in lower to midsection of back or vertebrae.
**9**. Right shoulder area pliable metal stay or sheets (optional) 2 or more inches long×½ inches wide in back of vest.
**10**. Left shoulder area pliable metal stay or sheets (optional) 2 or more inches long×½ inches wide in back of vest.
**11**. Short sleeves
**12**. long Sleeves

## DESCRIPTION OF INVENTION

FIG. **1** Shows what the vest looks like from the front. It has 2 linear strips with hook and loop fastener lining up at the beginning of the lower chest area above the abdominal area up to the neck area to adjust to the user's comfort to compress any pain or discomfort in the upper to mid back, along with pain or discomfort in the shoulder, chest, and sides of the body areas. Also there are durable string cord or strap attachments (optional, for example made from polyester) to lock the garment in place for the convenience and comfort of the individual user. Also (optional) there is a collar for neck pains and 2 linear strips with hook and loop fastener attachment to compress that area for pain relief. (((The vest is shaped to go from the lower right and left sides of body frame up to the lower chest and around the abdominal area. THE ABDOMINAL AREA WHEN COMPRESSED CAN BE DISCOMFORTABLE WHILE SITTING, ESPECIALLY AFTER EATING.)))

FIG. **2** Shows what the vest looks like from the back. Within the lower to upper area of the back there are just for illustration 3 pliable metal stay or sheets for the back area for support and 2 pliable metal stay or sheets on the left and right side of the shoulder area for support.

Jackets can be long sleeve or short sleeve depending on the individual choice. Sizes will vary from small, medium, to large and if necessary small for kids and extra large for individuals who require extra large size.

Operation or How Invention Works

The way the Pain Relieving Vest or Jacket works is when either is put on, there is 2 linear strips with hook and loop fastener lining in the front of the chest area for attachment and adjustable to the comfort of the individual user for compression desired. Also there can be a durable string or strap attachments (optional) for attachment and adjustable for the convenience and comfort of the user. The collar (OPTIONAL) with foam insulation along with 2 linear strips with hook and loop fastener attachment to adjust compression in the neck area to the comfort of the individual user if needed. With the jacket it can be long or short sleeves. For long or short sleeves the compression will come from strong, breathable and lightweight compression fabric that feels good to the skin.

The invention claimed is:

**1**. A compression garment for use by a human user comprising:

a fabric portion having a neck opening and a waist opening, said neck opening adapted to allow a neck of the user to protrude from said fabric portion,

said fabric portion having a front adapted to cover a chest of the user, and a back adapted to cover an upper back, shoulders, and a lower back of the user,

said front having a substantially parabolic opening extending from said waist opening, said substantially parabolic opening terminating at said waist opening and adapted to leave an abdomen of the user uncovered by said front, said substantially parabolic opening having a vertex adapted to be positioned near a sternum of the user, said substantially parabolic opening having a width at said vertex and a width at said waist opening, where said width at said waist opening is greater than said width at said vertex,

said front having a vertical opening extending from said neck opening to said vertex, said vertical opening dividing said front into a front left and a front right, said vertical opening having hook and loop fasteners adapted to close selectively attach said front right to said front left and said hook and loop fasteners adapted to selectively open and close said vertical opening,

said front having a plurality of parallel horizontal strings extending over said vertical opening on said front from said front left to said front right,

said back having a plurality of stays,

said plurality of stays including a plurality of shoulder stays adapted to be positioned from a scapula of the user to a collar bone of the user, and a plurality of lower back stays extending substantially vertically and adapted to be positioned on the lower back of the user to support the lower back of the user,

said compression garment being adapted to provide effective therapeutic compression,

said compression garment being adapted to provide compressive force to the shoulders, the chest, sides, the upper back and the lower back of the user.

**2**. The compression garment according to claim **1**, wherein said compression garment is a jacket with sleeves.

**3**. The compression garment according to claim **1** wherein said compression garment is a sleeveless vest.

* * * * *

Option - B

US 20160378108A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2016/0378108 A1**

**Paczan et al.** (43) **Pub. Date: Dec. 29, 2016**

(54) **COLLECTIVE UNMANNED AERIAL VEHICLE CONFIGURATIONS**

(71) Applicant: **Amazon Technologies, Inc.**, Seattle, WA (US)

(72) Inventors: **Nathan Michael Paczan**, Seattle, WA (US); **Michael John Elzinga**, Woodinville, WA (US); **Raphael Hsieh**, Seattle, WA (US); **Luan Khai Nguyen**, Seattle, WA (US)

(21) Appl. No.: **14/626,376**

(22) Filed: **Feb. 19, 2015**

**Publication Classification**

(51) **Int. Cl.**

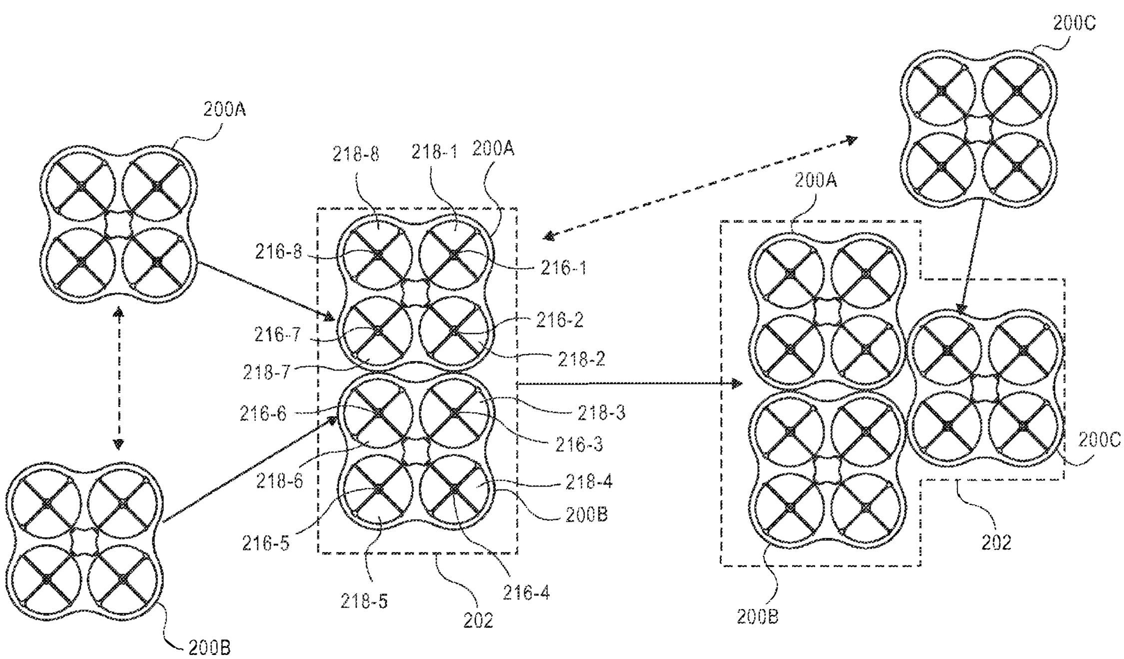
| | |
|---|---|
| ***G05D 1/00*** | (2006.01) |
| ***G06Q 10/08*** | (2006.01) |
| ***B64C 37/02*** | (2006.01) |
| ***B64C 39/02*** | (2006.01) |
| ***B64D 31/06*** | (2006.01) |

(52) **U.S. Cl.**

CPC ........... ***G05D 1/0027*** (2013.01); ***B64C 39/024*** (2013.01); ***B64D 31/06*** (2013.01); ***B64C 37/02*** (2013.01); ***G06Q 10/083*** (2013.01); *B64C 2201/128* (2013.01); *B64C 2201/108* (2013.01)

(57) **ABSTRACT**

This disclosure describes a collective UAV in which multiple UAVs may be coupled together to form the collective UAV. A collective UAV may be used to aerially transport virtually any size, weight or quantity of items, travel longer distances, etc. For example, rather than using one large UAV to carry a larger or heavier item, multiple smaller UAVs may couple together to form a collective UAV that is used to carry the larger or heavier item.



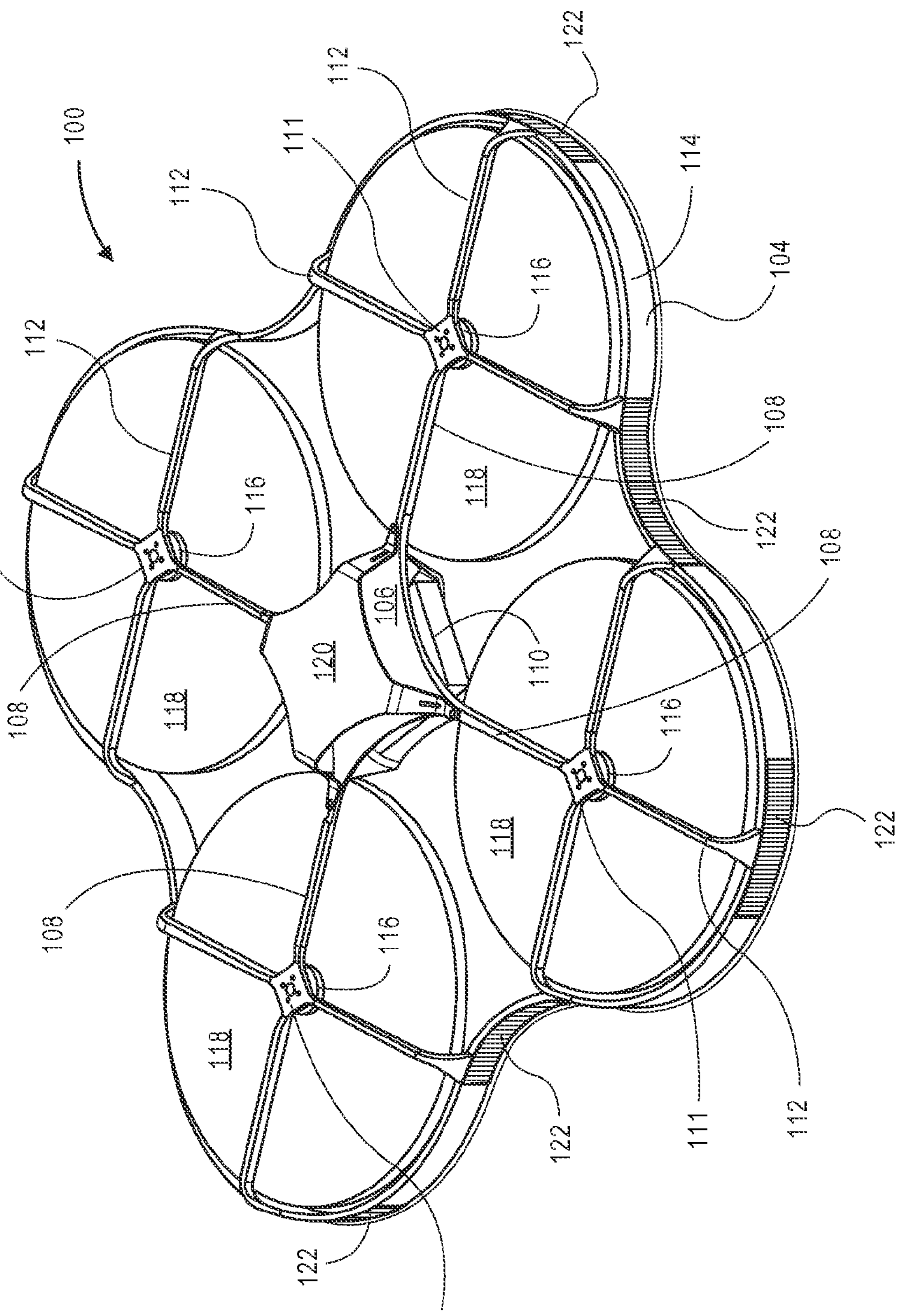

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FIG. 1

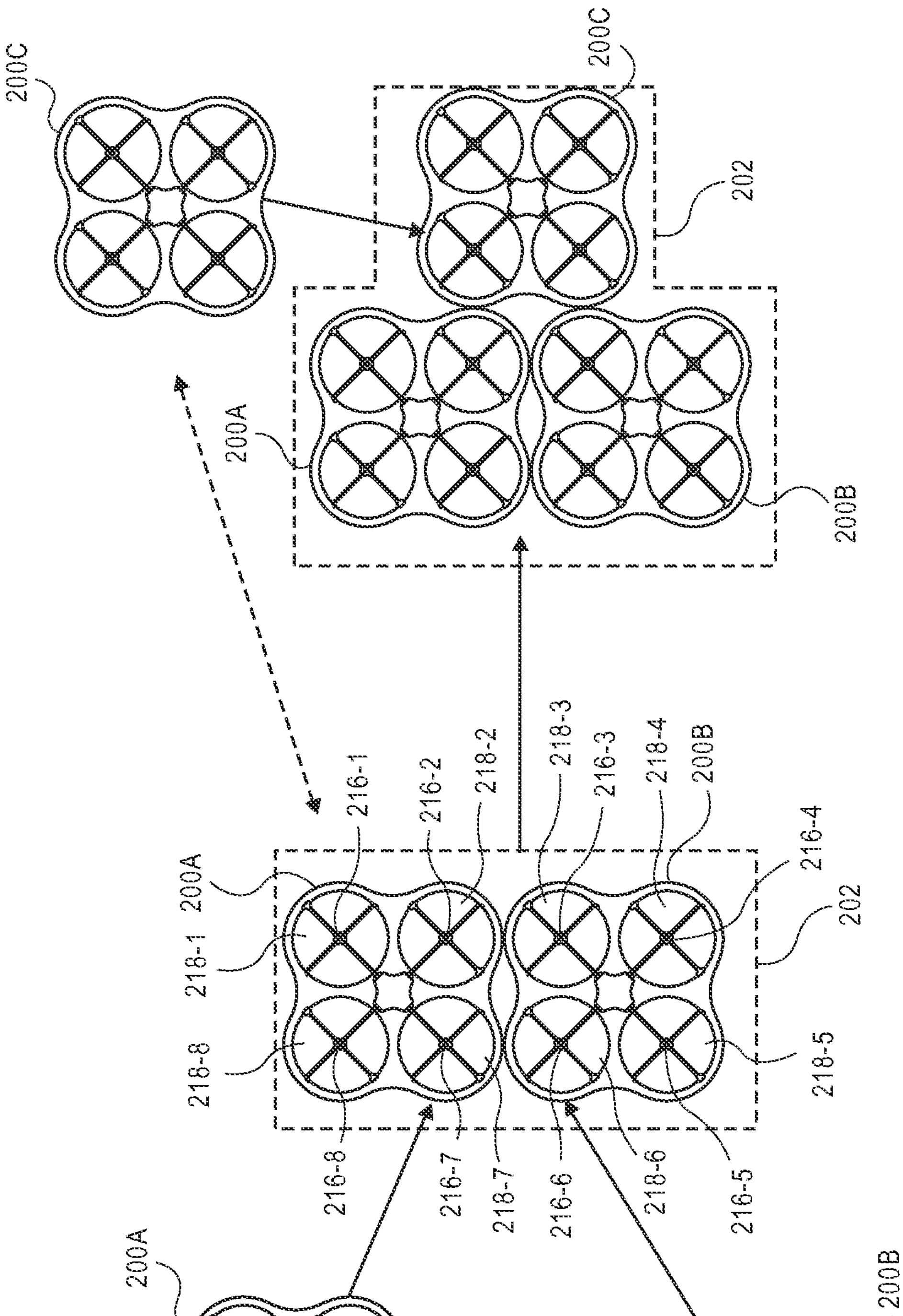
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FIG. 2

