Nov. 15, 1960 R. F. PATTERSON 2,960,291

ARTICULATED ARM AERODYNAMIC DRAG DEVICE

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Fig. 2

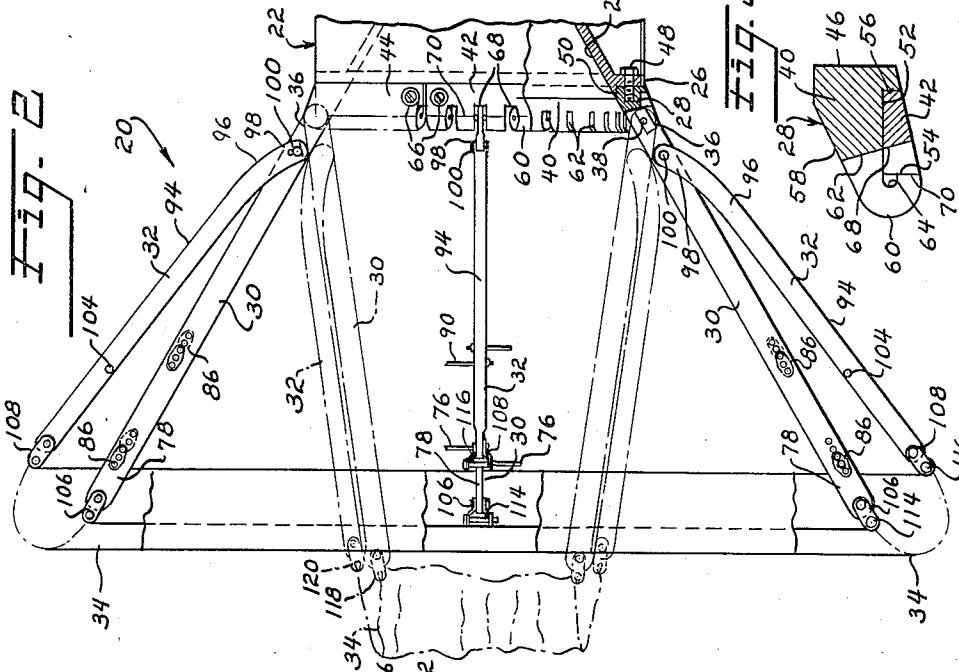
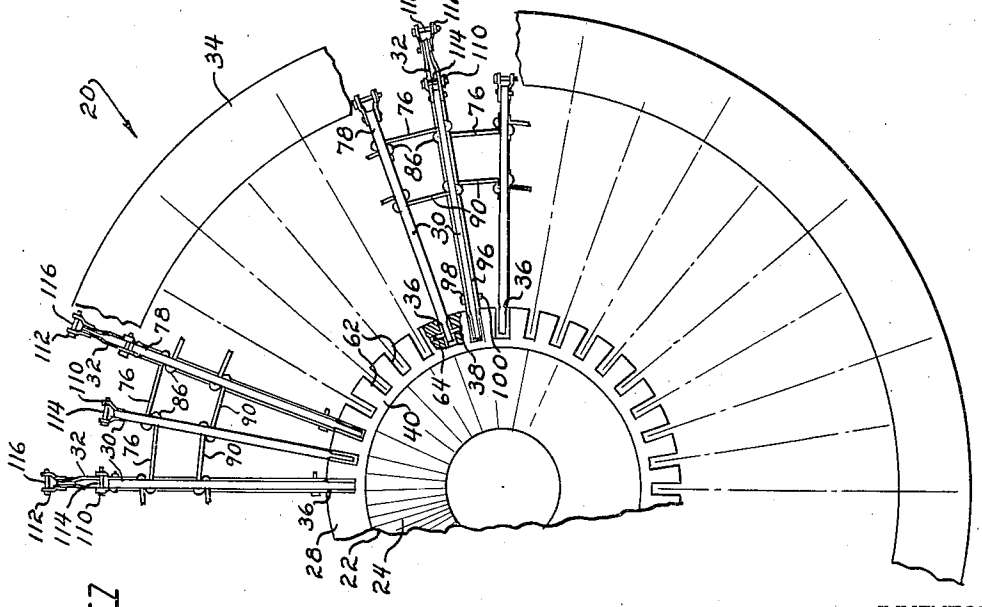


