Engineering Notes

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Inflatable System for Fast Deployment of Parachutes at Low Altitudes

H. O. Bucker*
São Paulo—SP, Brazil

Introduction

IN recent years, many tragic fires in high rise buildings have resulted in heavy loss of life. The usual fire department ladders and towers cannot be extended above a certain height; therefore there is no escape route for those trapped. A last chance escape system was investigated for firemen on rescue operations. One of the prototypes featured a frame of restrained, folded, preinflated tubes enclosed within and attached to the parachute canopy. These tubes expand the canopy almost immediately on being released, such that fast deployment is achieved at the low speeds at the beginning of the fall.

The increase in the popularity of hang gliding has been accompanied by a large increase in accidents, some of which have resulted in deaths. Conventional emergency parachutes deploy slowly at the low speeds of these aircraft. Both the expansion and deployment of the canopies depend on the speed of the air, such that, at low speeds, too much height is lost before a proper deployment can be achieved for safe landing. A similar but much lighter system based on the original concept was developed to the prototype stage for attachment to a hang glider prone pilot or to the lower part of the control trapeze. It features additional radial rigid elements connecting a much smaller preinflatable flexible frame to the canopy in a nonfixed relationship by means of attaching devices which disengage on deployment.

Description

System for Stationary Launch

This system consists of a lightweight flexible frame of a suitable shape attached to the skirt of a canopy.

The frame is folded properly and enveloped by the canopy before inflation, both being held together tightly by a restraining device, which can be a belt or any other adequate means.

The restraining device is kept locked during and after inflation and can be released when desired. The frame tends to recover its normal shape when inflated, being kept folded under tension by the retaining belt (Fig. 1).

On releasing the retaining belt, the frame recovers its unrestrained shape at a speed which depends on the gas pressure and length and diameter of the tubes, thereby expanding and exposing the attached canopy to the air rapidly (Figs. 2 and 3).

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*Chemist.

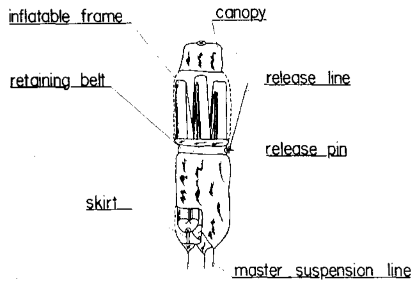

Fig. 1 Preinflated prototype for stationary launch.

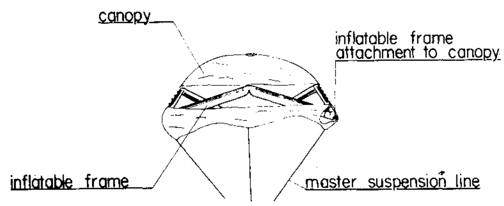

Fig. 2 Prototype for stationary launch during expansion.

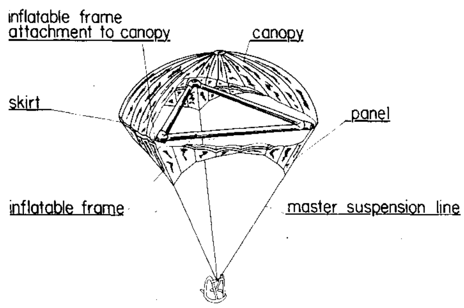

Fig. 3 Deployed prototype for stationary launch.

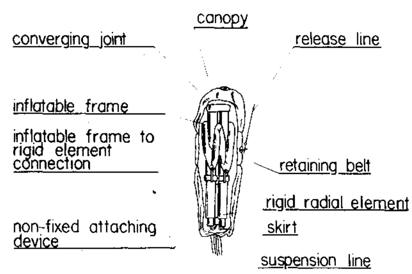

Fig. 4 Preinflated prototype for slow aircraft.

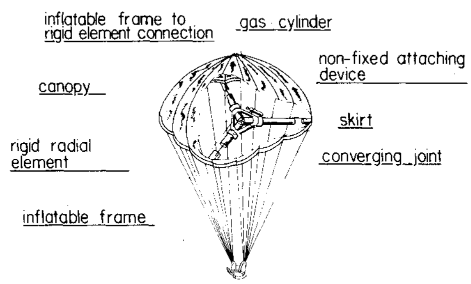

Fig. 5 Prototype for slow aircraft disengaged from deployed canopy.