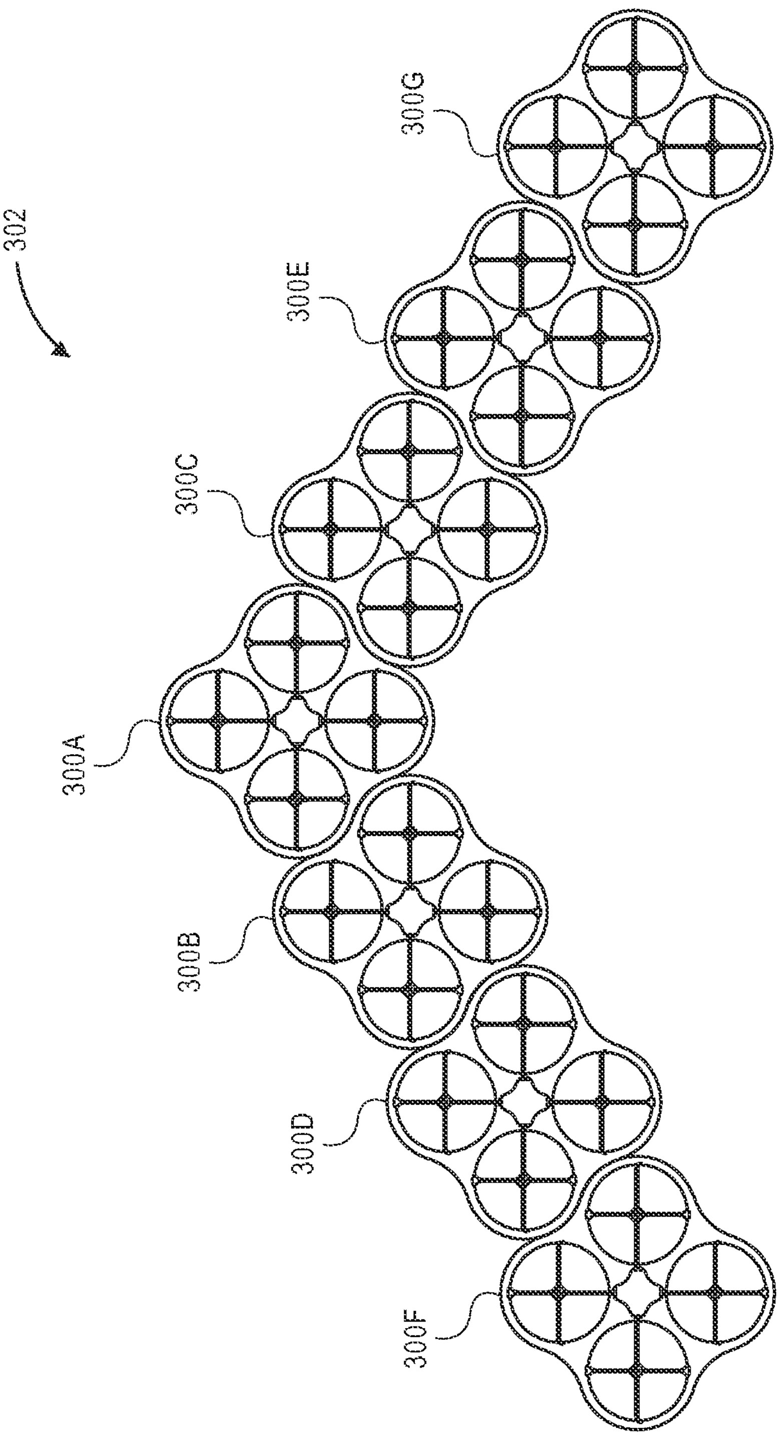


FIG. 3

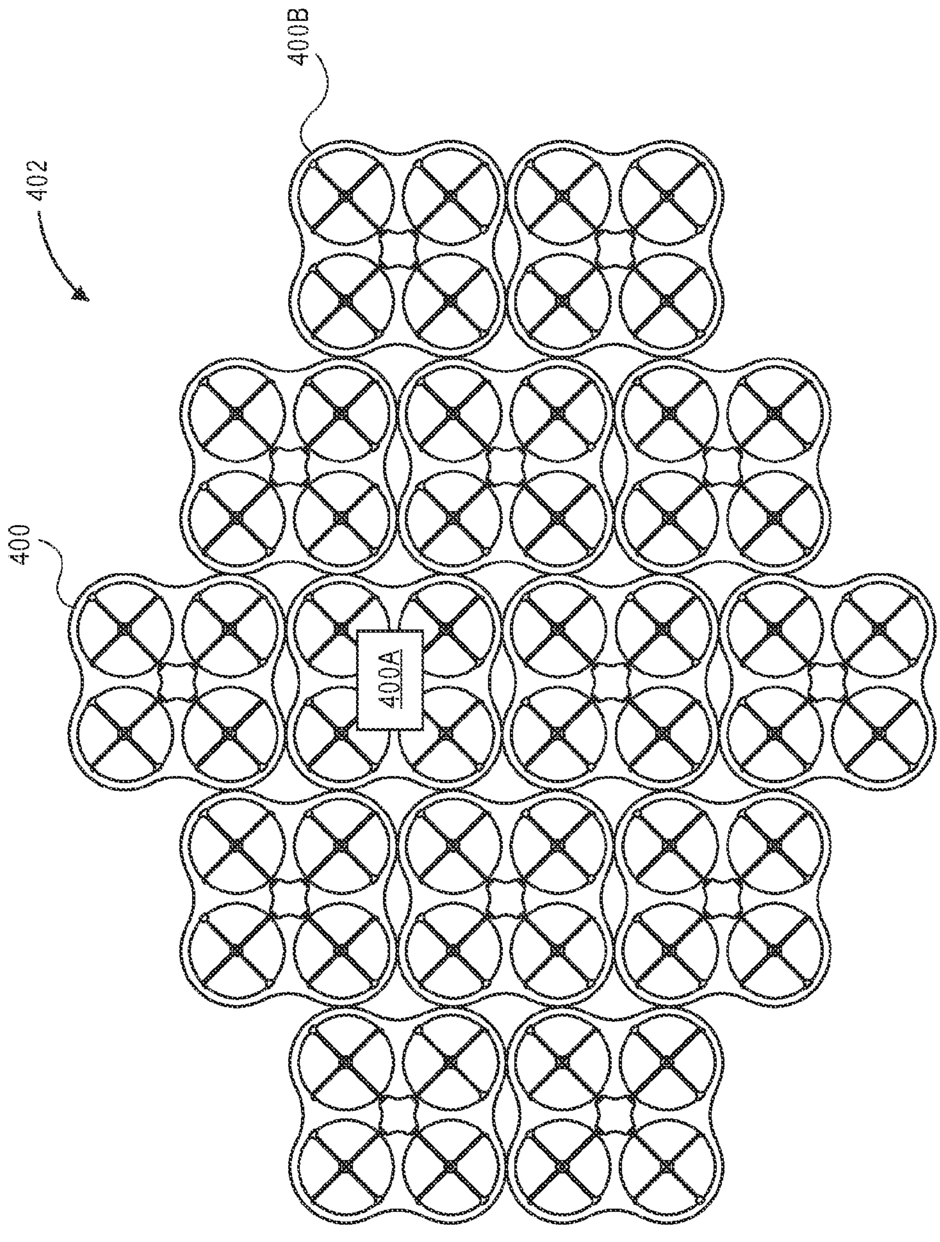


FIG. 4

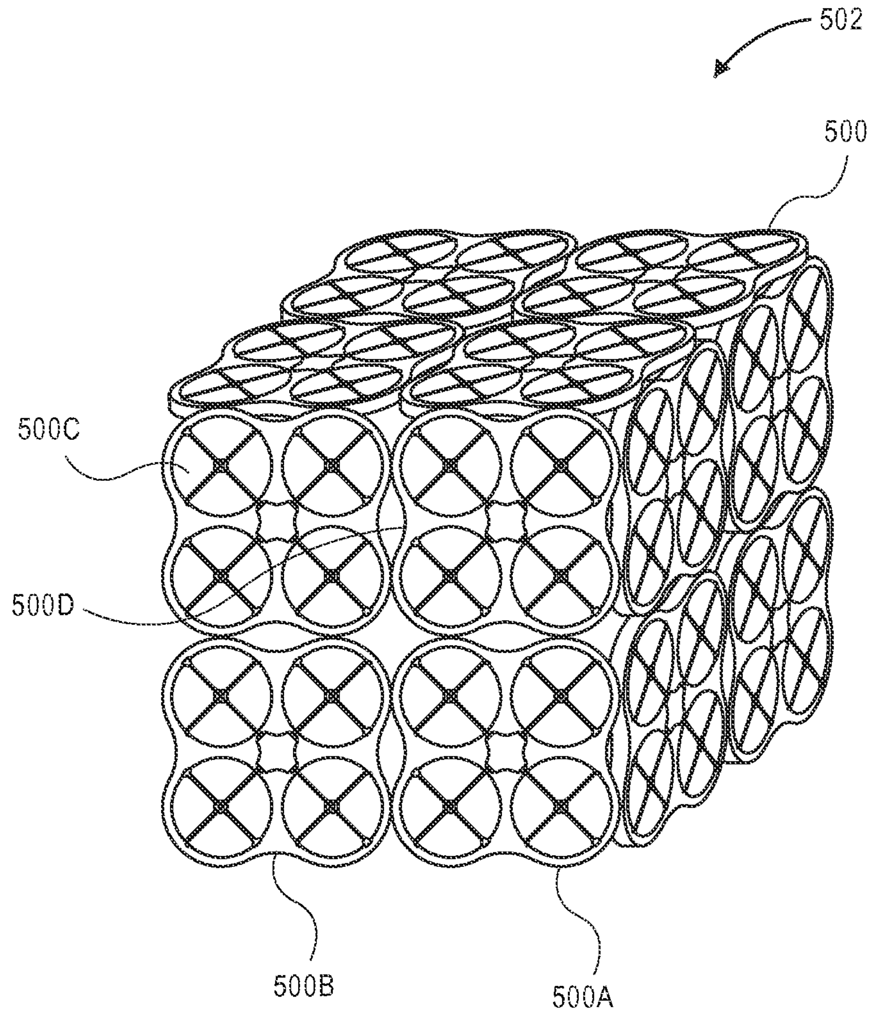


FIG. 5

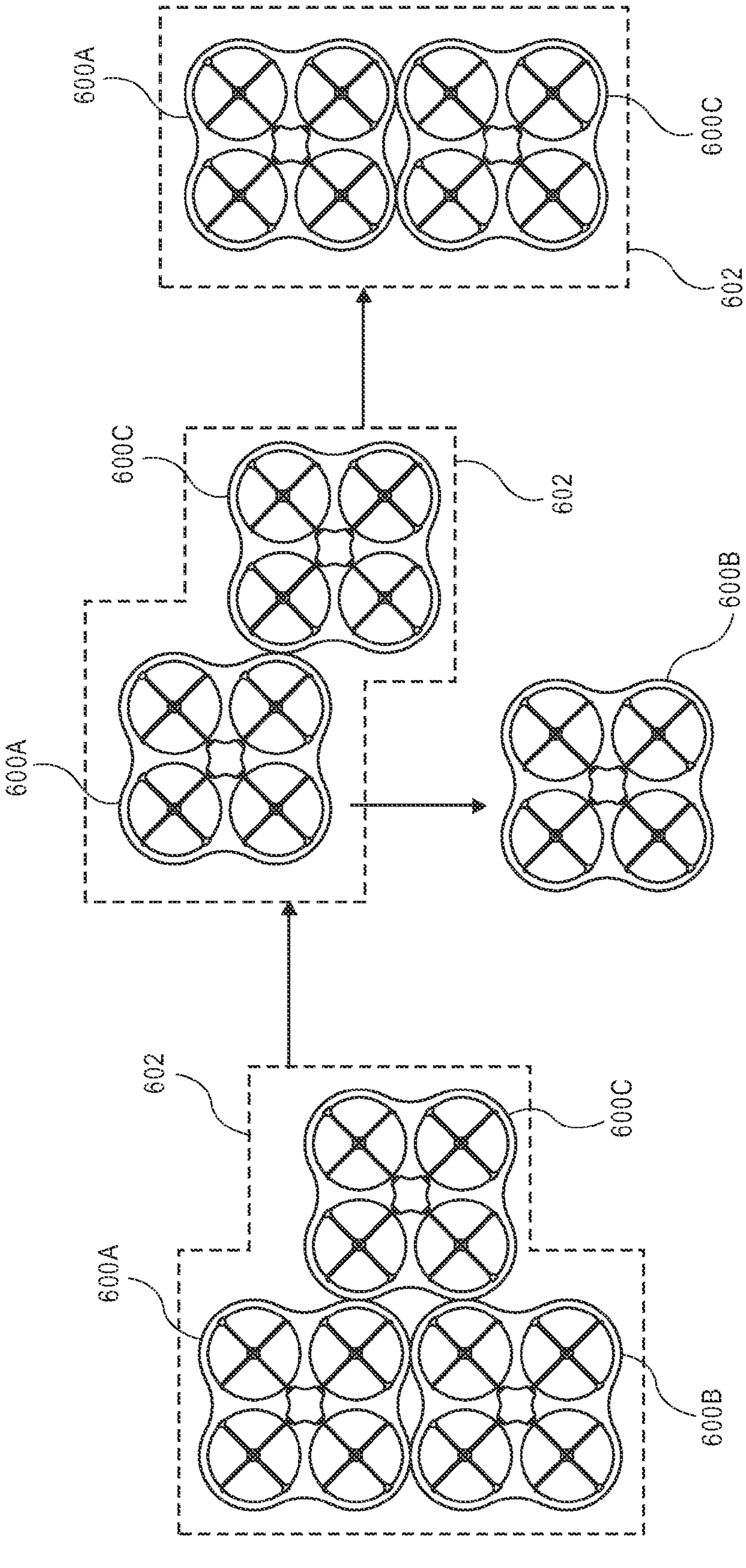


FIG. 6

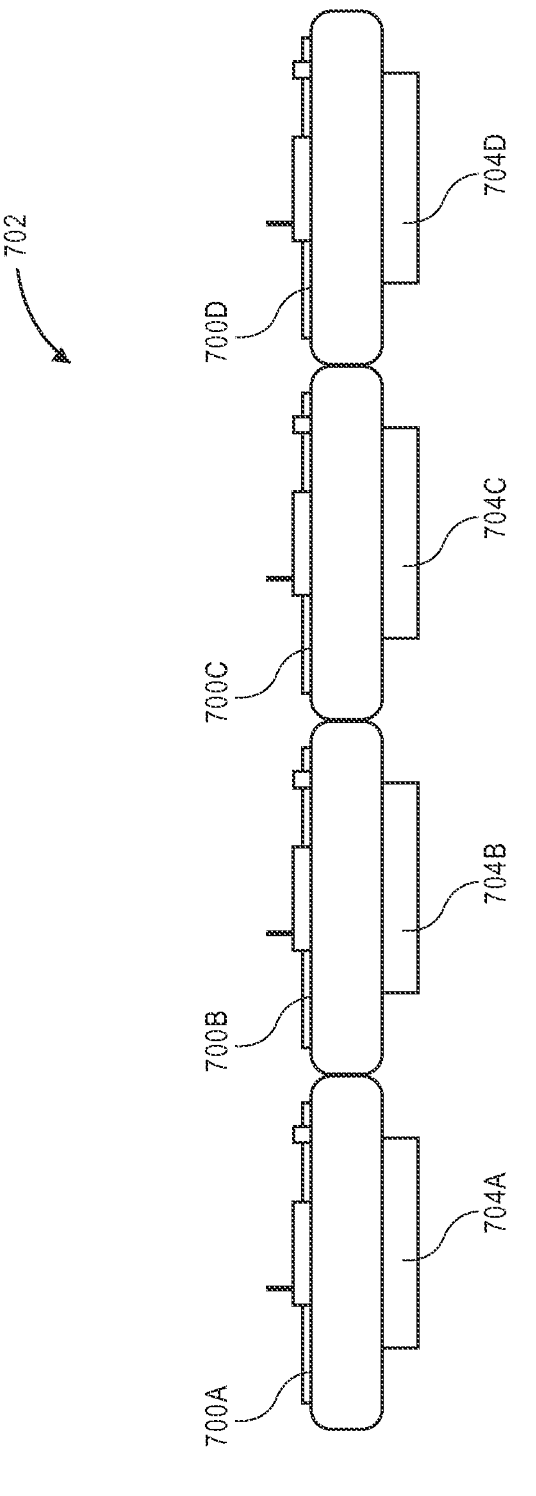


FIG. 7

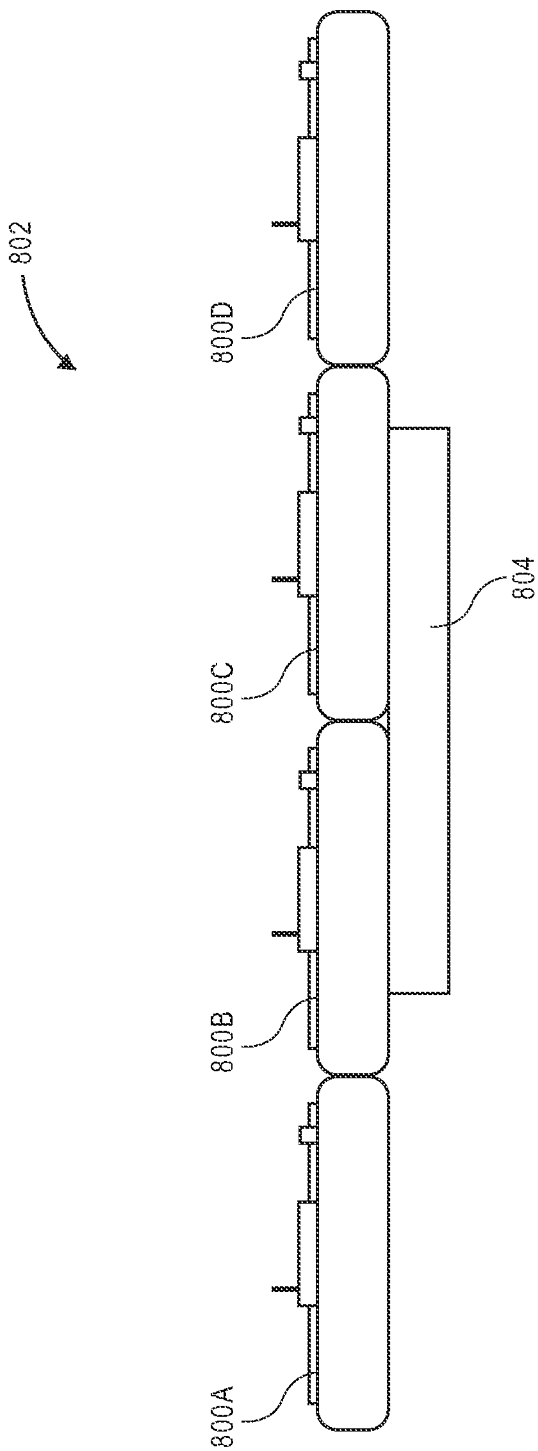


FIG. 8

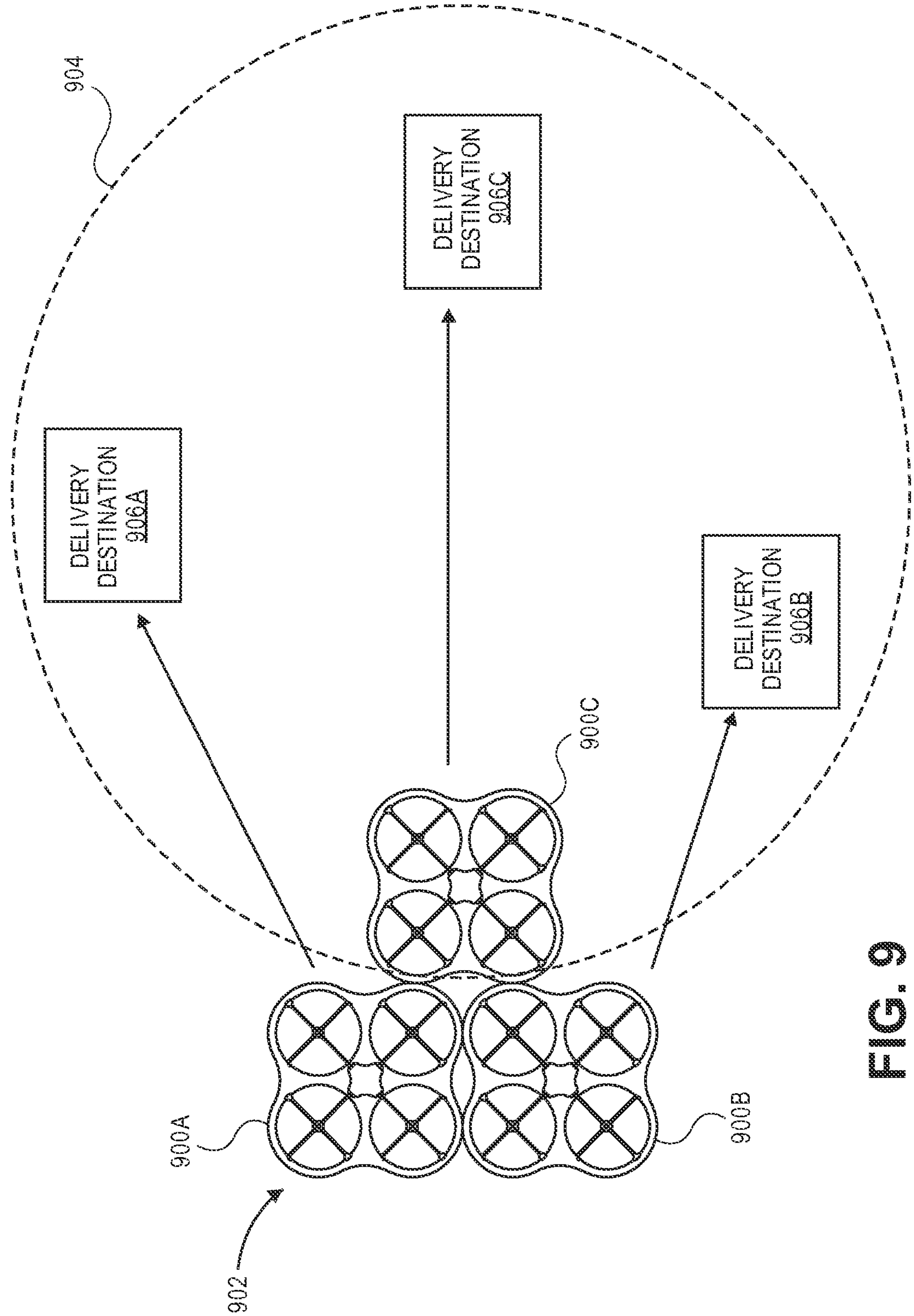
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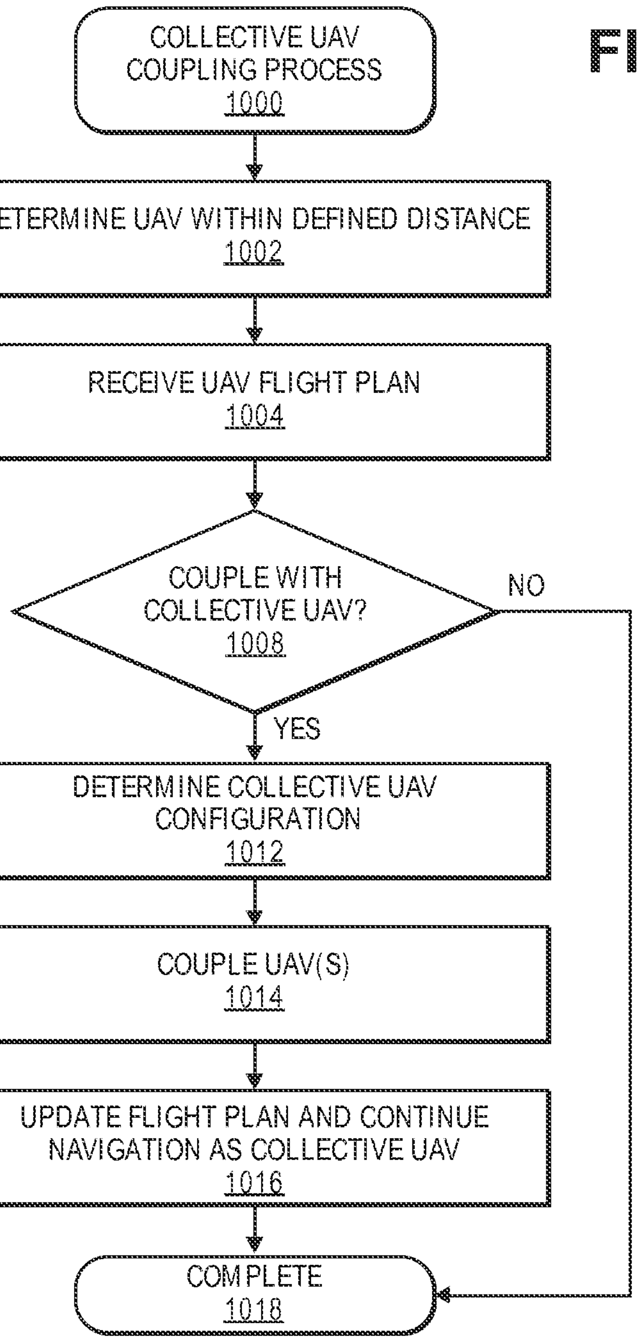
FIG. 9

FIG. 10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COUPLE WITH
COLLECTIVE UAV?
1008
NO
YES