Fig. 3

Fig. 1



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2 Sheets-Sheet 2

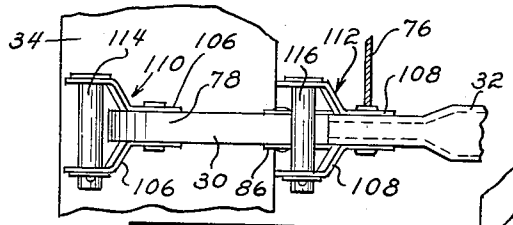


Fig. 4

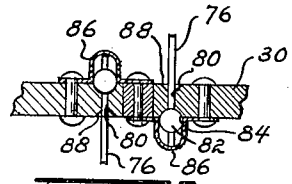


Fig. 6

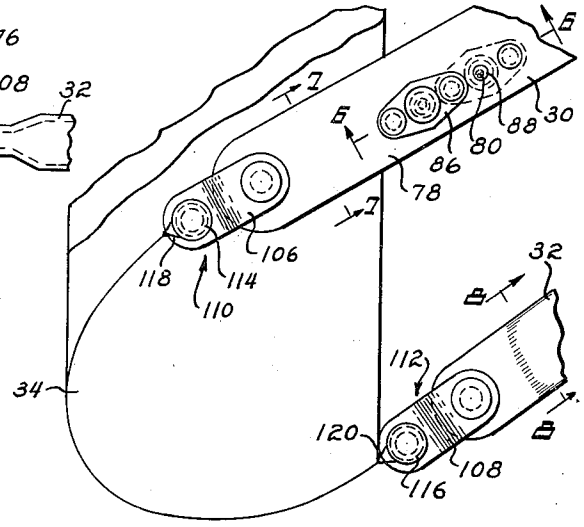


Fig. 5



Fig. 7

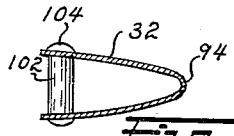


Fig. 8

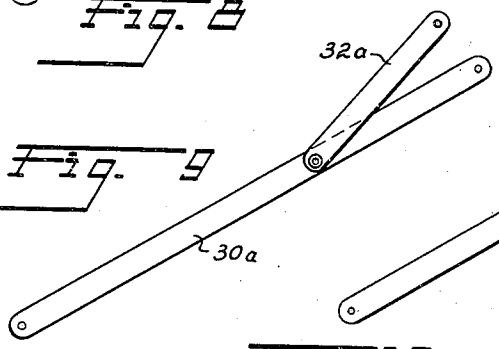


Fig. 9

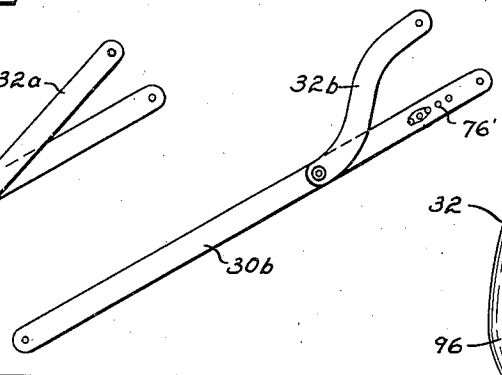


Fig. 10

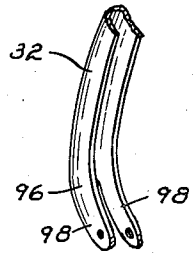


Fig. 12

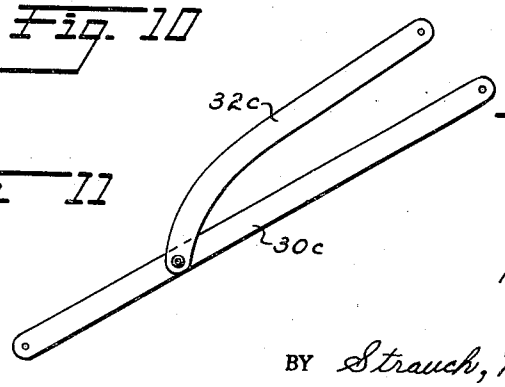


Fig. 11

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ARTICULATED ARM AERODYNAMIC DRAG DEVICE

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19 Claims. (Cl. 244—113)

This invention relates to an improvement in collapsible aerodynamic drag devices and is more particularly related to a support structure with articulated arm members for carrying a collapsible annular drag canopy.