System for Slow Moving Aircraft

This system is based on the same concept previously described, but it also includes additional radial rigid elements, movable around a converging joint, connecting the inflatable frame to the canopy. Smaller inflatable tubes are used, such that less gas is needed for inflation, with considerable weight and volume, as well as cost, savings (Fig. 4).

A second new feature consists of attaching devices between the extremities of the rigid elements and the canopy which hold them together in a nonfixed relationship before and during the expansion of the frame, and permits them to disengage for unrestrained deployment (Fig. 5). This device permits considerable size and weight reduction at the expense of some deployment speed since the system is smaller than the canopy's projected area.

Design and Tests

Prototype for Stationary Supports

Prototypes with the following characteristics were built for free fall drops from buildings:

1) Inflatable frame: triangular shape; one chamber of elastomer coated fabric; 0.15 m diameter; 13.5 m perimeter

2) Canopy: 22 ft; conical circular; 1.1-oz, 50-ft^3/min nylon; 24 gores; modified for three master suspension lines and side panels

3) Gas for inflation: 1 kg CO_2

4) Weight: 12 kg (including container and bottle)

Testing

Altitude: 25 m (lowest from a building)
Load: 55 kg
Frame pressure: 0.9 kg/cm^2
Frame expansion time: 0.35 s
Deployment: 11 m
Landing speed: 4.6 m/s

Prototype for Slow Aircraft

Prototypes for slow aircraft were tested from a launching pad on the top of a car. The characteristics were as follows:

1) Inflatable frame: triangular shape; one chamber of elastomer coated fabric; 0.05 m diameter; 1.6 m perimeter

2) Radial rigid elements: three resin/glass cloth tubes, 0.98 m long

3) Attachment devices: two sliding rods tied on the canopy and sheathed in the rigid radial elements

4) Canopy: conventional 22 ft; conical circular; 1.1-oz, 50-CFM nylon; 24 gores and 24 suspension lines

5) Gas for inflation: 20 g CO_2

6) Weight: 4.1 kg (including container and CO_2 cylinder)

Testing

Speed (constant): 50 km/h
Frame pressure: 4.3 kg/cm^2
Deployment time: 2 s

Conclusions

The fast expansion and deployment of canopies, obtained with lightweight prototypes of the present concepts, appear to have use in emergency parachutes at the low altitudes and speeds encountered in such sports as hang gliding, or as emergency equipment for firemen on rescue operations from buildings.

Furthermore, the availability of more modern and adequate engineering materials than those used in the tested prototypes leaves room for considerable weight and size reduction, as well as faster deployment. Somewhat smaller, lighter, and less reinforced canopies made of zero porosity nylon and lighter suspension lines are already available in the market. The use of aramid fabric on the inflatable frame should also be of benefit, especially for the fire rescue equipment.

Acknowledgments

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Department of Defense Flight Testing: An Overview

James C. O'Connor*
USAAVRADCOM, St. Louis, Mo.

Introduction

THE present Department of Defense policy of dividing DoD test and evaluation into two distinct communities, developmental and operational, has evolved over the past 20 years. During the 1960s, Secretary of Defense Robert McNamara centralized the decision process for development and procurement of major weapon systems at the Secretary level. The emphasis in acquisition decision was on cost and not on the operational effectiveness of the system. To help the decision makers, "systems analysis" and "cost-effective analysis" tradeoff studies were created. Operational testing was usually done after the production decision.

This led to several DoD studies in the late 1960s. In July 1970, the Blue Ribbon Defense Panel Report, listed three significant test and evaluation deficiencies:

1) Operational testing and evaluation (OT&E) has been inadequate and too late.

2) Service organization for OT&E is generally inadequate.

3) The most glaring deficiency of OT&E is the lack of any higher-than-service organization responsible for overseeing defense OT&E.

The "fly-before-buy" philosophy evolved from the studies and placed more emphasis on the effectiveness of the weapon system in a simulated combat environment.

In December 1972, the Report of Commission on Government Procurement, provided specific recommendations for the correction of the previous deficiencies:

1) Withhold a production decision until tested in a realistic environment.

2) Establish an OT&E activity separate from the developer and user.

Today Federal Government testing is conducted in all services under the guidance of DoD Directive 5000.3. The directive states that developmental testing will be conducted by the material developer and operational testing by an independent agency reporting directly to the service Chief of Staff level.

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*Major, U.S. Army and Aeronautical Engineer, Technical Management Division, CH-47 Modernization Program.