DETERMINE COLLECTIVE UAV
CONFIGURATION
1012
COUPLE UAV(S)
1014
UPDATE FLIGHT PLAN AND CONTINUE
NAVIGATION AS COLLECTIVE UAV
1016
COMPLETE
1018

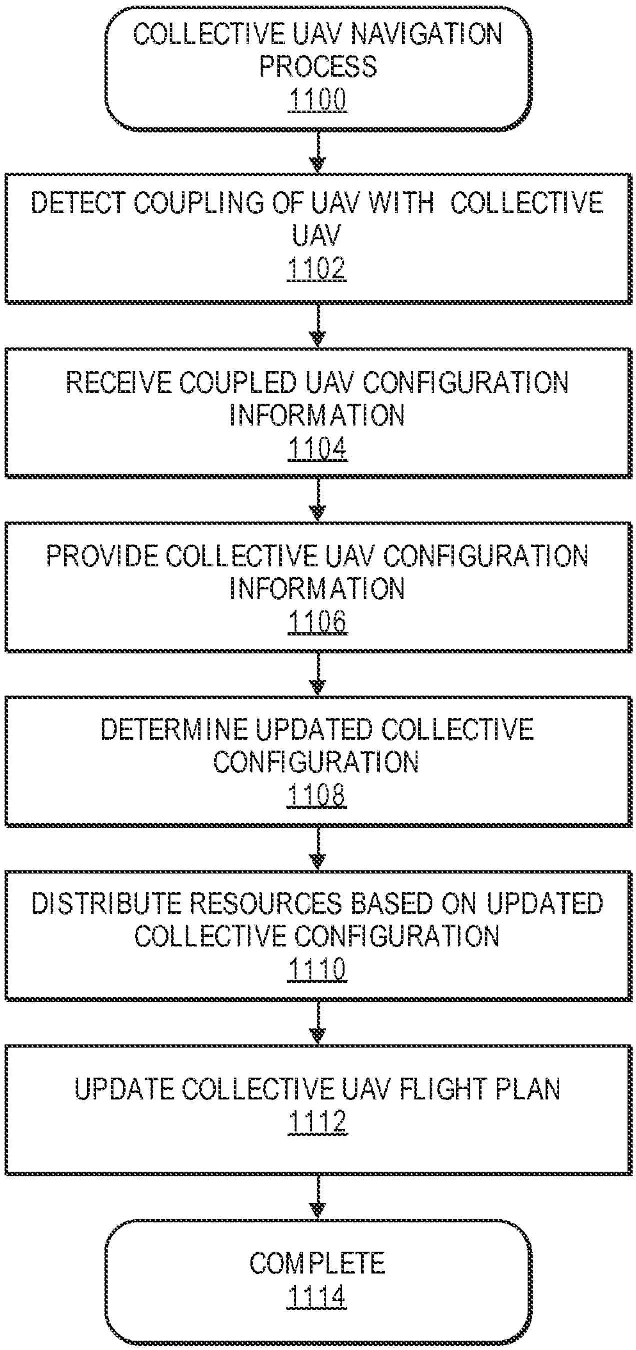
COLLECTIVE UAV NAVIGATION PROCESS
1100
DETECT COUPLING OF UAV WITH COLLECTIVE UAV
1102
RECEIVE COUPLED UAV CONFIGURATION INFORMATION
1104
PROVIDE COLLECTIVE UAV CONFIGURATION INFORMATION
1106
DETERMINE UPDATED COLLECTIVE CONFIGURATION
1108
DISTRIBUTE RESOURCES BASED ON UPDATED COLLECTIVE CONFIGURATION
1110
UPDATE COLLECTIVE UAV FLIGHT PLAN
1112
COMPLETE
1114