The original concept of the annular canopy drag device with relatively rigid pivotally mounted arms is disclosed in copending application for United States patent Serial No. 553,276, filed December 15, 1955, now United States Patent No. 2,823,881, the disclosed canopy support structure having two annular sets of rigid arms, one for the inner perimeter of a collapsible ring parachute canopy and the other set for the outer perimeter of the canopy. Since a primary use of this device was for inflight refueling drogues, the inner perimeter of the canopy conveniently enabled insertion of a probe coupling and the inner set of arms were utilized as a conical form guide fence converging toward a trailing reception coupling, the support arms being pivotally mounted on the perimeter of the reception coupling. Such a reception coupling would be attached to the end of a trailing hose from a tanker aircraft.

The dynamic forces on the ring canopy maintain the inner support arms divergent in the locus of a cone and a divergency limiting means was used in cooperation with the inner arms to maintain a specific conical divergence which also in effect controls the inner diameter of the canopy under dynamic conditions. The outer support arms are used to hold the outer canopy perimeter against the drag force exerted by the air on the annular portion of canopy between the two arms. As is particularly true of the preferred ring-foil-slot canopy disclosed in the aforementioned Patent No. 2,823,881 and also disclosed and claimed in application Serial No. 632,880, filed January 7, 1957, the edge portions of the canopy adjacent its attachment to inner and outer support arms are effective continuous airfoils while the center portion of the canopy serves as an annular drag bucket. The forces on the inner and outer continuous airfoil portions maintain the canopy in expanded form, and greater or less divergence between the inner and outer support arms to automatically vary the canopy drag coefficient at varying airspeeds is enabled by the essentially unlimited pivotal mounting of the outer support arms.

The present invention utilizes the same principle of automatically varying the canopy shape under varying airspeeds by relative pivotal movement between an outer set of canopy support arms and an inner set of support arms. However, as it is desirable to reduce mass and weight of the entire support assembly, to reduce necessary precision machining of the base support pivotal attachments, and to reduce drag area in front of the canopy for reasons expounded in the aforementioned United States Patent No. 2,823,881, this improvement invention, encompassing an articulated support arm assembly, was developed and has resulted in improved over-all construction by retaining inner canopy support arms as essentially elongate bar members pivotally fastened to the perimeter of a base structure and which retain their functional usefulness as

a probe guide fence, and the arms of the outer set of canopy supports are pivotally retained on certain members of the inner set of supports, e.g., alternate inner arms.

In addition to the articulated support arm construction, further improvements are present in the lashing devices and the end connections for attaching canopy connection loops.

Accordingly a primary object of this invention resides in the provision of a novel improved lightweight collapsible aerodynamic drag apparatus with articulated support arm devices having a decreased support structure drag effect.

Another object resides in providing a novel annular collapsible canopy support structure with a plurality of elongate substantially rigid inner arms for attachment to the inner perimeter of an annular canopy and pivotally connected to a perimetral portion of base structure and articulated auxiliary outer canopy support arms pivotally attached to associated ones of the inner arms at an intermediate position on the associated inner arm.

Still another object resides in the provision of a novel articulated arm device for use in supporting an annular collapsible parachute canopy, the device comprising a substantially rigid elongate bar member with one end portion for pivotal attachment to a base structure and another end portion for attachment to a member on one perimeter of a canopy, and an auxiliary arm pivotally fastened at one end to an intermediate position on the elongate bar member with a device at its other end for attachment to a member on the other perimeter of the canopy.

In conjunction with the foregoing object, a further novel object resides in the provision of cooperating streamlined cross-sections of the elongate bar and the auxiliary arm, which is channel shaped and disposed to partially embrace the bar at least at the attachment position.

It is still a further object to provide a novel articulated drogue structure wherein the novel auxiliary arm can be of various lengths according to specific installations and if desired a novel dog-leg offset can be provided in the auxiliary arm to prevent interference with lashing devices fastened on the elongate bar.

Further novel features and other objects of this invention will become apparent from the following detailed description, discussion and the appended claims taken in conjunction with the accompanying drawings showing preferred structures and embodiments, in which:

Figure 1 is a partial rear elevation view illustrating the annular arrangement of the canopy and support assembly of the articulated drag device of this invention, the majority of the arms being indicated diagrammatically by phantom center lines;

Figure 2 is a partially broken away side elevation view of the drag device of Figure 1, many of the articulated arm devices being omitted for clarity and simplicity and the collapsed state of the drag device being illustrated by phantom lines;

Figure 3 is an enlarged detail section through the pivot support assembly;

Figure 4 is an enlarged detail view of the ends of the support arms having fittings for attachment to the canopy;

Figure 5 is an enlarged side view of the support arm fittings shown in Figure 4;

Figure 6 is a section taken on line 6—6 of Figure 5 illustrating the lashing segment end attachments to the inner arm;

Figure 7 is an enlarged section taken on line 7—7 of Figure 5 showing the streamlined shape of an inner arm;

Figure 8 is an enlarged section taken on line 8—8 of Figure 5 showing the streamlined shape of an auxiliary outer arm;

Figures 9, 10 and 11 are alternate embodiments of auxiliary outer arms showing the various lengths and shapes that can be utilized; and

Figure 12 is a perspective view of the pivot attachment end of one of the articulated arms.

