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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 :
B64G 1/40, 1/62, 1/42, 1/64, 5/00

A3

(11) International Publication Number: **WO 97/38903**

(43) International Publication Date: 23 October 1997 (23.10.97)

(21) International Application Number: PCT/US97/06501

(22) International Filing Date: 17 April 1997 (17.04.97)

(30) Priority Data:
08/632,786 17 April 1996 (17.04.96) US

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(81) Designated States: AL, AM, AT, AU, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

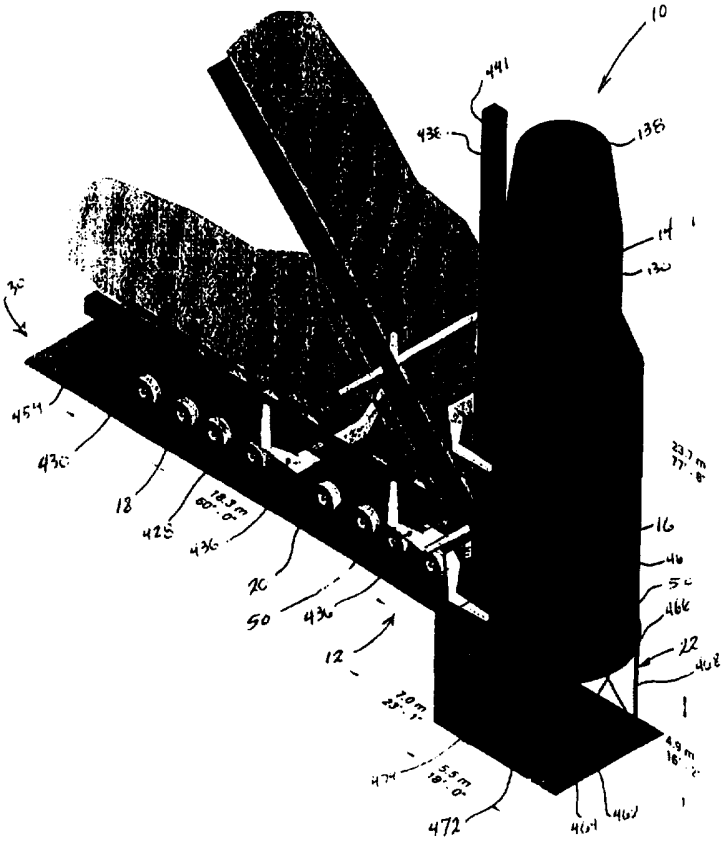
Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(88) Date of publication of the international search report:
5 March 1998 (05.03.98)

(54) Title: TWO-STAGE REUSABLE EARTH-TO-ORBIT AEROSPACE VEHICLE AND TRANSPORT SYSTEM

(57)Abstract

A two-stage wingless reusable aerospace vehicle (10) having upper and lower stages (14, 16) that take off from a take-off area (30) and separate at a separation point (26) along a first trajectory (24). The separation forces are generated by air retained between the upper and lower stages (14, 16), which is at a pressure higher than ambient pressure at the separation point (26). The lower stage (16) is then propelled along a return trajectory (28) to a landing area (30). After separation from the lower stage (16), the upper stage (14) continues to an Earth orbit (32) for deployment of a payload (71). After deploying the payload, the upper stage (14) moves out of the Earth orbit, re-enters the Earth's atmosphere, and returns to the take-off and landing area (30). The upper and lower stages (14, 16) are powered by liquid oxygen and kerosene engines (56, 152). The aerospace vehicle (10) is transported to a take-off area (20) by a transport vehicle (18) having a first fixed carriage (436) and a second translatable carriage (437)that is adapted to move the upper stage (14) relative to the lower stage (16) for assembly of the aerospace vehicle (10) while in the horizontal position. The transport vehicle then pivots the aerospace vehicle (10) from the horizontal to the vertical position for launching.