FIG. 11

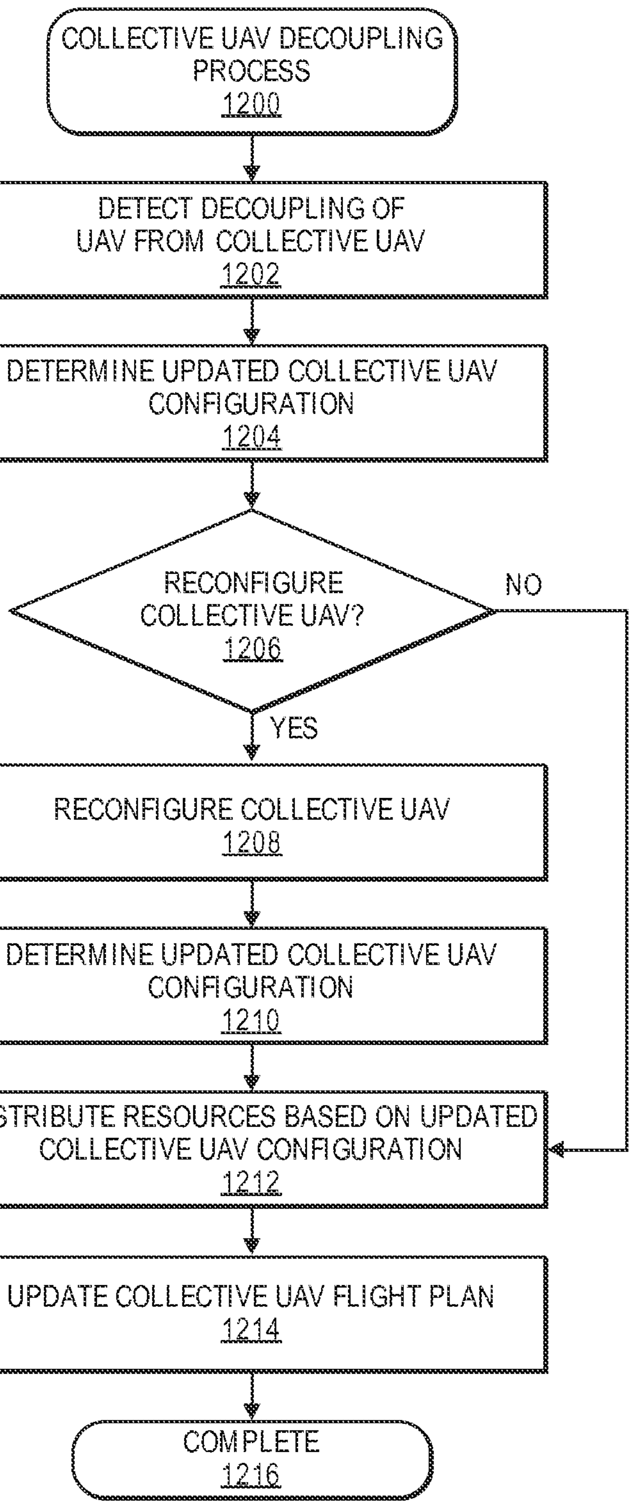
COLLECTIVE UAV DECOUPLING PROCESS
1200
DETECT DECOUPLING OF UAV FROM COLLECTIVE UAV
1202
DETERMINE UPDATED COLLECTIVE UAV CONFIGURATION
1204
RECONFIGURE COLLECTIVE UAV?
1206
NO
YES
RECONFIGURE COLLECTIVE UAV
1208
DETERMINE UPDATED COLLECTIVE UAV CONFIGURATION
1210
DISTRIBUTE RESOURCES BASED ON UPDATED COLLECTIVE UAV CONFIGURATION
1212
UPDATE COLLECTIVE UAV FLIGHT PLAN
1214
COMPLETE
1216

FIG. 12

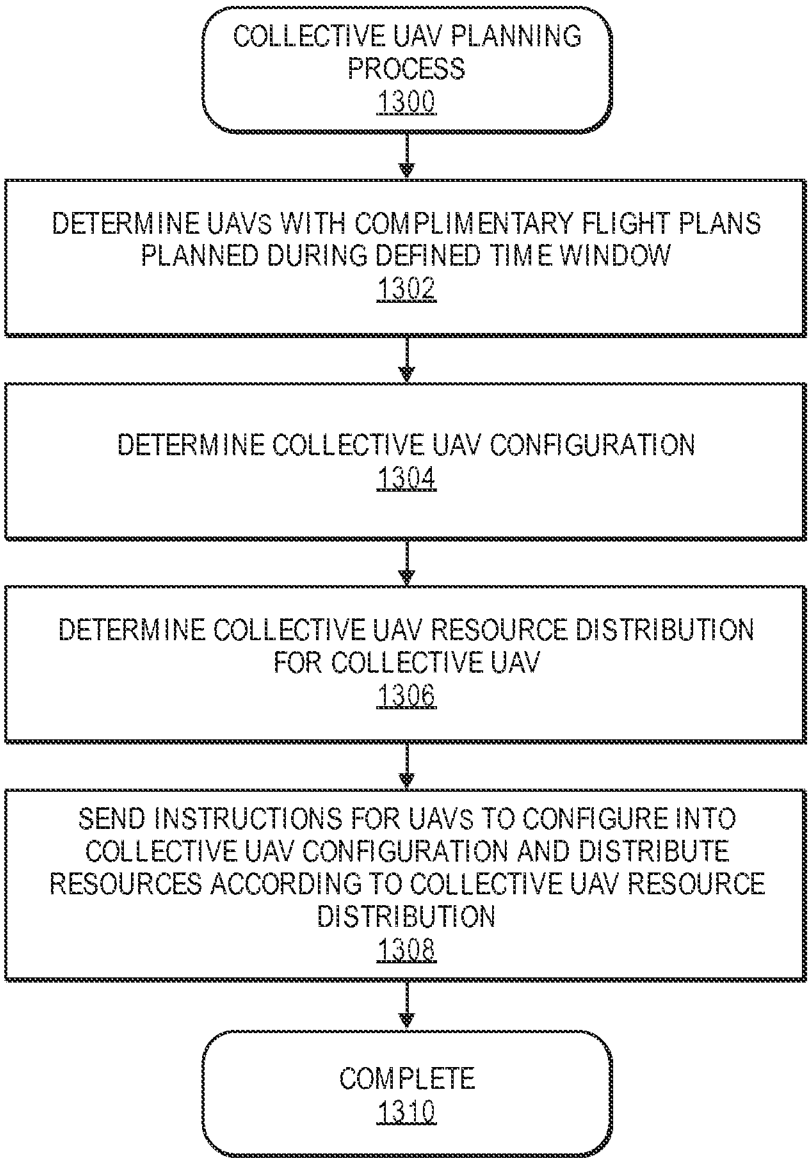
COLLECTIVE UAV PLANNING PROCESS 1300
DETERMINE UAVS WITH COMPLIMENTARY FLIGHT PLANS PLANNED DURING DEFINED TIME WINDOW 1302
DETERMINE COLLECTIVE UAV CONFIGURATION 1304
DETERMINE COLLECTIVE UAV RESOURCE DISTRIBUTION FOR COLLECTIVE UAV 1306
SEND INSTRUCTIONS FOR UAVS TO CONFIGURE INTO COLLECTIVE UAV CONFIGURATION AND DISTRIBUTE RESOURCES ACCORDING TO COLLECTIVE UAV RESOURCE DISTRIBUTION 1308
COMPLETE 1310

FIG. 13

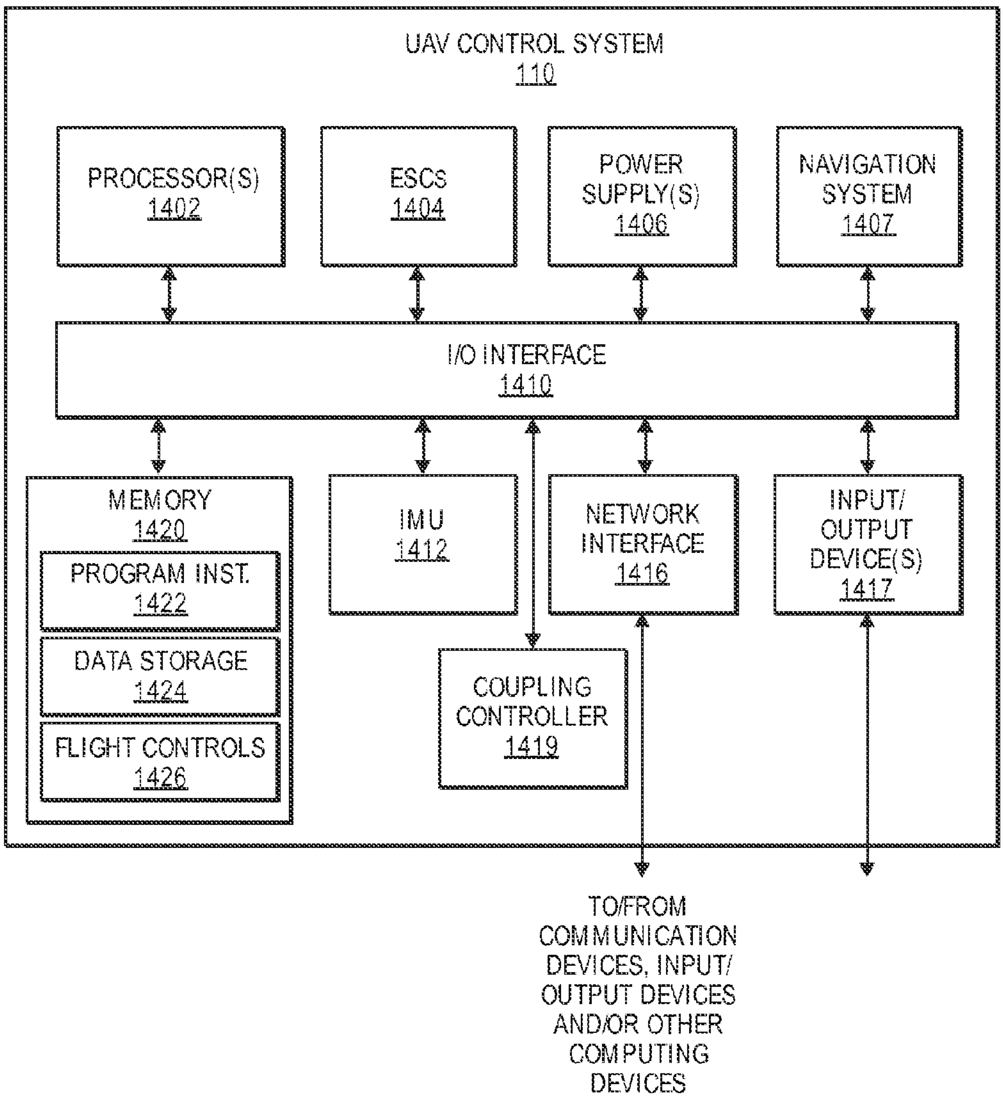
UAV CONTROL SYSTEM
110
PROCESSOR(S)
1402
ESCs
1404
POWER SUPPLY(S)
1406
NAVIGATION SYSTEM
1407
I/O INTERFACE
1410
MEMORY
1420
PROGRAM INST.
1422
DATA STORAGE
1424
FLIGHT CONTROLS
1426
IMU
1412
NETWORK INTERFACE
1416
INPUT/ OUTPUT DEVICE(S)
1417
COUPLING CONTROLLER
1419
TO/FROM COMMUNICATION DEVICES, INPUT/ OUTPUT DEVICES AND/OR OTHER COMPUTING DEVICES

FIG. 14

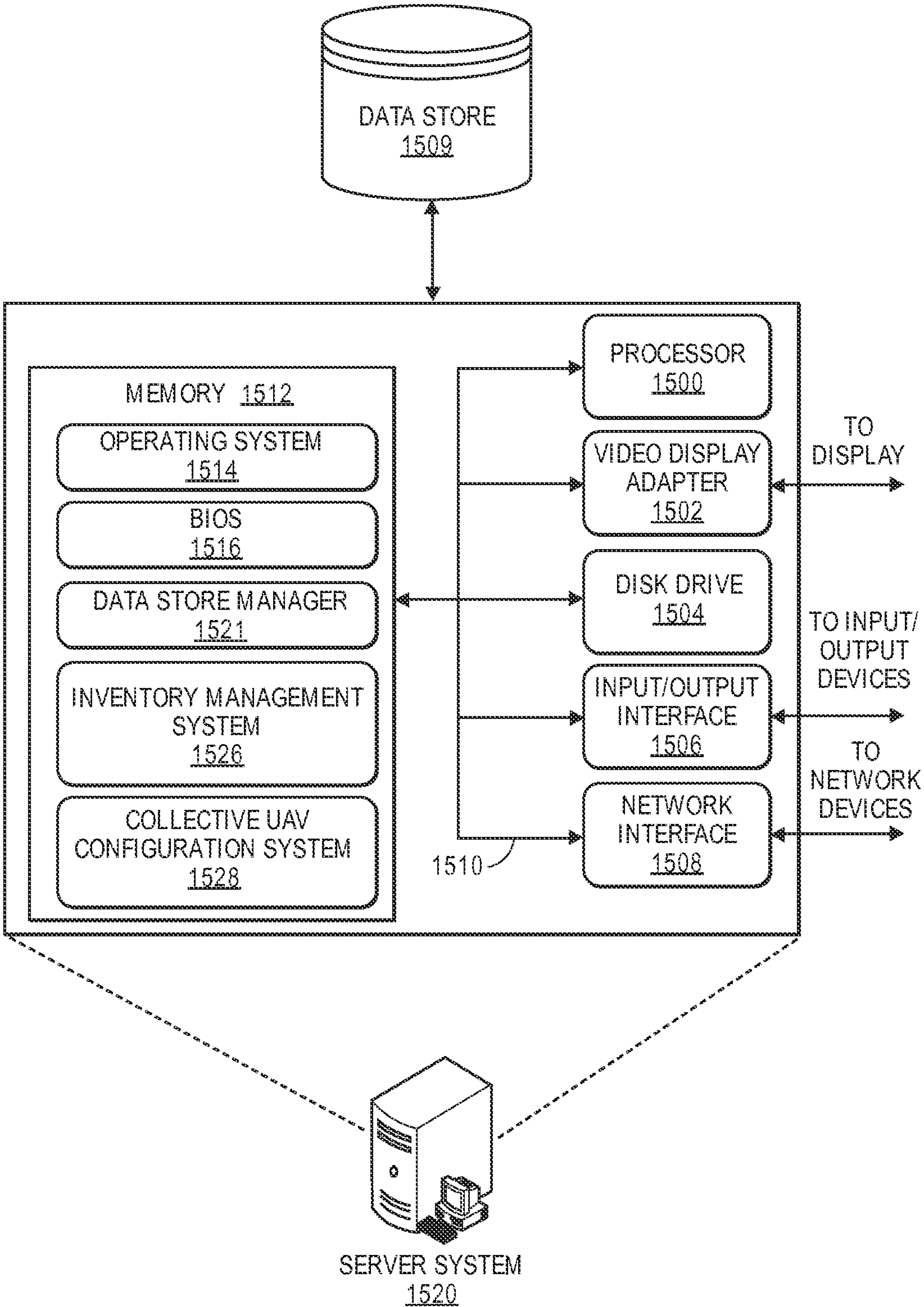
DATA STORE
1509
PROCESSOR
1500
MEMORY 1512
OPERATING SYSTEM
1514
BIOS
1516
DATA STORE MANAGER
1521
INVENTORY MANAGEMENT SYSTEM
1526
COLLECTIVE UAV CONFIGURATION SYSTEM
1528
VIDEO DISPLAY ADAPTER
1502
TO DISPLAY
DISK DRIVE
1504
TO INPUT/ OUTPUT DEVICES
INPUT/OUTPUT INTERFACE
1506
TO NETWORK DEVICES
NETWORK INTERFACE
1508
1510
SERVER SYSTEM
1520

FIG. 15

# COLLECTIVE UNMANNED AERIAL VEHICLE CONFIGURATIONS

## BACKGROUND

[0001] Unmanned aerial vehicles ("UAVs") are often designed to carry a payload and/or to remain airborne for a specified duration of time. For example, many multi-propeller aerial vehicles (e.g., quad-copters, octo-copters) are designed to carry a payload of up to ten pounds and remain airborne for up to thirty minutes. To carry larger payloads, the UAV typically has to be larger, with larger motors, larger propellers, and larger power modules to generate lifting forces sufficient to carry the larger payloads. Likewise, for extended flight duration, additional or larger power modules are typically necessary.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0002] The detailed description is set forth with reference to the accompanying figures. In the figures, the left-most digit(s) of a reference number identifies the figure in which the reference number first appears. The use of the same reference numbers in different figures indicates similar or identical items or features.