Referring now to Figures 1 and 2, a collapsible aerodynamic drag device **20** is illustrated for use in a drogue attached to a trailing hose inflight refueling reception coupling **22**, only a portion of which is shown. Coupling **22** is conventional and has a convergent inlet structure **24** which serves to guide a probe coupling into the reception coupling seating, sealing and clamping mechanism (not shown). The entrance edge of inlet structure **24** is provided with an annular radial flange **26** which serves as a mount for the drag device **20**.

Basic components of drag device **20** are an annular pivot support assembly **28**, inner arms **30**, outer arms **32** and a ring-shaped parachute canopy **34**. When a ring-shaped canopy is used as a drag device, attachment members are normally fastened between the inner perimeter of the canopy and a support and between the outer perimeter of the canopy and the support. It is particularly desirable that the inner perimeter edge of a ring canopy, and particularly a ring-foil-slot canopy which is the preferred type of canopy for use in this invention, be maintained in a substantially fixed configuration under dynamic conditions, while the outer perimeter is permitted to change under varying load conditions. Two coaxial annular groups of relatively rigid arms **30** and **32** with the ends of the arms **30** of one group fastened to spaced points on the canopy inner peripheral edge and the ends of the arms **32** of the other group fastened to spaced points on the canopy outer peripheral edge and the outer group of arms **32** being pivotally mounted in some manner to a support structure, will permit proper functioning of a ring type canopy throughout a large range of airstream velocities. As it is desirable to have the entire assembly collapsible, the inner arms **30** should also be pivotally mounted in some manner to the support structure. This dual pivotal mounting of both groups of arms **30** and **32** will permit all arms to be pivoted inwardly toward a collapsed condition as shown by phantom lines in Figure 2. With inner arms **30** being pivotally mounted on support **28**, a structure must be provided to limit divergent movement of the inner arms **30** so the trailing ends of the arms form an annular configuration which maintains the proper annular dimensions for the ring canopy. Many structures can be used to so limit the divergence of inner arms **30** and, if desired, the outer arms **32**. Several constructions are disclosed in the aforementioned copending application Serial No. 553,276, now Patent No. 2,823,881, and a further novel lashing construction will be fully described hereinafter.

By pivotally fastening only the inner group of arms **30** directly on the pivot support assembly **28**, the pivot assembly **28** can be constructed in a much simpler manner than that which would be required with both groups of arms pivoted directly on the pivot support assembly. Outer arms **32** can be indirectly pivotally mounted on the pivot support assembly **28** by pivotally securing each outer arm **32** to an associated inner arm. Thus outer arms **32** can pivot relative to the inner arms **30**, under dynamic drag conditions to permit the ring canopy to vary its dynamic drag configuration shape relative to variations in airstream velocity, and also all arms **30** and **32** can pivot on the pivot support **28**, with arms **32** having an articulated movement, to a collapsed state enabling withdrawal of the drag device **20** from an airstream. The articulated mounting of arms **32** results in shorter members, decreasing material cost and weight and also a shifting of the center of mass of the drag device **20** closer to the center of pressure on the canopy which will provide a more stable drag device.

The illustrated embodiment, being for primary use as a drag device to provide a highly stable trailing hose reception coupling, is provided with a sufficient number of inner arms to provide a coupling probe guide fence of approximately conical configuration from the inner periphery of the canopy **34** to the reception coupling inlet **24**. The number of arms **30** is such as to provide a spacing between arms **30**, when in their dynamic limited divergent position, which is less than the diametral thickness of a probe to prevent inadvertent passage of a probe between the inner arms **30** should the probe hit the arms with a side thrust when being inserted through the ring canopy into the reception coupling. When the drag device **20** is used to provide drag and stability on objects for other purposes, such as discharge of external or internal stores, spot dropping of mines or deceleration of aircraft, the spacing between inner arms will be determined by the size of the drag device and a desired minimum number of canopy attachment positions.