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INTERNATIONAL SEARCH REPORT

Internati. ..l Application No
PCT/US 97/06501

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B64G1/40 B64G1/62 B64G1/42 B64G1/64 B64G5/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B64G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	WO 96 04168 A (STIENNON, P.) 15 February 1996 see page 9, line 4 - page 13, line 5 see page 13, line 32 - page 23, line 13; figures 1-3 ---	1,2,5,7 4,6,8-21
Y	FR 2 073 449 A (DORNIER SYSTEM G.M.B.H.) 1 October 1971 see page 1, line 20 - page 2, line 7 see page 2, line 25 - page 4, line 3; figures 1-6 ---	1,2,5,7
A	US 4 796 839 A (DAVIS) 10 January 1989 see column 2, line 66 - column 4, line 30 see column 4, line 52 - column 9, line 46; figures 1-7 --- -/--	1

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

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Date of the actual completion of the international search	Date of mailing of the international search report
12 September 1997	23. 01. 98

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	RIVERO C.G.

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INTERNATIONAL SEARCH REPORT

Internat. .l Application No
PCT/US 97/06501

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A,P	PFEFFER H: "TOWARDS REUSABLE LAUNCHERS - A WIDENING PERSPECTIVE" ESA BULLETIN, no. 87, 1 August 1996, pages 58-65, XP000624079 see page 60, right-hand column, line 28 - page 62, right-hand column, line 3; figures 4-6 ---	1
A	BONO, P.: "THE REUSABLE BOOSTER PARADOX-AIRCRAFT TECHNOLOGY OR OPERATIONS?" SPACEFLIGHT, vol. 9, no. 11, November 1967, pages 379-387, XP002036154 see page 379, left-hand column, line 1 - page 382, right-hand column, line 18; figures 1-4 -----	1

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 97/06501

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-21

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

INVITATION TO PAY ADDITIONAL FEES

Internatio. . application No.
PCT/US 97/06501

1. Claims 1-21 directed to a reusable two-stage aerospace vehicle having a wingless upper stage and a wingless lower stage both having power plants activatable after separation to move the stages to a return trajectory towards take-off and lanfing area.
2. Claims 22-31 directed to a reusable two-stage aerospace vehicle having an upper stage and a lower stage, first stage activatable to move upper stage out of the orbit for re-entry, a separation sleeve attached to both stages.
3. Claims 32-34 directed to a reusable two-stage aerospace vehicle having a wingless upper stage and a wingless lower stage, and a single payload fairing actuating as a heat shield.
4. Claims 35-37 directed to a reusable two-stage aerospace vehicle having a wingless upper stage with a first parachute assembly, a wingless lower stage having a power plant activatable after separation to move the lower stage to a trajectory towards the take-off and landing area and a second parachute assembly.
5. Claim 38 directed to a reusable two-stage aerospace vehicle having an upper stage, a lower stage with a vehicle redirection parachute and a power plant activatable to move the lower stage from the separation portion to the return trajectory to the take-off and landing area.
6. Claim 39 directed to a reusable two-stage aerospace vehicle having a wingless upper stage, a first control computer assembly and a plurality of first sensors, a wingless lower stage having a second flight control computer and a plurality of second sensors.
7. Claims 40-42 directed to a reusable two-stage aerospace vehicle having a wingless upper stage with a first power plant, a fuel tank assembly, a landing system and a flight control computer, four microprocessors and multiple sensors attached to these components and a data bus for connection with the flight control computer, and a wingless lower stage with a second power plant, a fuel tank assembly and a landing system.
8. Claims 43-57 directed to a method of transporting a payload using a two-stage aerospace vehicle having a lower stage and an upper stage by deploying the payload to a selected Earth orbit after opening a payload fairing.
Both stages are recovered at take-off and landing area, but no reactivation of power plants for recovery is mentioned.
9. Claims 58-60 directed to a portable aerospace transport and launch vehicle for use in launch and assembly of a two-stage reusable wingless aerospace vehicle.

These nine groups of inventions are not so linked as to form a single general inventive concept.
The common technical features of the various inventions are all known from e.g. WO9604168 and FR2073449 cited in the present partial search report.
There exists consequently no technical relationship among the various inventions involving one or more of the same or corresponding technical features.

INTERNATIONAL SEARCH REPORT

Information on patent family members

Internat .l Application No
PCT/US 97/06501

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9604168 A	15-02-96	US 5568901 A	29-10-96
		EP 0773883 A	21-05-97
FR 2073449 A	01-10-71	DE 1960564 A	09-06-71
		GB 1301863 A	04-01-73
US 4796839 A	10-01-89	NONE	