[0003] FIG. **1** depicts a view of a UAV configuration, according to an implementation.

[0004] FIG. **2** depicts a top-down view of a plurality of UAVs forming a collective UAV, according to an implementation.

[0005] FIG. **3** depicts a top-down view of a collective UAV configuration, according to an implementation.

[0006] FIG. **4** depicts a top-down view of another collective UAV configuration, according to an implementation.

[0007] FIG. **5** depicts a view of another collective UAV configuration, according to an implementation.

[0008] FIG. **6** depicts a top-down view of a collective UAV configuration with a UAV decoupling from the collective UAV, according to an implementation.

[0009] FIG. **7** depicts a side-view of a collective UAV configuration, according to an implementation.

[0010] FIG. **8** depicts another side-view of a collective UAV configuration, according to an implementation.

[0011] FIG. **9** depicts a top-down view of a collective UAV arriving at a delivery area, according to an implementation.

[0012] FIG. **10** is a flow diagram of an example collective UAV coupling process, according to an implementation.

[0013] FIG. **11** is a flow diagram of an example collective UAV navigation process, according to an implementation.

[0014] FIG. **12** is a flow diagram of a collective UAV decoupling process, according to an implementation.

[0015] FIG. **13** is a flow diagram of a collective UAV planning process, according to an implementation.

[0016] FIG. **14** is a block diagram of an illustrative implementation of a UAV control system that may be used with various implementations.

[0017] FIG. **15** is a block diagram of an illustrative implementation of a server system that may be used with various implementations.

[0018] While implementations are described herein by way of example, those skilled in the art will recognize that the implementations are not limited to the examples or drawings described. It should be understood that the drawings and detailed description thereto are not intended to limit implementations to the particular form disclosed but, on the contrary, the intention is to cover all modifications, equivalents and alternatives falling within the spirit and scope as defined by the appended claims. The headings used herein are for organizational purposes only and are not meant to be used to limit the scope of the description or the claims. As used throughout this application, the word "may" is used in a permissive sense (i.e., meaning having the potential to), rather than the mandatory sense (i.e., meaning must). Similarly, the words "include," "including," and "includes" mean including, but not limited to. Additionally, as used herein, the term "coupled" may refer to two or more components or UAVs connected together, whether that connection is permanent (e.g., welded) or temporary (e.g., bolted, mechanical), direct or indirect (i.e., through an intermediary), mechanical, chemical, optical, or electrical. Furthermore, as used herein, "horizontal" flight refers to flight traveling in a direction substantially parallel to the ground (i.e., sea level), and that "vertical" flight refers to flight traveling substantially radially outward from the earth's center. It should be understood by those having ordinary skill that trajectories may include components of both "horizontal" and "vertical" flight vectors.

## DETAILED DESCRIPTION

[0019] This disclosure describes a collective UAV configuration in which multiple UAVs may be coupled together to form a collective UAV. A collective UAV, as used herein, is two or more coupled UAVs. A collective UAV may be used to aerially transport virtually any size, weight, or quantity of items, travel longer distances, etc. For example, rather than using one large UAV to carry a larger or heavier item, multiple smaller UAVs may couple together to form a collective UAV that is used to carry the larger or heavier item.

[0020] In many instances, a single UAV configuration may be capable of delivering a large percentage of the ordered items. However, some items may require a larger UAV that is capable of lifting and aerially transporting a larger or heavier item. Likewise, some orders for items may specify delivery destinations that require a UAV with longer flight duration. Rather than having to maintain multiple UAV configurations or utilize a UAV configuration that is not necessary for the majority of the item deliveries, the implementations described herein utilize multiple UAVs to form a collective UAV that is capable of transporting larger and/or heavier items or aerially navigating longer distances.

[0021] In addition to forming a collective UAV to carry larger and/or heavier items or to aerially navigate longer distances, as described herein, UAVs that are capable of carrying an item independent of other UAVs may couple to form a collective UAV to aerially navigate as a collective UAV to a delivery area. When one or all of the UAVs reach the delivery area, the UAVs may decouple to deliver items to different delivery destinations. By aerially navigating as a collective UAV, the coupled UAVs can share resources (e.g., computing resources, power, navigation, etc.), be more efficient, be more visible, generate larger radar or object detection, be more detectable by ground based radar or air traffic control, etc. For example, a collective UAV that includes multiple coupled UAVs (e.g., twenty) will be more visible to other aircraft as well as air traffic control, thereby improving safety for the UAVs and other aircraft. Likewise, when multiple UAVs are coupled to form a collective UAV, some of the UAVs may reduce the rotational speed of one or more of their motors, relying on the lifting force of the collective UAV, thereby reducing the overall energy consumed during aerial navigation.

**[0022]** FIG. **1** illustrates a view of a UAV **100**, according to an implementation. As illustrated, the UAV **100** includes a frame **104**. The frame **104** or body of the UAV **100** may be formed of any suitable material, such as graphite, carbon fiber, aluminum, titanium, etc., or any combination thereof. In this example, the frame **104** of the UAV **100** is a single carbon fiber frame. The frame **104** includes a hub **106**, motor arms **108**, motor mounts **111**, support arms **112**, and a perimeter protective barrier **114**. In this example, there is a single hub **106**, four motor arms **108**, four motor mounts **111**, twelve support arms **112**, and a single perimeter protective barrier **114**. In other implementations, a UAV may include additional or fewer hubs, motor arms, motor mounts, support arms, or protective barriers.

**[0023]** Each of the motor arms **108** extend from the hub **106** and couple with or terminate into the motor mounts **111**. Lifting motors **116** are coupled to an inner side of the motor mount **111** so that the lifting motor **116** and corresponding lifting propeller **118** are within the frame **104**. In one implementation, the lifting motors **116** are mounted so that the propeller shaft of the lifting motor that mounts to the lifting propeller **118** is facing downward with respect to the frame **104**. In other implementations, the lifting motors may be mounted at other angles with respect to the frame **104** of the UAV **100**. The lifting motors may be any form of motor capable of generating enough rotational speed with the propellers to lift the UAV **100** and an engaged payload, thereby enabling aerial transport of the payload.

**[0024]** Mounted to each lifting motor **116** is a lifting propeller **118**. The lifting propellers **118** may be any form of propeller (e.g., graphite, carbon fiber) and of a size sufficient to lift the UAV **100** and any payload engaged by the UAV **100** so that the UAV **100** can navigate through the air, for example, to deliver a payload to a delivery destination. For example, the lifting propellers **118** may each be carbon fiber propellers having a dimension or diameter of twenty-nine inches. While the illustration of FIG. **1** shows the lifting propellers **118** all of a same size, in some implementations, one or more of the lifting propellers **118** may be different sizes and/or dimensions. Likewise, while this example includes four lifting propellers, in other implementations, more or fewer propellers may be utilized as lifting propellers **118**. Likewise, in some implementations, the lifting propellers **118** may be positioned at different locations on the UAV **100**. In addition, alternative methods of propulsion may be utilized as “motors” in implementations described herein. For example, fans, jets, turbojets, turbo fans, jet engines, internal combustion engines, and the like may be used (either with propellers or other devices) to provide lift for the UAV.

**[0025]** Extending from each motor mount **111** are three support arms **112** that couple with or otherwise terminate into the perimeter protective barrier **114**. The perimeter protective barrier **114** extends around the perimeter of the UAV and encompasses the lifting propellers **118**. In some implementations, the perimeter protective barrier **114** may include a vertical component that extends substantially downward from the support arms and approximately perpendicular to the axis of rotation of the lifting propellers **118**. The vertical component may be of any vertical dimension and width. For example, the vertical component may have a vertical dimension of approximately three inches and a width of approximately 0.5 inches. In other implementations, the vertical dimension and/or the width may be larger or smaller. Likewise, the vertical component of the perimeter protective barrier may include a core, such as a foam, wood and/or plastic core. The vertical component may be coupled to each of the support arms and extend around the outer perimeter of each propeller **118** to inhibit access to the propellers from the sides of the UAV **100**.

**[0026]** The perimeter protective barrier **114** provides safety for objects foreign to the UAV **100** by inhibiting access to the propellers **118** from the side of the UAV **100**, provides protection to the UAV **100** and increases the structural integrity of the UAV **100**. For example, if the UAV **100** is traveling horizontally and collides with a foreign object (e.g., wall, building), the impact between the UAV and the foreign object will be with the perimeter protective barrier **114**, rather than a propeller. Likewise, because the frame is interconnected, the forces from the impact are dissipated across the frame **104**.

**[0027]** Likewise, the perimeter protective barrier **114** provides a surface upon which one or more components of the UAV may be mounted. For example, one or more antennas may be mounted to the perimeter protective barrier **114**. The antennas may be used to transmit and/or receive wireless communications. For example, the antennas may be utilized for Wi-Fi, satellite, near field communication (“NFC”), cellular communication, or any other form of wireless communication. Other components, such as cameras, time of flight sensors, distance determining elements, gimbals, Global Positioning System (“GPS”) receiver/transmitter, radars, illumination elements, speakers, and/or any other component of the UAV **100** or the UAV control system (discussed below), etc., may likewise be mounted to the perimeter protective barrier **114**. Likewise, identification or reflective identifiers may be mounted to the vertical component to aid in the identification of the UAV **100**.

**[0028]** The perimeter protective barrier **114** may also include one or more coupling components **122**. The coupling components may be configured to enable coupling between the UAV **100** and another UAV to form a collective UAV. In this example, there are multiple coupling components **122** distributed at different locations along the perimeter protective barrier **114**, thereby enabling coupling of the UAV **100** at different locations and/or coupling of the UAV **100** with multiple other UAVs. In some implementations, the entire protective barrier **114** may include coupling components, thereby enabling coupling of UAVs at any position and/or orientation with the UAV **100**. The coupling component may provide any form of coupling sufficient to engage two or more UAVs together. For example, the coupling component may include a mechanical coupling, an electrical coupling, an electromechanical coupling, a magnetic coupling, an electromagnetic coupling, etc. In one implementation, the protective barrier **114** may include a series of electromagnets that may be activated by the UAV control system **110** to couple the UAV **100** with another UAV or deactivated to decouple the UAV **100** from another UAV. In other implementations, the coupling may be a static or stationary coupling such as a series of latches or grooves that mate together to couple two or more UAVs.

**[0029]** The coupling components **122** may be on the side, top, or bottom of the perimeter protective barrier **114** to enable coupling of other UAVs at different angles or orientations. For example, the UAV **100** may include a coupling component on a top of the mounting plate **120** so that the UAV **100** may be coupled with a second UAV in a vertical configuration. An example collective UAV configuration with UAVs coupled in different orientations is illustrated in FIG. **5**.

**[0030]** In some implementations, the coupling components **122** could be hinged or otherwise configured to allow pivoting or rotation between coupled UAVs. For example, as discussed below with respect to FIG. **4**, the coupling components may allow one or more degrees of freedom in rotation between coupled UAVs to allow the collective UAV configuration to flex or adjust as it navigates.

**[0031]** In addition to providing a physical coupling between two or more UAVs, the coupling component **122** may provide electrical and/or data communication between coupled UAVs. For example, UAVs may exchange navigation information and/or share computing resources via a data transmission between the coupling components **122** of the coupled UAVs. Likewise, power resources may be shared via the coupling components **122** of the UAVs. For example, the UAV **100** may have excess power supply stored in the power modules. While the UAV **100** is coupled with another UAV, it may provide the excess power supply to the coupled UAV via the connection component **122**.

**[0032]** While the example illustrated in FIG. **1** shows a perimeter protective barrier **114** with a vertical component and a series of coupling components **122**, in other implementations, the perimeter protective barrier may have other configurations. For example, the perimeter protective barrier may be angled (e.g., forty-five degree angle) with respect to the UAV **100**, and extend from above the lifting propellers where it is coupled with the support arms **112** to below the lifting propellers **118**. The angles on different sides of the UAV **100** may extend in opposite directions. Other UAVs may couple with the UAV **100** by aligning an opposing angled side with a side of the UAV **100** and coupling the coupling components between the two UAVs. Such a configuration may improve the aerodynamics of the UAV **100** and/or a collective UAV configuration. In other implementations, the perimeter protective barrier may have other configurations or designs.

**[0033]** In addition to providing protection for the UAV **100** and coupling components to enable coupling of multiple UAVs, the frame **104** provides structural support for the UAV **100**. By interconnecting the hub **106**, motor arms **108**, motor mounts **111**, support arms **112**, and perimeter protective barrier **114**, the resulting frame has structural stability and is sufficient to support the lifting motors, lifting propellers, a payload (e.g., items), UAV control system, and/or other components of the UAV.

**[0034]** In some implementations, the frame **104** may also include a permeable material (e.g., mesh, screen) that extends over the top and/or lower surface of the frame to inhibit vertical access to the propellers from above or below the propellers **118**. Likewise, in some implementations, one or more mounting plates **120** may be affixed to the frame **104** to provide additional surface area for mounting components to the UAV **100**. The mounting plates **120** may be removably coupled to the frame **104**, for example, using screws, fasteners, etc. Alternatively, the mounting plates **120** may be formed as part of the frame **104**.

**[0035]** A UAV control system **110** is also mounted to the frame **104**. In this example, the UAV control system **110** is mounted between the hub **106** and a mounting plate **120**. The UAV control system **110**, as discussed in further detail below with respect to FIG. **14**, controls the operation, routing, navigation, communication, motor controls, resource sharing, coupling components **122**, and the payload engagement mechanism of the UAV **100**.

**[0036]** Likewise, the UAV **100** includes one or more power modules (not shown). The power modules may be mounted to various locations on the frame. For example, in some implementations, four power modules may be mounted to each mounting plate **120** and/or to the hub **106** of the frame. The power modules for the UAV **100** may be in the form of battery power, solar power, gas power, super capacitor, fuel cell, alternative power generation source, or a combination thereof. For example, the power modules may each be a 6000 mAh lithium-ion polymer battery, or polymer lithium ion (Li-poly, Li-Pol, LiPo, LIP, PLI or Lip) battery. The power module(s) are coupled to and provide power for the UAV control system **110**, the lifting motors **116**, the payload engagement mechanism, the coupling components **122**, etc.

**[0037]** In some implementations, one or more of the power modules may be configured such that it can be autonomously removed and/or replaced with another power module while the UAV is landed or in flight. For example, when the UAV lands at a location, the UAV may engage with a charging member at the location that will recharge the power module. As another example, when the UAV is coupled to and part of a collective UAV, it may receive excess power from another coupled UAV and utilize that excess power to provide power to the UAV **100** components and/or to re-charge the power module(s) of the UAV **100**.

**[0038]** As mentioned above, the UAV **100** may also include a payload engagement mechanism (not shown). The payload engagement mechanism may be configured to engage and disengage items and/or containers that hold items. In this example, the payload engagement mechanism is positioned beneath and coupled to the hub **106** of the frame **104** of the UAV **100**. The payload engagement mechanism may be of any size sufficient to securely engage and disengage containers that contain items. In other implementations, the payload engagement mechanism may operate as the container, in which it contains item(s). The payload engagement mechanism communicates with (via wired or wireless communication) and is controlled by the UAV control system **110**. In some implementations, the payload engagement mechanism may be configured to operate in conjunction with payload engagement mechanisms of other UAVs that are coupled to form a collective UAV to engage/disengage larger items.