Only the inner arms **30** of drag device **20** (Figure 2) are directly fastened to the pivot support **28**. Each arm **30** is an elongate thin member of streamlined cross-sectional contour, shown in Figure 7, disposed in streamlined relationship with the path of air-flow essentially parallel to the longitudinal center line of reception coupling **22**. The leading ends **36** of arms **30** have a flat surface on either side, are apertured transverse to the streamlined contour, and a pivot pin **38** is force fit through the aperture. The opposite ends **78** of each arm **30** are also apertured to provide means for attaching a canopy connection fitting to be described hereinafter.

Pivot support assembly **28** can be considered an adaptor which provides a rigid support for the arms **30** and **32** and canopy **34**, and can be rigidly secured to a suitable object, in this case the reception coupling **22**. To enable the plurality of arms **30** to be rapidly assembled and disassembled from the pivot support **28** for repair, servicing and replacement, the pivot support **28** is made in three sections, an inner ring **40** and a split outer ring of two parts **42** and **44**. A radially plane annular end surface **46** on inner ring **40** enables the inner ring **40** to be disposed on the annular flange **26** of reception coupling **22**. Screws **48** projecting through holes in flange **26** are threaded into associated tapped bores in the inner ring **40**, thereby rigidly fixing ring **40** on the coupling surrounding the coupling inlet **24**. A narrow, axially disposed piloting shoulder **50** on the inner edge of flange **26** and integral with the coupling inlet **24** coacts with the inner ring **40** of pivot support **28** to assure accurate coaxial alignment of the pivot support **28** around the coupling inlet **24**.

An annular recess **52** in the outer peripheral side of inner ring **40**, clearly seen in Figure 3, provides side shoulders **54** and **56**. The inner surface **58** of ring **40** has a frusto-conical shape which matches and serves as an extension of the reception coupling inlet **24**. Surface **58** fairs into a curved end **60** of the ring **40** which is formed on a radius approximately the distance of one half the width of an inner arm **30**. A plurality of equiangularly spaced radial slots **62** are made through the curved end of ring **40**, the width of each slot being of sufficient dimension to receive the end **36** of an inner arm with a free close fit. One arm **30** can be positioned in each of slots **62** by placing an end **36** in a slot **62** from the outer side of ring **40**. The pin **38**, ends of which project from both sides of arm end **36**, will pass under the shoulder **54** on each side of slot **62** and will fit into grooves **64** undercut in shoulders **54**. After the arms **30** are placed in assembled position the outer ring parts **42** and **44** are placed in the recess **52** in inner ring **40** and secured by screws **66** to the inner ring **40**. The rear end of each outer ring part **42** and **44** has slots **68** which coextensively match the inner ring slots **62** when assembled. Division fingers **70** of ring parts **42** and **44**, between each slot **68**, are disposed closely adjacent to or abutting the inner ring shoulders **54** and under the pivot pin grooves **64**. Thus

the outer ring parts 42 and 44 lock the arms 30 in their pivotal position. Note that either or both of ring parts 42 and 44 can be removed from the inner ring 40, by removing screws 66, without removing the inner ring 40 from its mount on the reception coupling 22. This will enable removal of any arm 30 from its pivot mount. If desired the outer ring (42, 44) can be made of more than two parts so a smaller number of arms 30 are locked by each outer ring part, and in removal of a selected arm 30, the major portion of arms 30 can remain in locked assembly.

If desired, in lieu of the pivot pins 38, a continuous or multiple section locking wire can be threaded through the apertured ends 36 of arms 30, in which case a multiplicity of the arms 30 are placed as a group in their respective slots 62 with the locking wire fitting in the grooves 64. The plurality of pins at the pivot ends of arms 30 or the noted alternative continuous or multiple section locking wire can be aptly termed "ring means." A similar installation using three coaxial ring devices with inner and outer pivot wires is disclosed in aforementioned copending application Serial No. 553,276, now Patent No. 2,823,881.

Arms 30 are desirably relatively rigid and can be made from metal or composition such as a fibre impregnated plastic, "Fiberglas," or relatively rigid nylon rod, and should have a slight amount of flexibility to prevent breakage upon application of high localized momentary stresses which can occur when a probe hits the arms. Short segments of flexible lashing cable 76 (Figure 1) are secured between each of arms 30 near the rear ends 78 of the arms and, although permitting pivotal movement between the phantom line position and the full line position shown in Figure 2, will limit the outward divergence of arms 30 to the locus of a cone with a base as required by the inner perimeter of canopy 34. With specific reference to Figures 5 and 6, the lashing segments 76 have ends that project through associated holes 80 in arm 30 and have a small metal ball 82, pressure clamped or otherwise secured on each end. When the ball engages a socket 84 on the side of arm 30 as the arms 30 move to a divergent relation the lashing segment 76 will become taut and prevent further divergent movement of the adjacent arms. Shown in Figure 1 the segments 76 between adjacent pairs of arms are offset slightly. To prevent movement of the ends of lashing segments 76 into interference with adjacent arms 30 when the arms are collapsed, small caps 86 are riveted over the ball ends as shown in Figures 5 and 6. Edges 88 of holes 80 are chamfered to prevent fraying of the lashing segments 76.

One or more annular groups of similar lashing segments 90 can be used between adjacent arms 30 at positions intermediate the lashing segments 76 and pivoted ends 36 to prevent bowing of the arms which might occur if a probe were to make a direct hit between two arms during a coupling operation.

Outer arms 32 are preferably made of metal, although they can be molded of some high strength lightweight composition as previously described for the inner arms, and have a channel-shaped cross-section seen in Figure 8, the channel flanges converging to a leading edge joinder 94 of small curvature in cross-section to provide a streamlined shape which, in assembly, faces generally toward the front of drag device 20, i.e., the channel flanges will be disposed in a trailing direction relative to an airstream during dynamic operation of the drag device. The forward ends 96 of arms 32 are bifurcated (Figure 12) providing two apertured ears 98 which are placed over the inner arm 30 at a position near the pivoted ends 36 of arms 30. A pivot pin 100, projected through ears 98 and a hole in arm 30 and retained as by a cotter pin, provides a pivot mounting for the arm 32 on arm 30.

Located near the trailing end of arm 32 is a spacer 102 secured adjacent the open edge of the channel by a rivet 104. Spacer 102 is a limit abutment which, when the arms are collapsed, will engage the edge of inner arm 30 and prevent the channel-shaped arm 32 from overlapping arm 30 and contacting the lashing segments in the vicinity of the lashing segment attachment caps 86.

Apertured bracket members 106 and 108, riveted on the trailing ends of inner arm 30 and outer arm 32, respectively, provide forked fittings 110 and 112 through the ends of which are projected removable canopy loop attachment pins 114 and 116, respectively. Pins 114 and 116 can be retained in fittings 110 and 112 by safety wire or cotter pins as desired. Attachment loops 118 and 120 (Figure 5) on inner and outer peripheries, respectively, of canopy 34 are placed within respective forks 110 and 112 and the canopy loop pins then placed through the apertured fork ends and the canopy loops. The details of canopy loops 118 and 120 per se form no part of the present invention, however, if desired, a specific canopy construction with appropriate loop attachments can be seen in either of the aforementioned copending applications (one now being U.S. Patent No. 2,823,881).

The outer arms 32 need not be spaced as close together as inner arms 30 since the outer arms have no probe guiding function. In the illustrated embodiment, alternate inner arms 30 carry an outer arm 32, however, outer arms can be carried by all inner arms or some ratio of outer arms to inner arms less than 1:2 could be used provided a sufficient number of outer arms are used to maintain the outer periphery of the canopy in an approximately annular configuration.

Viewing Figure 2, the pivoted end 96 of each outer arm 32 curves in toward the inner arm 30 and provides for an essentially parallel relationship between the associated inner and outer arms when the drag device 20 is in a collapsed condition. Outer arms may be of much shorter length than that disclosed in Figures 1 and 2, for example see the arms 32*a*, 32*b* and 32*c* in Figures 9, 10 and 11 respectively. All of the embodiments of short outer arms 32*a*, 32*b* and 32*c* have channel-shaped configuration with a bifurcated pivot end similar to arms 32 and can utilize a pivot pin attachment to their respective inner arms 30*a*, 30*b* and 30*c* similar to the installation of pivot pins 100 in Figures 1 and 2. Arm 32*c* has a pivot end curvature similar to that on arm 32. Arm 32*a* illustrates the feasibility of a straight outer arm while arm 32*b* illustrates the use of a dog-leg bend in a short arm to permit an offset, at least adjacent the attachment positions of lashing segments 76′, to prevent contact between the outer arms and the lashing segments during a collapsed condition.