**[0039]** While the implementations of the UAV **100** discussed herein utilize propellers to achieve and maintain flight, in other implementations, the UAV may be configured in other manners. For example, the UAV may include fixed wings and/or a combination of both propellers and fixed wings.

**[0040]** FIG. **2** depicts a top-down view of a plurality of UAVs **200** forming a collective UAV **202**, according to an implementation. As illustrated in this example, two UAVs **200**A, **200**B wirelessly communicate to determine if they should couple to form a collective UAV **202**. For example, each UAV **200** may exchange flight plan information, configuration information, etc., to determine if forming a collective UAV is beneficial. In one implementation, if the flight plans of each UAV are complementary, it may be determined that the UAVs should couple to form a collective UAV **200**. Flight plans may be determined to be complementary if the UAVs **200** are navigating in a similar direction, toward a similar destination (e.g., materials handling facility, delivery area, etc.), coupling would result in a net power savings, coupling would result in increased safety, coupling would result in faster aerial transport, etc. For example, if UAV **200**A and UAV **200**B are both navigating to the same materials handling facility, it may be determined that their flight plans are complementary. As another example, if UAV **200**A is navigating to a first delivery area and UAV **200**B is navigating to a second delivery area, it may be determined that the flight plans of the two UAVs **200**A, **200**B are complementary if UAV **200**B will pass the first delivery area within a defined distance as it navigates to the second delivery area.

**[0041]** Other factors may also be considered in determining if UAVs should couple. For example, the remaining power of each UAV may be considered, weather and/or other external factors may also be considered. For example, if the UAVs are in an area with other aircraft, it may be determined that the UAVs should couple to form a collective UAV to increase visibility of the UAVs to other aircraft.

**[0042]** If it is determined that the two UAVs **200**A, **200**B are to couple, the UAVs will determine a collective UAV configuration and then couple according to that collective UAV configuration to form a collective UAV **200**. The collective UAV configuration may be determined by one or more of the UAVs **200**A, **200**B, and/or may be determined by a collective UAV configuration system **1528** (FIG. **15**) operating on a remote computing resource and provided wirelessly to one or more of the UAVs **200**A, **200**B.

**[0043]** Once coupled, the UAVs **200**A, **200**B may determine or receive from the collective UAV configuration system **1528** combined operating information and a collective flight plan. For example, if the two UAVs **200**A, **200**B are navigating to the same materials handling facility, one or more of the UAVs may determine a collective UAV flight plan that is to be followed by each UAV to navigate the collective UAV to the materials handling facility.

**[0044]** The UAVs may operate in a distributed manner, each UAV navigating a component or offset of the flight plan and controlling the motors of the UAV. In other implementations, one or more of the UAVs may control the collective UAV configuration. For example, UAV **200**A may be designated as the master UAV of the collective UAV **202** and provide speed control instructions to the motors of the UAV **200**A and the motors of the UAV **200**B, to control the operation and navigation of the collective UAV **202**. In such an implementation, data may be exchanged between the UAVs through the coupling components that couple the UAVs and/or transmitted wirelessly. Likewise, one or more components of the slave UAV **200**B, such as the control system, may transition to a lower power state, thereby conserving power.

**[0045]** In some implementations, one or more of the UAVs **200**A, **200**B may also determine if the rotational speed of one or more of the motors of the UAV may be reduced or terminated. For example, because UAV **200**A has coupled with UAV **200**B, the collective UAV **202** has eight motors and propellers. In some implementations, the rotational speed of the interior motors **216-2**, **216-3**, **216-6**, **216-7** and corresponding interior propellers **218-2**, **218-3**, **218-6**, **218-7** of the collective UAV **202** may be reduced or terminated and the exterior motors **216-1**, **216-4**, **216-5**, **216-8** and corresponding exterior propellers **218-1**, **218-4**, **218-5**, **218-8** may be utilized to aerially navigate the collective UAV **202**.

**[0046]** Any number or combination of UAVs may couple to form any size and configuration of a collective UAV **202**. As illustrated in FIG. **2**, a third UAV **200**C wirelessly communicates with the collective UAV **202** and then couples with and becomes part of the collective UAV **202**. As with the initial coupling of UAVs **200**A, **200**B, the UAVs **200** may directly communicate, exchanging UAV configurations, collective UAV configuration, flight plan information, etc. Alternatively, the collective UAV configuration system **1528** may wirelessly send instructions to the collective UAV **202** and/or the UAV **200**C instructing the coupling of the UAV **200**C to the collective UAV **202**.

**[0047]** A UAV **200**C may couple with one or more UAVs that form a collective UAV **202**. As illustrated in FIG. **2**, the UAV **200**C has coupled with both UAV **200**A and UAV **200**B according to a determined collective UAV configuration. The collective UAV configuration may take any form and may vary depending on, for example, the number of UAVs forming the collective UAV, the weather, the number and/or weight of items carried by UAVs of the collective UAV, power requirements, whether one or more of the UAVs of the collective UAV is damaged or inoperable, etc.

**[0048]** For example, FIG. **3** depicts a top-down view of a collective UAV **302** having a "V" configuration, according to an implementation. The collective UAV **302**, in this example, includes seven UAVs **300**A, **300**B, **300**C, **300**D, **300**E, **300**F, **300**G that are coupled to form the collective UAV **302**. Each UAV **300** is coupled to one other UAV of the collective UAV. The V configuration of the collective UAV may be utilized to provide better aerodynamics, benefit from lift from leading UAVs of the collective UAV, and/or reduce the overall power consumed by the collective UAV.

**[0049]** FIG. **4** depicts another top-down view of a collective UAV **402** having a different configuration, according to an implementation. In this example, there are fourteen UAVs **400** coupled to one another to form the collective UAV **402**. In this example, each UAV is coupled to at least one other UAV to form the collective UAV **402**. Some of the UAVs are coupled to up to six different UAVs. In some implementations, the coupling components that couple one or more of the UAVs **400** of the collective UAV **402** may allow one or more degrees of freedom of rotation at the coupling. For example, as the collective UAV **400** adjusts its heading, yaw, pitch and/or roll, the leading perimeter UAVs **400** may begin the adjustment and the coupling between those leading perimeter UAVs **400** may allow flex between the leading perimeter UAVs and the UAVs **400** to which they are coupled. As the collective UAV **402** adjusts its heading, yaw, pitch, and/or roll, the other coupled UAVs **400** will likewise adjust until the adjustment of the collective UAV **402** has completed.

**[0050]** FIG. **5** is another illustration of a collective UAV **502**, according to an implementation. In comparison to the collective UAVs discussed above with respect to FIGS. **2-4**, the collective UAV **502** illustrates UAVs coupled at different orientations. In this example, the collective UAV **502** is in the form of a cube that includes a total of twenty-four UAVs **500** coupled to form the cube; each side of the cube including four UAVs **500**. While FIG. **5** illustrates the collective UAV **502** in the form of a cube, the collective UAV may be arranged to have any shape. For example, rather than a cube, the UAVs may couple to form a sphere shaped collective UAV **502**.

**[0051]** In a cube shape, such as that illustrated in FIG. **5**, the collective UAV **502** includes larger surface area on each side of the collective UAV **502** making it more detectable by other aircraft and/or flight control systems. Likewise, the propellers of the UAVs on different sides of the collective UAV **502** may be utilized to adjust the heading, pitch, yaw, and/or roll of the UAV. Still further, one or more of the propellers on a side of the collective UAV **502** may be utilized to provide horizontal thrust to propel the collective UAV in a direction that includes a horizontal component. For example, the propellers of the UAVs **500**A, **500**B, **500**C, and **500**D that are coupled to form a side of the collective UAV **502** may be utilized to provide horizontal thrust for the collective UAV **502**. Likewise, the propellers on the top and/or bottom of the collective UAV **502** may provide lifting force to lift the collective UAV **502**.

**[0052]** As discussed above with respect to FIG. **2**, the UAVs of a collective UAV, such as those illustrated in FIGS. **2-5**, may share resources, reduce rotational speed of one or more motors, and/or otherwise function as a collective to reduce the overall power consumed by the collective UAV and/or to extend the distance or time the collective UAV may aerially navigate. For example, referring again to FIG. **4**, the interior UAVs, such as UAV **400**A, is coupled to six other UAVs and may be able to reduce and/or terminate the rotation of the motors of the UAV **400**A and be supported by the other UAVs **400** of the collective UAV **402**, thereby conserving power. In comparison, UAV **400**B, which is on the perimeter of the collective UAV **402**, may maintain rotational speed of some or all of its motors to provide sufficient lift to aerially navigate the collective UAV **402**. In this example, UAV **400**B may operate in conjunction with each of the other UAVs **400** coupled along the perimeter of the collective UAV **402**.

**[0053]** As additional UAVs couple with a collective UAV and/or as UAVs decouple from a collective UAV, the UAV configuration changes and one or more of the other UAVs of the collective may decrease or increase the rotational speed of one or more of its motors and/or share resources with the collective UAV. Likewise, as discussed above, a collective UAV may operate in a distributed manner, with each UAV maintaining and operating the motors and/or other components of the UAV. Alternatively, the collective UAV may operate in a master-slave configuration in which one of the UAVs of the collective UAV operates as a master, providing navigation instructions, motor speed control instructions, etc., to the other UAVs of the collective UAV. Any control scheme may be utilized to maintain the operation and control of the collective UAV and the distributed configuration and master-slave configuration are provided only as examples. For example, the collective UAV configuration system **1528** may provide navigation instructions to each of the UAVs of the collective UAV.

**[0054]** FIG. **6** depicts a top-down view of a collective UAV **602** with a UAV **600**B decoupling from the collective UAV, according to an implementation. In this example, the collective UAV **602** includes three coupled UAVs **600**A, **600**B, **600**C that are aerially navigating along a flight path. At some point during aerial navigation, UAV **600**B decouples from the collective UAV **602**. For example, UAV **600**B may have reached a point in the flight path where it is to decouple from the collective UAV and navigate to another location (e.g., delivery destination).

**[0055]** Upon decoupling from the collective UAV **602**, the UAV **600**B may resume aerial navigation utilizing its own UAV control system to aerially navigate to a destination. Likewise, when a UAV decouples from a collective UAV **602**, the collective UAV **602** determines the updated collective UAV configuration and/or whether the remaining UAVs **600**A, **600**C of the collective UAV **602** should reconfigure into a different configuration. For example, upon decoupling of UAV **600**B, the remaining UAVs **600**A, **600**C are coupled with one coupling component and offset from one-another. Because this may not be a preferred UAV configuration, it may be determined that the UAVs **600**A, **600**C should decouple and then recouple to form a different UAV configuration, as illustrated. In other implementations, the UAVs may remain in the existing configuration.

**[0056]** While the example illustrated in FIG. **6** shows a perimeter UAV **600**B of the collective UAV **602** decoupling, in other implementations, any UAV of a collective UAV may decouple. For example, referring back to FIG. **4**, the UAV **400**A may decouple from the collective UAV **402**. In such an example, the collective UAV **402** may reconfigure, another UAV that is either already coupled with the collective UAV or requesting to couple with the UAV may be instructed to assume the position of the now decoupled UAV **400**A, or an empty space may be left in the collective UAV **402**.

**[0057]** As discussed above, one or more UAVs of a collective UAV may carry a payload (e.g., item or item package) or multiple UAVs of the collective UAV may operate together to carry a single payload. For example, FIG. **7** depicts a side-view of a collective UAV configuration **702**, according to an implementation. In this example, each UAV **700**A, **700**B, **700**C, **700**D is carrying a respective payload **704**A, **704**B, **704**C, **704**D. As discussed further below, the UAVs **700** of the collective UAV **702** may all be navigating to a delivery area in which they will deliver the respective payload **704** to a delivery destination within that delivery area. The UAVs **700** may couple to form the collective UAV **702** as they aerially navigate from a location (e.g., materials handling facility) until they reach the delivery area. As the collective UAV reaches the delivery area, one or more of the UAVs **700** may decouple and complete delivery of the payload to the delivery destination.

**[0058]** Likewise, as UAVs complete delivery of a payload, they may couple with other UAVs to form a collective UAV to aerially navigate from the delivery area. For example, as the UAVs **700** complete delivery of the payloads **704** to respective delivery destinations, the UAVs may couple back together to form the collective UAV **702** and aerially navigate to another location (e.g., return to the materials handling facility).

**[0059]** FIG. **8** depicts another side-view of a collective UAV **802** configuration, according to an implementation. In this example, two of the UAVs **800**B, **800**C are coupled to a single payload **804** and two other UAVs **800**A, **800**D are coupled to UAVs **800**B, **800**C, but do not have any coupled payloads. In this example, the payload **804** is heavier than a single UAV can aerially transport, so two UAVs **800**B, **800**C are coupled to form a collective UAV that is coupled to the payload **804** to enable aerial transport of the payload **804**. Likewise, the delivery destination is beyond the range that two coupled UAVs **800**B, **800**C can reach under their own power so two additional UAVs **800**A, **800**D are coupled with the UAVs **800**B, **800**C to form the collective UAV **802** to enable aerial transport of the payload **804**. In such an example, the collective UAV may aerially navigate the payload to a delivery area. When the collective UAV **802** reaches the delivery area, the two UAVs **800**B, **800**C may decouple from the other two UAVs **800**A, **800**D to complete delivery of the payload **804** to a delivery destination. After the payload is delivered, the two UAVs **800**B, **800**C may recouple with the two UAVs **800**A, **800**D to aerially navigate together to another location.

**[0060]** Decoupling one or more of the UAVs from the collective UAV to complete delivery of the item improves the safety around the delivery destination and increases the agility of the UAV or collective UAV as it delivers the item to the delivery destination. For example, if there are numerous UAVs coupled to form a collective UAV, the collective UAV may be several feet wide. For example, referring again to FIG. **4**, if each UAV **400** is approximately two feet wide by approximately two feet long, the collective UAV **402** will be approximately ten feet wide by approximately eight feet long. As another example, referring to FIG. **5**, if each UAV **500** is approximately two feet wide by approximately two feet long, the collective UAV **502** will be approximately four feet wide by approximately four feet long by approximately four feet tall.

**[0061]** While the collective UAV configuration improves visibility and safety while the UAV is at high altitudes by making it more visible to other aircraft, such a large configuration may not be desirable at low altitudes during item delivery. For example, if a user has ordered an item and specified a location in the backyard of their home as the delivery destination, it may be dangerous to attempt to deliver the item with a collective UAV that is approximately ten feet wide by eight feet long. In contrast, delivery with a single UAV that is approximately two feet wide by two feet long may be much safer.

**[0062]** Continuing with the above examples, FIG. **9** depicts a top-down view of a collective UAV **902** arriving at a delivery area **904**, according to an implementation. As the collective UAV **902** arrives at the delivery area **904**, the UAVs **900**A, **900**B, **900**C may decouple and complete delivery of payload carried by the UAV to a delivery destination **906**. For example, UAV **900**A may decouple from the collective UAV **902** and complete delivery of a payload to delivery destination **906**A. UAV **900**B may decouple from the collective UAV **902** and complete delivery of a payload to delivery destination **906**B. Likewise, UAV **900**C may decouple from the collective UAV and complete delivery of a payload to delivery destination **906**C.