Generally, for ease in balance, manufacturing, assembly and standardization for replacement, all outer arms should be the same. All inner arms of desired lengths could be standardized to carry any one of a number of different lengths of outer arms merely by including a plurality of holes spaced at appropriate positions along the inner arms for receiving the outer arm pivot pins 100. Nevertheless, long and short outer arms (32, 32*a*, 32*b* or 32*c*) could be installed on associated inner arms 30 in a single drag device but care should be taken to obtain a proper balanced relationship in such annular group of different length outer arms.

Obviously the arms need not have the specific configurations disclosed since the outer arm could be fabricated of solid stock with attached bifurcated pivot devices or arms with integral bifurcated ends could be forged. The pivot end of the outer arms need not be bifurcated as it could have but one apertured ear pivotally fastened at one side of the inner arm.

Regardless of the exact shape and configuration of the inner and outer groups of arms, the foregoing description adequately discloses an improved lighter weight collapsible drag device with canopy and relatively rigid articulated support arms, a combination which is more eco-

nomical to produce, has less structure ahead of the drag canopy and is easier to service than any prior art drag device of this type.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. For use in combination with an annular collapsible canopy with inner and outer perimeters, a canopy support structure comprising: a base structure; a plurality of annularly grouped arm devices, each of said plurality of devices including a first arm means pivotally mounted at one end on said base structure and a second arm means secured intermediate the ends and to said first arm for articulated movement relative to said support, said two groups of arm means adapted to be secured to the inner and outer perimeters of such a canopy.

2. A canopy support structure as defined in claim 1, wherein said first arm means comprises a first elongate relatively rigid member having means at one end for pivotal attachment to said base structure, and means at the opposite end enabling attachment to one perimeter of such a canopy; and said second arm means comprises a second elongate relatively rigid member having means at one end pivotally secured to said first elongate member, and means at the opposite end enabling attachment to the other perimeter of such a canopy.

3. The canopy support structure as defined in claim 2, wherein a plurality of substantially rigid arms are annularly spaced and disposed between spaced ones of said arm devices, each said rigid arm being pivotally mounted at one end on said base structure and having means at the opposite end adapted to be secured to a perimeter of such a canopy.

4. The canopy support structure as defined in claim 1, wherein lashing means are secured between said arm devices to limit divergent pivotal movement of said arm devices from the axis about which said arm devices are annularly arranged.

5. An aerodynamic drag and stabilizing device comprising: an annular collapsible canopy with inner and outer perimeters with first fastening means equally circumferentially spaced about the inner perimeter and second fastening means equally circumferentially spaced about the outer perimeter, each of said second fastening means being radially aligned with an associated one of said first fastening means; an annular base structure; a plurality of first substantially rigid circumferentially disposed arms, each pivotally secured at one end to said base structure and having means at the opposite end secured to one of said first fastening means; and a plurality of second substantially rigid circumferentially spaced arms, each pivotally secured at one end to an intermediate position on an associated one of said first arms and having means at its opposite end secured to an associate one of said second fastening means.

6. The aerodynamic device as defined in claim 5 wherein lashing means interconnect all adjacent ones of said first arms at least at one position intermediate said canopy and said base structure to limit the extent of pivotal movement relative to said base structure.

7. The aerodynamic drag device as defined in claim 6 wherein said lashing means constitute cable devices disposed between adjacent ones of said first arms at least at two annular positions, one position being between said canopy and the attachment positions of said second arms and another position being between the attachment positions of said second arms and said base structure, whereby the outward divergence between adjacent ones of said first arms due to pivotal movement is limited to an essentially conical fence structure.

8. A support structure for an annular collapsible canopy comprising: a base structure with a peripheral group of pivotal attachment means; a first plurality of substantially rigid arms each having one end pivotally secured in an associated one of said attachment means and including, at its opposite end, means enabling securing of an inner perimetral fastening member on the canopy; and a second plurality of substantially rigid arms effectively shorter than said first plurality of rigid arms each being pivotally secured adjacent one of its ends to an associated one of said first plurality of rigid arms and including means adjacent its other end enabling securing of an outer perimetral fastening member on the canopy.

9. The canopy support structure as defined in claim 8 wherein said second plurality of arms have a channel-shaped cross-section whereby at least a portion of each of said second plurality of arms will be disposed in embracing relation with a portion of the associated one of said first plurality of arms adjacent the interconnections therewith.

10. The canopy support structure as defined in claim 9 wherein lashing means interconnect all adjacent ones of said first plurality of arms at least between the canopy and said connections between associated ones of said first and second plurality of arms; and each of said second plurality of arms has an offset portion adjacent its connection with its associated one of said first plurality of arms whereby said second plurality of arms can be pivoted to a position essentially parallel to and alongside the associated arms of said first plurality of arms, without interference with said lashing means.