**[0063]** While this example shows all of the UAVs **900** of the collective UAV **902** decoupling from the collective UAV to deliver a payload to a delivery destination within the delivery area **904**, in other implementations, one or more of the UAVs of the collective UAV **902** may not be delivering a payload to a delivery destination within the delivery area. For example, some UAVs of the collective UAV **902** may be aerially navigating past the delivery area **904** to a second delivery area to complete delivery of payloads to delivery destinations within that second delivery area. As another example, some of the UAVs of the collective UAV may only provide support for the aerial transport of the collective UAV and may not carry any payload for delivery. For example, some of the UAVs may carry as a payload additional power modules that may be utilized by the collective UAV to extend the flight duration and/or distance of the collective UAV. As another example, one of the UAVs may be configured as a master UAV of the collective UAV and be configured to aid in the aerial navigation of the collective UAV to the delivery area.

**[0064]** FIG. **10** is a flow diagram of an example collective UAV coupling process **1000**, according to an implementation. This process, and each process described herein, may be implemented by the architectures described herein or by other architectures. The process is illustrated as a collection of blocks in a logical flow graph. Some of the blocks represent operations that can be implemented in hardware, software, or a combination thereof. In the context of software, the blocks represent computer-executable instructions stored on one or more computer readable media that, when executed by one or more processors, perform the recited operations. Generally, computer-executable instructions include routines, programs, objects, components, data structures, and the like that perform particular functions or implement particular abstract data types.

**[0065]** The computer readable media may include non-transitory computer readable storage media, which may include hard drives, floppy diskettes, optical disks, CD-ROMs, DVDs, read-only memories (ROMs), random access memories (RAMs), EPROMs, EEPROMs, flash memory, magnetic or optical cards, solid-state memory devices, or other types of storage media suitable for storing electronic instructions. In addition, in some implementations, the computer readable media may include a transitory computer readable signal (in compressed or uncompressed form). Examples of computer readable signals, whether modulated using a carrier or not, include, but are not limited to, signals that a computer system hosting or running a computer program can be configured to access, including signals downloaded through the Internet or other networks. Finally, the order in which the operations are described is not intended to be construed as a limitation, and any number of the described operations can be combined in any order and/or in parallel to implement the process.

**[0066]** The example process **1000** may be performed by a UAV, a collective UAV, and/or the collective UAV configuration system **1528** (FIG. **15**). While the example discussed below with respect to FIG. **10** describes two UAVs, in other implementations, the example process may be used with a UAV and a collective UAV, or two collective UAVs.

**[0067]** The example process **1000** begins by determining a first UAV within a defined distance of a second UAV, as in **1002**. The defined distance may be any defined distance between UAVs (e.g., one mile). Upon determination that the first UAV is within a defined distance of the second UAV, flight plans of the UAV(s) is received, as in **1004**. For example, the two UAVs may each transmit flight plans. Alternatively, the collective UAV configuration system may periodically receive and/or determine flight plans for the UAVs.

**[0068]** Based on the flight plans, a determination is made as to whether the flight plans of the two UAVs are complementary and whether the two UAVs should be coupled to form a collective UAV, as in **1008**. For example, if both flight plans are similar, in a similar direction, toward a similar destination (e.g., delivery area, materials handling facility), it may be determined that the flight plans of the two

UAVs are complementary. Likewise, it may be determined that the UAVs should couple if they are both capable of coupling to one another, if there is sufficient distance remaining in their respective flight plans that coupling will be beneficial, etc. Other factors may also be considered in determining whether the UAVs should couple. For example, the net energy that will be saved by coupling the UAVs into a collective UAV may be estimated and considered, the increased visibility of the collective UAV may be considered, the lifting capacity of the collective UAV may be considered, etc.

**[0069]** If it is determined that either the flight plans are not complementary and/or that the two UAVs should not couple, the example process **1000** completes, as in **1018**. However, if it is determined that the flight plans are complementary and that the UAVs should couple, a collective UAV configuration is determined, as in **1012**. As discussed above, any collective UAV configuration may be determined.

**[0070]** Upon determining the collective UAV configuration, the first UAV and the second UAV couple to form a collective UAV according to the determined collective UAV configuration, as in **1014**. The flight plans are also updated or a single flight plan for the collective UAV is determined based on the destinations of each UAV, as in **1016**. For example, if the two UAVs are navigating to different destinations that are separated by a distance, a collective UAV flight plan may be determined that causes that collective UAV to aerially navigate to a point between the two destinations before the two UAVs decouple and complete navigation independently to the respective destinations. In some implementations, the point between the destinations may be a midpoint. In other implementations, the point between the destinations may be determined based on the location of the destinations, the power and navigation capabilities of the UAVs, the delivery time for the UAVs, etc. For example, a first UAV may have more power remaining than a second UAV so the flight plan may instruct the collective UAV to navigate toward the destination of the first UAV and for the second UAV to decouple at a point along the flight plan to complete navigation to the destination of the second UAV.

**[0071]** FIG. **11** is a flow diagram of an example collective UAV navigation process **1100**, according to an implementation. The example process **1100** begins by detecting a coupling of a UAV with the collective UAV, as in **1102**. As discussed above with respect to FIG. **10**, a UAV may be instructed to couple with the collective UAV according to a collective UAV configuration. Once the UAV couples with the collective UAV, the coupling is detected by at least one other UAV of the collective UAV. For example, a first UAV of the collective UAV to which a second UAV couples may determine that the second UAV has coupled with the collective UAV.

**[0072]** Upon coupling, the UAV configuration information of the coupled UAV is received from the coupled UAV, as in **1104**. The UAV configuration information may include a UAV identifier, navigation information, power supply capabilities, motor and propeller configuration, weight of the UAV and/or payload, the location of the UAV's sensors, etc. In addition to receiving UAV configuration information from the coupled UAV, the collective UAV configuration information may be provided to the coupled UAV, as in **1106**. The collective UAV configuration information may identify, for example, the navigation information of the collective UAV, operating parameters, the configuration of the collective UAV, the sensor locations of sensors that are being used by the collective UAV, etc.

**[0073]** In addition to exchanging information, the configuration of the collective UAV may be updated to include the coupled UAV, as in **1108**. In addition, a determination may be made as to whether any resources should be distributed or redistributed based on the addition of a UAV to the collective UAV, as in **1110**. As discussed above, one or more resources (e.g., power, motors/propellers, control systems, etc.) may be shared among multiple UAVs of a collective UAV. In some implementations, UAVs on the perimeter of a collective UAV may operate their motors to provide the lifting force to aerially navigate the collective UAV. In such an implementation, the rotational speed of motors of internal UAVs and/or the internal motors of perimeter UAVs may be reduced or terminated to conserve power. Accordingly, when a UAV couples with a collective UAV, it may be determined whether resources are to be distributed or redistributed. For example, the UAV that coupled with the collective UAV may be instructed to continue rotating its motors and propellers to provide lift and another UAV may be instructed to reduce or terminate the rotation of its motors and corresponding propellers.

**[0074]** In addition to distributing or redistributing the resources of the collective UAV, the flight plan of the collective UAV is updated, as in **1112**. For example, the heading of the collective UAV may be adjusted to account for the destination of the added UAV and/or may be adjusted based on the power capabilities of the added UAV. The example process **1100** then completes, as in **1114**.

**[0075]** FIG. **12** is a flow diagram of a collective UAV decoupling process **1200**, according to an implementation. The example process **1200** begins when a decoupling of a UAV from the collective UAV is determined, as in **1202**. As discussed above with respect to FIGS. **6** and **9**, a UAV may decouple from the collective UAV to, for example, complete delivery of a payload to a delivery destination. Once the UAV decouples from the collective UAV, the decoupling is detected by at least one other UAV of the collective UAV. For example, a first UAV of the collective UAV from which a second UAV decoupled may determine that the second UAV has decoupled from the collective UAV. Likewise, the second UAV may provide a notification that it is decoupling from the collective UAV.

**[0076]** Upon decoupling, the updated collective UAV configuration is determined for the collective UAV, as in **1204**. Based on the updated collective UAV configuration, a determination is made as to whether the collective UAV should reconfigure, as in **1206**. For example, as discussed above with respect to FIG. **6**, if the remaining UAVs of the collective UAV may be reconfigured in a manner that provides more efficiency, power savings, etc., it may be determined that the collective UAV is to be reconfigured.

**[0077]** If it is determined that the collective UAV is to reconfigure, instructions are sent to the UAV that remain part of the collective UAV to complete the reconfiguration of the collective UAV, as in **1208**. Once the collective UAV is reconfigured, the updated collective UAV configuration is determined, as in **1210**. After either reconfiguring the collective UAV or if it is determined that the collective UAV is not to be reconfigured (block **1206**), the resources of the collective UAV are distributed and/or redistributed according to the updated UAV configuration, as in **1212**. As discussed above, one or more resources (e.g., power, motors/

propellers, control systems, etc.) may be shared among multiple UAVs of a collective UAV. In some implementations, UAVs on the perimeter of a collective UAV may operate their motors to provide the lifting force to aerially navigate the collective UAV. In such an implementation, the rotational speed of motors of internal UAVs and/or the internal motors of perimeter UAVs may be reduced or terminated to conserve power. Accordingly, when a UAV decouples from a collective UAV, it may be determined whether resources are to be distributed or redistributed. For example, if the UAV that decoupled from the collective UAV was on the perimeter and providing lifting force for the collective UAV, it may be determined that the resources of the collective UAV need to be redistributed so that a remaining UAV can assume the responsibility of rotating its motors and corresponding propellers to provide lifting force for the collective UAV.

**[0078]** In addition to distributing or redistributing the resources of the collective UAV, the flight plan of the collective UAV is updated, as in **1214**. For example, the heading of the collective UAV may be adjusted to account for the decoupling of the UAV. The example process **1200** then completes, as in **1216**.

**[0079]** FIG. **13** is a flow diagram of an example collective UAV planning process **1300**, according to an implementation. The example collective UAV planning process **1300** may be performed by the collective UAV configuration system **1528**. For example, the collective UAV configuration system **1528** may perform that collective UAV planning process while items are being packaged for delivery at a materials handling facility to determine a collective UAV that will aerially navigate from the materials handling facility to a delivery area.

**[0080]** The example process **1300** begins by determining UAVs that have or will have complementary flight plans during a defined time window, as in **1302**. For example, items ordered by customers may each have similar delivery expectations and/or delivery times. Based on the delivery times, the distance between the materials handling facility from which the items will be transported and the speed of aerial transport, an approximate departure time can be determined for the UAVs that will transport the items. If the approximate departure time is within the defined time window and the flight plans are complementary, the UAVs may be selected for forming a collective UAV.

**[0081]** Based on the number of UAVs determined at block **1302**, a collective UAV configuration is determined, as in **1304**. The collective UAV configuration may specify the shape of the configuration and where in the collective UAV configuration each UAV is to be positioned. The positioning of the UAVs in the collective UAV configuration may be determined based on the power capabilities of the UAVs, the motors, propellers and/or lifting capabilities of the UAVs, the size of the UAVs, the payload weight of the UAVs, the location of the delivery destinations of the UAVs, etc. For example, UAVs that will decouple first from the collective UAV may be positioned on a perimeter of the collective UAV.

**[0082]** In addition to determining the collective UAV configuration, a collective UAV resource distribution is determined for the collective UAV, as in **1306**. Similar to positioning of the UAVs in the collective UAV configuration, resource distribution may be determined based on, for example, the power capabilities of the UAVs, the motors, propellers and/or lifting capabilities of the UAVs, the size of the UAVs, the payload weight of the UAVs, the location of the delivery destinations of the UAVs, etc. For example, UAVs that will have excess power based on the distance to their delivery destination and/or payload weight, may be instructed to provide power to other UAVs of the collective UAV to enable operation of the collective UAV.

**[0083]** Based on the determined UAVs, determined collective UAV configuration, and determined resource distribution, instructions are sent to each UAV that is be included in the collective UAV to configure into the collective UAV and distribute resources according to the determined resource distribution, as in **1308**. The instructions may be sent to the UAVs as the ordered items are packed and prepared for departure, as part of their navigation instructions, etc. Finally, the example process **1300** completes, as in **1310**.

**[0084]** FIG. **14** is a block diagram illustrating an example UAV control system **110**. In various examples, the block diagram may be illustrative of one or more aspects of the UAV control system **110** that may be used to implement the various systems and methods discussed herein and/or to control operation of the UAVs described herein. In the illustrated implementation, the UAV control system **110** includes one or more processors **1402**, coupled to a memory, e.g., a non-transitory computer readable storage medium **1420**, via an input/output (I/O) interface **1410**. The UAV control system **110** may also include electronic speed controls **1404** (ESCs), power supply modules **1406**, a navigation system **1407**, and/or an inertial measurement unit (IMU) **1412**. In some implementations, the IMU may be incorporated into the navigation system **1407**. The UAV control system **110** may also include a coupling controller **1419** configured to control the coupling component(s) that is used to couple/decouple the UAV from other UAVs. The UAV control system **110** may also include a payload engagement controller (not shown), a network interface **1416**, and one or more input/output devices **1417**.

**[0085]** In various implementations, the UAV control system **110** may be a uniprocessor system including one processor **1402**, or a multiprocessor system including several processors **1402** (e.g., two, four, eight, or another suitable number). The processor(s) **1402** may be any suitable processor capable of executing instructions. For example, in various implementations, the processor(s) **1402** may be general-purpose or embedded processors implementing any of a variety of instruction set architectures (ISAs), such as the x86, PowerPC, SPARC, or MIPS ISAs, or any other suitable ISA. In multiprocessor systems, each processor(s) **1402** may commonly, but not necessarily, implement the same ISA.

**[0086]** The non-transitory computer readable storage medium **1420** may be configured to store executable instructions, data, flight plans, flight control parameters, collective UAV configuration information, UAV configuration information, and/or data items accessible by the processor(s) **1402**. In various implementations, the non-transitory computer readable storage medium **1420** may be implemented using any suitable memory technology, such as static random access memory (SRAM), synchronous dynamic RAM (SDRAM), nonvolatile/Flash-type memory, or any other type of memory. In the illustrated implementation, program instructions and data implementing desired functions, such as those described herein, are shown stored within the non-transitory computer readable storage medium **1420** as program instructions **1422**, data storage **1424** and flight controls **1426**, respectively. In other implementations, program instructions, data, and/or flight controls may be received, sent, or stored upon different types of computer-accessible media, such as non-transitory media, or on similar media separate from the non-transitory computer readable storage medium **1420** or the UAV control system **110**. Generally speaking, a non-transitory, computer readable storage medium may include storage media or memory media such as magnetic or optical media, e.g., disk or CD/DVD-ROM, coupled to the UAV control system **110** via the I/O interface **1410**. Program instructions and data stored via a non-transitory computer readable medium may be transmitted by transmission media or signals, such as electrical, electromagnetic, or digital signals, which may be conveyed via a communication medium such as a network and/or a wireless link, such as may be implemented via the network interface **1416**.