11. For use in combination with an annular ring shaped canopy having a plurality of fastening devices along its inner and outer perimeters, a canopy support structure comprising: a base with a perimetral series of pivotal mounting means; and a plurality of canopy support arm devices at least a portion of which are articulated double arm devices, each support arm device having means providing a single pivotal connection to one of said pivotal mounting means and means enabling attachment to a perimetral fastening device on one of the perimeters of the canopy, and each of said articulated double arm devices having relatively pivotable arms, one of said arms including a said means enabling attachment to a perimetral fastening device on said one perimeter of the canopy and the other of said arms including means enabling attachment to a perimetral fastening device on the other perimeter of the canopy.

12. An aerodynamic drag construction comprising a support coupling; a series of probe guide arm devices attached to said coupling, a portion of said devices including arms which are articulated relative to said coupling; and ring-shaped canopy drag means having its inner perimeter connected to all of said devices and its outer perimeter connecting to said articulated arms whereby said probe guide arm devices are maintained in the locus of a cone when said drag construction is subjected to dynamic operating conditions and the articulated arms enable canopy perimetral adjustment upon variations in dynamic operating conditions.

13. An aerodynamic drag device comprising a support; a plurality of articulated arm devices each of which includes at least two elongate members with one of said members pivotally secured intermediate the ends of the other, and with the other of said members of all said devices pivotally secured on said support at circumferentially spaced positions, said devices extending divergently from said support; and a ring-shaped drag structure fastened to other parts of each of said members.

14. For use in combination with an aerodynamic drag device having a ring shaped collapsible drag structure and a support, a plurality of articulated arm devices with

one part of all of the devices adapted to be secured on the support at circumferentially spaced positions so the devices will extend divergently from the support and carry the ring shaped drag structure spaced from the support, each articulated arm device comprising: an elongate bar of streamlined transverse cross-section; having one end enabling pivotal attachment to a support and the other end enabling attachment to a canopy, a channel-shaped auxiliary arm member of streamlined transverse cross-section from the closed side and of such dimension to enable at least a portion of said arm member to closely embrace the streamlined elongate bar, one end of said arm member being pivotally mounted on said elongate bar at a position intermediate its ends, and the other end of said arm member including means enabling attachment to a canopy.

15. The articulated arm device of claim 14, wherein said arm member is shaped with a dog-leg offset intermediate its ends, whereby it may be pivotally positioned essentially parallel to said elongate bar without the necessity of its major portion overlapping said bar.

16. An aerodynamic drag device is defined in claim 13 wherein said support comprises: plural interengaging ring members with coextensive radial slots; pivot grooves between said slots in at least one ring member closed to form a passage between said slots by assembly of said interengaging ring members; means to maintain said interengaging ring members in assembly; and pivot means engaging the secured ends of each of said articulated arm devices and disposed in said pivot grooves to pivotally secure said articulated arm devices on said support.

17. A support adaptor for pivotally retaining the ends of a group of aerodynamic drag canopy support arm devices comprising: plural interengaging ring devices at least one device being split in at least two parts of partially circular shape, coextensive radial slots intersecting said plural ring devices and pivot grooves between said slots in at least one ring device closed to form a passage between said slots by assembly of said interengaging ring devices, and means releasably retaining the parts of said ring device which is split to one other of said ring devices.

18. A support adaptor for pivotally retaining the ends of a group of aerodynamic drag canopy support arm devices comprising: plural interengaging ring devices, one of which has a plurality of spaced radial slots in one end and an annular recess in its outer peripheral side intersecting all radial slots with outwardly disposed overhanging shoulders between each slot, a groove in each overhanging shoulder within said recess between slots adjacent each shoulder; ring segments providing a complete ring device disposed in said recess closely adjacent said shoulder and, with said grooves, providing pivot support passages between each of said plurality of slots; and means releasably securing said ring segments as a ring device in said recess.

19. A supporting structure for pivotally carrying the support arms of a ring type canopy having at least one annular group of support arms comprising: at least one ring means, said ring means including at least two segments with adjacent segment ends closely abutted, and a plurality of concentric radially slotted interlocking ring devices enclosing said ring means whereby said ring means intersects said slots in said ring devices, to provide at least one annular group of pivot journals for pivotally carrying the annular group of support arms.

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