**[0087]** In one implementation, the I/O interface **1410** may be configured to coordinate I/O traffic between the processor (s) **1402**, the non-transitory computer readable storage medium **1420**, and any peripheral devices, the network interface and/or other peripheral interfaces, such as input/output devices **1417**. In some implementations, the I/O interface **1410** may perform any necessary protocol, timing or other data transformations to convert data signals from one component (e.g., non-transitory computer readable storage medium **1420**) into a format suitable for use by another component (e.g., processor(s) **1402**). In some implementations, the I/O interface **1410** may include support for devices attached through various types of peripheral buses, such as a variant of the Peripheral Component Interconnect (PCI) bus standard or the Universal Serial Bus (USB) standard, for example. In some implementations, the function of the I/O interface **1410** may be split into two or more separate components, such as a north bridge and a south bridge, for example. Also, in some implementations, some or all of the functionality of the I/O interface **1410**, such as an interface to the non-transitory computer readable storage medium **1420**, may be incorporated directly into the processor(s) **1402**.

**[0088]** The ESCs **1404** communicate with the navigation system **1407** and/or the IMU **1412** and adjust the rotational speed of each lifting motor to stabilize the UAV and guide the UAV along a determined flight plan. The navigation system **1407** may include a GPS, indoor positioning system (IPS), IMU or other similar system and/or sensors that can be used to navigate the UAV **100** to and/or from a location. The payload engagement controller communicates with the actuator(s) or motor(s) (e.g., a servo motor) used to engage and/or disengage items.

**[0089]** The coupling controller **1419** communicates with the processor **1402** and/or other components and controls the coupling, data and/or resources sharing between the UAV and other coupled UAVs. For example, if the coupling component is an electromagnet, the coupling controller **1419** may be utilized to activate the electromagnet to couple the UAV with another UAV or deactivate the electromagnet to decouple the UAV from another UAV.

**[0090]** The network interface **1416** may be configured to allow data to be exchanged between the UAV control system **110**, other devices attached to a network, such as other computer systems (e.g., remote computing resources), and/or with UAV control systems of other UAVs. For example, the network interface **1416** may enable communication between the UAV that includes the control system **110** and a UAV control system of another coupled UAV. In another example, the control system **110** may enable wireless communication between the UAV that includes the control system **110** and a UAV control system that is implemented on one or more remote computing resources. For wireless communication, an antenna of a UAV and/or other communication components may be utilized. As another example, the network interface **1416** may enable wireless or wired communication between numerous UAVs. For example, when UAVs are coupled, they may utilize a wired communication via the coupling components to communicate.

**[0091]** When UAVs are not coupled, they may utilize wireless communication to communicate. In various implementations, the network interface **1416** may support communication via wireless general data networks, such as a Wi-Fi, satellite, and/or cellular networks.

**[0092]** Input/output devices **1417** may, in some implementations, include one or more displays, imaging devices, thermal sensors, infrared sensors, time of flight sensors, accelerometers, pressure sensors, weather sensors, cameras, gimbals, landing gear, etc. Multiple input/output devices **1417** may be present and controlled by the UAV control system **110**. One or more of these sensors may be utilized to assist in landing as well as to avoid obstacles during flight.

**[0093]** As shown in FIG. **14**, the memory may include program instructions **1422**, which may be configured to implement the example processes and/or sub-processes described herein. The data storage **1424** may include various data stores for maintaining data items that may be provided for determining flight plans, landing, identifying locations for disengaging items, engaging/disengaging the pushing motors, etc. In various implementations, the parameter values and other data illustrated herein as being included in one or more data stores may be combined with other information not described or may be partitioned differently into more, fewer, or different data structures. In some implementations, data stores may be physically located in one memory or may be distributed among two or more memories.

**[0094]** Those skilled in the art will appreciate that the UAV control system **110** is merely illustrative and is not intended to limit the scope of the present disclosure. In particular, the computing system and devices may include any combination of hardware or software that can perform the indicated functions. The UAV control system **110** may also be connected to other devices that are not illustrated, or instead may operate as a stand-alone system. In addition, the functionality provided by the illustrated components may, in some implementations, be combined in fewer components or distributed in additional components. Similarly, in some implementations, the functionality of some of the illustrated components may not be provided and/or other additional functionality may be available.

**[0095]** Those skilled in the art will also appreciate that, while various items are illustrated as being stored in memory or storage while being used, these items or portions of them may be transferred between memory and other storage devices for purposes of memory management and data integrity. Alternatively, in other implementations, some or all of the software components may execute in memory on another device, such as a UAV control system of a coupled UAV, and communicate with the illustrated UAV control system **110**. Some or all of the system components or data structures may also be stored (e.g., as instructions or structured data) on a non-transitory, computer-accessible medium or a portable article to be read by an appropriate drive. In some implementations, instructions stored on a computer-accessible medium separate from the UAV control system **110** may be transmitted to the UAV control system **110** via transmission media or signals such as electrical, electromagnetic, or digital signals, conveyed via a communication medium such as a wireless link. Various implementations may further include receiving, sending, or storing instructions and/or data implemented in accordance with the foregoing description upon a computer-accessible medium. Accordingly, the techniques described herein may be practiced with other UAV control system configurations.

**[0096]** FIG. **15** is a pictorial diagram of an illustrative implementation of a server system **1520** that may be used in the implementations described herein. The server system **1520** may include a processor **1500**, such as one or more redundant processors, a video display adapter **1502**, a disk drive **1504**, an input/output interface **1506**, a network interface **1508**, and a memory **1512**. The processor **1500**, the video display adapter **1502**, the disk drive **1504**, the input/output interface **1506**, the network interface **1508**, and/or the memory **1512** may be communicatively coupled to each other by a communication bus **1510**.

**[0097]** The video display adapter **1502** provides display signals to a display (not shown in FIG. **15**) permitting an agent of the server system **1520** to monitor and configure operation of the server system **1520** and/or to provide information (e.g., regarding collective configurations, navigation paths, etc.). The input/output interface **1506** likewise communicates with external input/output devices not shown in FIG. **15**, such as a mouse, keyboard, scanner, or other input and output devices that can be operated by an agent of the server system **1520**. The network interface **1508** includes hardware, software, or any combination thereof, to communicate with other computing devices. For example, the network interface **1508** may be configured to provide communications between the server system **1520** and other computing devices, such as that of a materials handling facility, delivery location, and/or UAV, via a network.

**[0098]** The memory **1512** generally comprises random access memory (RAM), read-only memory (ROM), flash memory, and/or other volatile or permanent memory. The memory **1512** is shown storing an operating system **1514** for controlling the operation of the server system **1520**. A binary input/output system (BIOS) **1516** for controlling the low-level operation of the server system **1520** is also stored in the memory **1512**.

**[0099]** The memory **1512** additionally stores program code and data for providing network services to UAVs, materials handling facilities, the inventory management system **1526**, and/or the collective UAV configuration system **1528**. The program instructions enable communication with a data store manager application **1521** to facilitate data exchange between the data store **1509**, the inventory management system **1526** and/or the collective UAV configuration system **1528**.

**[0100]** As used herein, the term "data store" refers to any device or combination of devices capable of storing, accessing, and retrieving data, which may include any combination and number of data servers, databases, data storage devices and data storage media, in any standard, distributed or clustered environment. The server system **1520** can include any appropriate hardware and software for integrating with the data store **1509** as needed to execute aspects of one or more applications for a collective UAV, materials handling facility, delivery location, collective UAV configuration system **1528**, and/or the inventory management system **1526**.

**[0101]** The data store **1509** can include several separate data tables, databases or other data storage mechanisms and media for storing data relating to a particular aspect. For example, the illustrated data store **1509** includes mechanisms for maintaining information related to operations, inventory, maps, GPS data, etc., which can be used to generate and deliver information to one or more UAVs, the inventory management system **1526**, and/or the collective UAV configuration system **1528**. It should be understood that there might be additional aspects that can be stored in the data store **1509** and that additional data stores beyond the one illustrated may be included. For example the data store **1509** may maintain collective UAV configurations and information relating to efficiency, flight duration, etc., of UAVs when coupled according to each collective UAV configuration. The data store **1509** is operable, through logic associated therewith, to receive instructions from the server system **1520** and obtain, update or otherwise process data in response thereto.

**[0102]** The memory **1512** may also include the inventory management system **1526**, discussed above. The inventory management system **1526** may be executable by the processor **1500** to implement one or more of the functions of the server system **1520**. In one implementation, the inventory management system **1526** may represent instructions embodied in one or more software programs stored in the memory **1512**. In another implementation, the inventory management system **1526** can represent hardware, software instructions, or a combination thereof.

**[0103]** The memory **1512** may also include the collective UAV configuration system **1528**, discussed above. The collective UAV configuration system **1528** may be executable by the processor **1500** to implement one or more of the functions of the server system **1520**. In one implementation, the collective UAV configuration system **1528** may represent instructions embodied in one or more software programs stored in the memory **1512**. In another implementation, the collective UAV configuration system **1528** can represent hardware, software instructions, or a combination thereof.

**[0104]** The server system **1520**, in one implementation, is a distributed environment utilizing several computer systems and components that are interconnected via communication links, using one or more computer networks or direct connections. However, it will be appreciated by those of ordinary skill in the art that such a system could operate equally well in a system having fewer or a greater number of components than are illustrated in FIG. **15**. Thus, the depiction in FIG. **15** should be taken as being illustrative in nature and not limiting to the scope of the disclosure.

**[0105]** Those skilled in the art will appreciate that in some implementations the functionality provided by the processes and systems discussed above may be provided in alternative ways, such as being split among more software modules or routines or consolidated into fewer modules or routines. Similarly, in some implementations, illustrated processes and systems may provide more or less functionality than is described, such as when other illustrated processes instead lack or include such functionality respectively, or when the amount of functionality that is provided is altered. In addition, while various operations may be illustrated as being performed in a particular manner (e.g., in serial or in parallel) and/or in a particular order, those skilled in the art will appreciate that, in other implementations, the operations may be performed in other orders and in other manners. The various methods, systems, and processes as illustrated in the figures and described herein represent example implementations. The methods, systems, and processes may be implemented in software, hardware, or a combination thereof in other implementations. Similarly, the order of any process may be changed and various elements may be added, reordered, combined, omitted, modified, etc., in other implementations.

**[0106]** Although the subject matter has been described in language specific to structural features and/or methodological acts, it is to be understood that the subject matter defined in the appended claims is not necessarily limited to the specific features or acts described. Rather, the specific features and acts are disclosed as exemplary forms of implementing the claims.

What is claimed is:

**1**. A collective unmanned aerial vehicle ("UAV"), comprising:

a first UAV, including:

a first motor and a second motor;

a first propeller coupled to the first motor;

a second propeller coupled to the second motor;

a first UAV control system configured to provide rotational speed instructions to each of the first motor and the second motor;

a first power module configured to provide power to at least one of the first UAV control system, the first motor, or the second motor;

a first connection component configured to connect the first UAV with a second UAV;

the second UAV removably coupled to the first UAV, including:

a third motor and a fourth motor;

a third propeller coupled to the third motor;

a fourth propeller coupled to the fourth motor;

a second connection component configured to couple the second UAV with the first UAV;

a second power module configured to provide power to at least one of a second UAV control system, the third motor, or the fourth motor;

the second UAV control system configured to provide rotational speed instructions to each of the third motor and the fourth motor, wherein the second UAV control system is further configured to at least:

receive first UAV configuration information from the first UAV;

determine a collective UAV configuration based at least in part on the first UAV configuration and a second UAV configuration for the second UAV;

determine a rotational speed for the third motor, wherein the rotational speed is determined based at least in part on the collective UAV configuration; and

send a rotational speed instruction to the third motor to adjust the rotational speed of the third motor.

**2**. The collective UAV of claim **1**, wherein the rotational speed instruction is an instruction for the third motor to stop a rotation of the third propeller.

**3**. The collective UAV of claim **1**, wherein the first connection component of the first UAV is coupled to the second connection component of the second UAV.

**4**. The collective UAV of claim **3**, wherein at least one of data or power may be exchanged between the first UAV and the second UAV between the first connection component and the second connection component.

**5**. The collective UAV of claim **1**, wherein the first connection component and the second connection component provide at least one of an electrical coupling between the first UAV and the second UAV, a mechanical coupling between the first UAV and the second UAV, an electromechanical coupling between the first UAV and the second UAV, a magnetic coupling between the first UAV and the second UAV, or an optical coupling between the first UAV and the second UAV.

**6**. A method to provide aerial delivery of an item to a delivery destination, the method comprising:

coupling the item to a first unmanned aerial vehicle ("UAV"), wherein the first UAV is capable of aerial navigation;

coupling the first UAV to a second UAV, wherein the second UAV is capable of aerial navigation;

aerially transporting the item, using the first UAV coupled with the second UAV, to a delivery area; and

delivering the item to the delivery destination within the delivery area.

**7**. The method of claim **6**, further comprising:

aerially navigating the first UAV and the second UAV to a location within the delivery area;

decoupling the first UAV from the second UAV; and

aerially transporting the item using the first UAV from the location to the delivery destination.

**8**. The method of claim **6**, wherein a second item is coupled to the second UAV and the second UAV is configured to aerially transport the second item to a second delivery destination.

**9**. The method of claim **6**, further comprising:

receiving a request from a third UAV to couple with at least one of the first UAV or the second UAV;

determining a collective UAV configuration for a coupling of the first UAV, the second UAV, and the third UAV; and

instructing the third UAV to couple with at least one of the first UAV or the second UAV according to the collective UAV configuration.

**10**. The method of claim **9**, further comprising:

determining that a first flight plan of the third UAV and a second flight plan of the coupled first UAV and second UAV are complementary.

**11**. The method of claim **9**, further comprising:

detecting a decoupling of the second UAV from at least one of the first UAV or the third UAV;

determining an updated collective UAV configuration based at least in part on the first UAV and the third UAV;

determining that the updated collective UAV configuration is to be reconfigured; and

causing a reconfiguration of a coupling between the first UAV and the third UAV.

**12**. The method of claim **6**, further comprising:

determining a resource distribution for distributing resources between the first UAV and the second UAV while coupled.

**13**. The method of claim **12**, wherein the resources include at least one of: a power module, a computing component, a navigation component, a camera, a motor, or a control system.

**14**. The method of claim **6**, further comprising:

determining, based at least in part on the coupling between the first UAV and the second UAV, a rotational speed for at least one motor of a plurality of motors of the first UAV.

**15**. The method of claim **6**, wherein coupling the first UAV and the second UAV is done during aerial transport of the item.

**16**. A computer implemented method, comprising:

under control of one or more computing systems configured with executable instructions,

determining a plurality of unmanned aerial vehicles ("UAV") each having a complementary flight plan during a defined time window;

determining a collective UAV configuration in which each UAV of the plurality of UAVs is coupled to at least one other UAV of the plurality of UAVs; and

instructing each of the plurality of UAVs to couple with at least one other UAV of the plurality of UAVs according to the collective UAV configuration to form a collective UAV.

**17**. The computer implemented method of claim **16**, further comprising:

determining a collective UAV resource distribution for the collective UAV; and

instructing each of the plurality of UAVs to distribute resources according to the collective UAV resource distribution.

**18**. The computer implemented method of claim **16**, further comprising:

instructing each of the plurality of UAVs to aerially navigate while coupled to the at least one other UAV of the plurality of UAVs.

**19**. The computer implemented method of claim **16**, wherein at least one of the plurality of UAVs is coupled to an item that is to be aerially transported to a delivery destination.

**20**. The computer implemented method of claim **16**, wherein at least one of the plurality of UAVs is not coupled to an item that is to be aerially transported to a delivery destination.

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